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DEAR COLLEAGUES,

We sincerely wish the summer of 2016 brings peace, happiness and health to all my colleagues and their families. We are happy to accomplish the third issue of 2016.

There are 6 research articles in this issue. The first article is about the morphologic analysis of the nerve root tunnel of the sacrum. In the second article, radiologic outcomes have been evaluated with comparing sharp and round type of the kyphosis. The third study is about the school screening for the scoliosis. In the fourth study, epidemilogic analysis of anterior cervical disc herniation are presented. In the fifth study, evaluation of the patients treated with thoracic and lumbar instrumentation has done. The last article are about the TLICS classification of the thoracolumbar fractures. We believe that all those studies will quietly interest the readers.

In this issue, three case report were presented. One of them is from South Korea about the new fracture in the fused area without history of injury after removal of the pedicular screws. Second one is about the case with the multiple meningeal cysts. The last one is a case with the fibrous displasia.

In this issue, two review articles about the rehabilitation of the paraplegic patients and recent advances in the medical therapy of the osteoporosis were also presented.

In this issue, in the "Frontiers of the Spinal Surgery" section, the biography was presented about the Prof. Fahir ÖZER. The author of the this article is Dr. Onur Yaman.

The "Marmara Spinal Group Meetings", which includes İstanbul and neighboring cities and which is conducted to increase the interests of especially assistants and new specialist on spinal surgery and to contribute to their trainings and to transfer the experiences of experienced colleagues and will be organized each month regularly by the regulatory board, and which Assoc. Prof. Dr. Onat ÜZÜMCÜGİL will perform the headship this year just elected and Assoc. Prof. Dr. Halil BURÇ perform the secretariat just elected, you can find the other meeting contents from the announcements section.

We wish healthy, successful and peaceful days to Turkish Spinal Surgery family and we present our deepest respects.

Prof. Dr. İ. Teoman BENLİ
JTSS Editor

Volume: 27, Issue: 3, July 2016 pp: 125/130 ORIGINAL ARTICLE / ORJİNAL MAKALE

ANATOMY OF THE UPPER SACRAL AND THE SECOND SACRAL NERVE ROOT TUNNELS: A MORPHOLOGIC STUDY

ÜST SAKRAL VE İKİNCİ SAKRAL KÖK TÜNELLERİNİN ANATOMİSİ: MORFOLOJİK ÇALIŞMA

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SUMMARY:

Sacral anatomy is unique when compared to the other vertebral columns. The posterior structure of the sacrum is similar to the upper part of the spinal column but the fusion between these segments.

On the other hand, anterior anatomy of the sacrum contains a bony bridge between the transverse processes and the vertebral body. This bony bridge contains tunnels. Anterior foramen of the S1 and S2 nerve root leaves the spinal canal in this bony tunnel and reaches to abdominal cavity. In this study we define the coronal angle of these two S1 and S2 tunnels on CT scans of 76 patients.

Key words: Sacrum; anatomy; posterior pelvis; sacral nerve root

Level of Evidence: Retropective clinical study, Level III

ÖZET:

Sakrum anatomisi, diğer vertebral kolon ile kıyaslandığında benzersizdir. Genel olarak, sakrum posterior kemik yapıları, üst vertebral kolon anatomisi ile büyük benzerlik göstermektedir ancak aradaki tek fark bu anatomik yapılar arasındaki füzyondur.

Ancak; sakrumun anterior anatomisi vertebra korpuslarının sadece füzyonundan ibaret değildir. Anterior sakrumda vertebra gövdeleri arasında füzyona ek olarak vertebra korpusundan transvers çıkıntılara uzanan bir kemik blok vardır. Bu kemik bloğun içinden ilgili sinir kökünün anterior ramusu; adeta bir kemik tünel içerisinden anterior foramen aracılığı ile abdominal kaviteye açılmaktadır. Bu anatomiyi anlamanın ameliyat esnasında cerrahlara büyük kolaylık sağlayacağı muhakkaktır. Bu çalışmanın amacı: S1 ve S2 anterior ramuslarının geçtiği kemik tünellerin anatomisini tanımlamaktır. Bu amaçla 76 hastanın pelvis bilgisayarlı tomografileri değerlendirilmiş ve bu tünellerin koronal planda yaptıkları açılanmalar ölçülmüştür.

Anahtar Kelimeler: Sakrum; anatomi; posterior pelvis; sacral sinir kökleri

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey IV

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INTRODUCTION:

Anatomy of the sacrum is complex. In addition to the unusual bony architecture, many vital structures are located within millimeters of the safe bony corridor for implant placement[3,14]. Anterior foramen of the S1 nerve root (containing the anterior ramus) leaves the spinal canal in a bony tunnel and reaches to abdominal cavity. In the literature this tunnel is named as "upper sacral nerve root tunnel (USNRT)" by Farrell ED et al.[5]. In that article the course of the USNRT tunnel has been defined and studied by trauma surgeons for iliosacral screw placement. Farrell et al. defined the USNRT tunnel course on pelvic outlet views.

For pedicule screw or alar screw placement the course of this tunnel is also important. And during prone positioned spinal surgery, outlet view of the sacrum is not easy to achieve and hard to cooperate.

In the literature, there is no data for the course of USNRT on coronal plane during the prone positioned spinal surgery. The aim of this study is to anatomically define the coronal angle of USNRT from CT images.

The definition of the USNRT by trauma surgeons is only for S1 sacral nerve root. But for spinal surgery and sacral fracture surgery, additionally we need to define the S2 nerve root tunnel (S2NRT). To our knowledge; in the literature there is no definition for the S2NRT anatomy and this study defines the coronal course of this S2NRT.

MATERIALS AND METHODS:

Patients who had a pelvic CT in our hospital were retrospectively defined. The exclusion criteria's for the study group was; having anomaly or fracture of the sacrum, pelvis or lumber vertebral column.

Seventy six patients with pelvis CT selected for the study group. On these CT scans the coronal slices were detected for the USNRT and S2NRT measurements.

For USNRT coronal angle measurements; a midline was defined from the S1 vertebral corpus. Then a second line drawn from the midpoint of the proximal and distal part of the USNRT. The angles between these lines were calculated bilaterally **(Figure-1).**

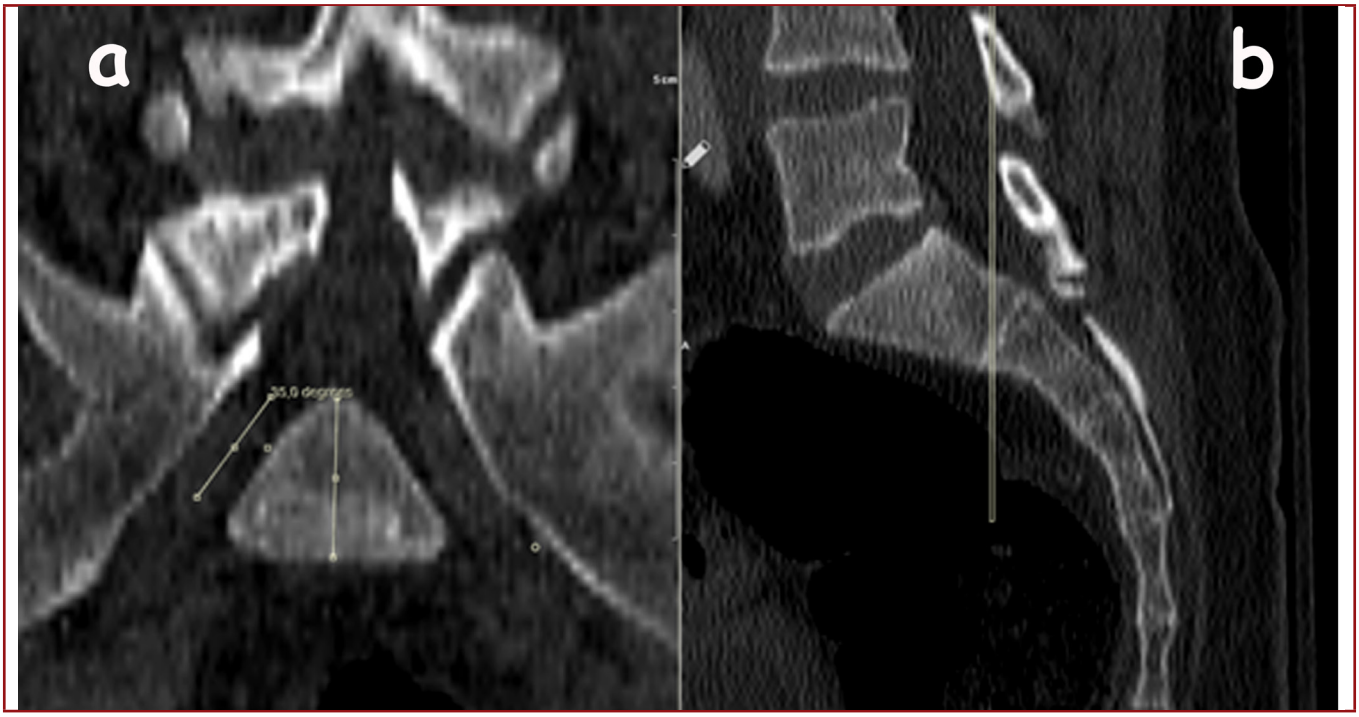

Figure-1. CT of the pelvis **a)** The coronal view of the USNRT. The tunnel course angle from the midline measured between vertebral corpus vertical line and the USNRT line. **b)** The sagittal CT section, showing the coronal view orientation which was used to measure the USNRT course angle.

For S2NRT coronal angle measurements; a midline was defined from S2 vertebral corpus. Then the second line defined from the midpoint of the proximal and distal of the S2NRT. The angles between these two lines were measured bilaterally **(Figure-2).**

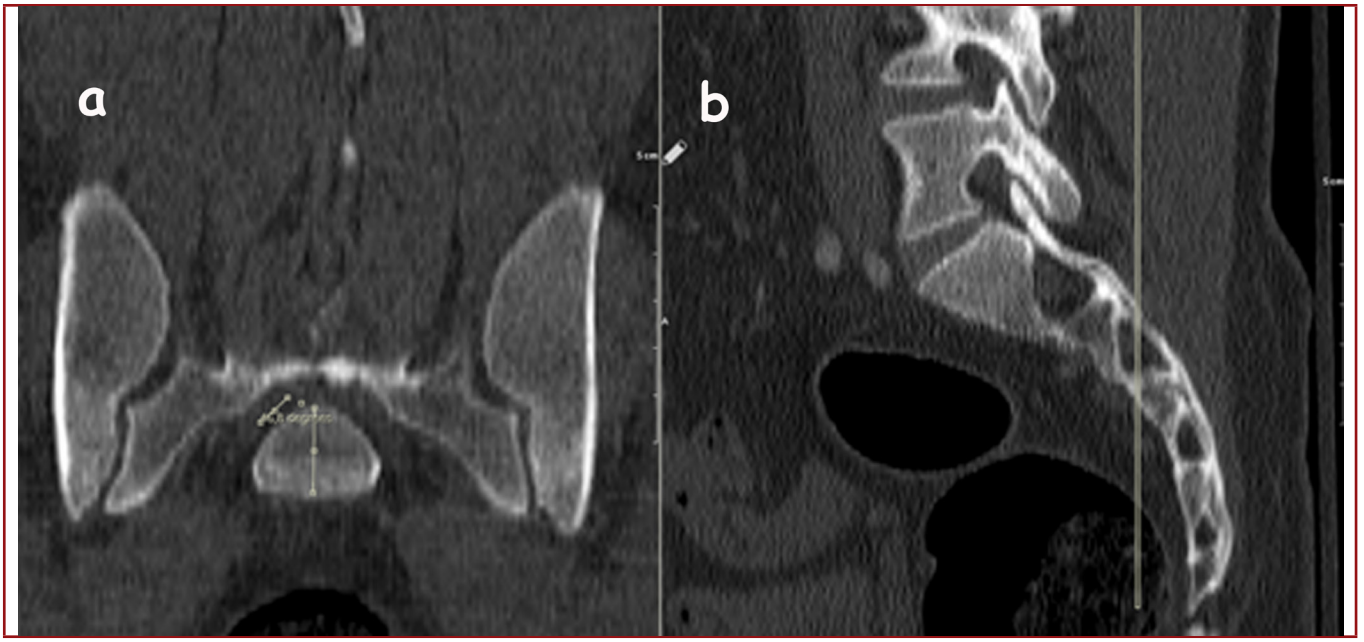

Figure-2. CT of the pelvis **a)** The coronal view of the S2NRT. The tunnel course angle from the midline measured between vertebral corpus vertical line and the S2NRT line. **b)** The sagittal CT section, showing the coronal view orientation which was used to measure the S2NRT course angle.

RESULTS:

The average age was 47 years (range, 5-85) and there were 31 male and 45 female patients.

The mean right side upper sacral nerve root tunnel (USNRT) coronal angle was 32° (range, 24°-45°) and mean left side USNRT angle was 32° (range, 18°-50°). The mean right side S2NRT coronal angle was 39° and the mean left side S2NRT angle was 39° (range, 21°-55°) **(Table-1).**

The mean right side USNRT coronal angle in male group was 32° (range, 24°-39°) and in the female group the mean right USNRT angle was 32° (range, 26°-45°). The left side USNRT angle in the male group was 31° (range, 23°-50°) and in the female group the mean left USNRT angle was 33° (range 18°-43°) **(Table-1).**

The mean right side S2NRT coronal angle in male group was 37° (range, 27°-52°) and in the female group the mean right S2NRT angle was 40° (range, 26°-49°). The left side S2NRT angle in the male group was 37° (range, 21°-55°) and in the female group the mean left S2NRT angle was 41° (range 22°-54°) **(Table-1).**

Table-1. Measured coronal angles of upper sacral nerve root tunnel (USNRT) and the S2 nerve root tunnel (S2NRT).

	USNRT		S2NRT	
	Right	Left	Right	Left
Male	32° (range, 24°-39°)	31° (range, 23°-50°)	37° (range, 27°-52°)	37° (range, 21°-55°)
Female	32° (range, 26°-45°)	33° (range, 18°-43°)	40° (range, 26°-49°)	41° (range 22°-54°)
Mean	32° (range,24°-45°)	32° (range, 18°-50°)	39° (range, 26°-52°)	39° (range, 21°-55°)

DISCUSSION:

Numerous authors have investigated the conditions of the posterior pelvis based on Xray images or CT scans[1-2,6,11-13,15]. In the literature; for iliosacral screw placement, USNRT and the angle of their course have been defined from outlet view of the sacrum. Ziran et al. define the osseous anatomy of the USNRTs as complex and is oblique in all 3 cardinal planes beginning within the midline sacral spinal canal. The tunnels then course laterally (approximately 60 degrees from the midline on the outlet view), anteriorly (approximately 20 degrees from the midline on the inlet view), and inferiorly on the lateral view[17].

Jackson et al. defined the USNRT exit point of the upper sacral neural foramen, which is a trumpet-shaped orifice in the anterior sacrum where the nerve root exits[7].

The radiographic image of the USNRT is best seen on the pelvic outlet image, and screw placement above the upper sacral neural foramen on this view is critical.[9] However, additional anatomic information is necessary and available on the outlet and other views that guide intraosseous screw placement[16]. Also, on the outlet view, the radiolucent spica cast appearance of the USNRT can and should be identified, and this is often a good starting point for visualizing the three dimensional structure of the nerve root tunnels. It is important to recognize that the more readily visualized foramina are only the exit points of the obliquely oriented tunnels. The two tunnels or spica cast thighs are formed by the radiodense medial and lateral corticated tunnel walls and the relative radiolucency of the interposed tunnel containing the nerve root. Ideally, an extreme outlet view would be used to position the fluoroscopic beam along the same axis as the USNRT to ensure that the screw is positioned anteriorly, but the sagittal plane obliquity is approximately 60 degrees, and it is rarely feasible to obtain this degree of outlet tilt in a surgical situation[17]. Although USNRT visualization on a standard outlet view is not as apparent as the upper sacral neural foramen, the USNRT spica cast was seen in all patients in this consecutive clinical series.

During posterior instrumentation; to be successful and safe, a thorough understanding of the complex bony and posterior pelvic fluoroscopic architecture is critical. In particular, the surgeon must have a clear sense of the spinal canal, the sacral ala, the vertebral cortical limits, and particularly the USNRT position and course[4,8,10.]

During sacral surgery with posterior approach, because of the fusion mass between the vertebra corpus and the posterior anatomic structures, the only reference point for the surgeon is the posterior foramens[4]. And the anterior foramens are not in the same horizontal plane of the posterior foramens due to sacral slope. In prone positioned patient, defining the USNRT course from outlet and inlet view of the pelvis is hard to achieve and cooperate. Because of poor anatomic landmarks, poor visualization and complex anatomy of the sacrum, spinal surgeon needs well defined USNRT course[10].

In our study, on coronal plane the mean USNRT angle from midline was 32 degrees (18° to 50°). This acute angle means a safe bony corridor just inferior and superior to the posterior foramens of the sacrum. With additional anatomic and morphologic studies, the definition of this bony corridor may cause new posterior S1 screw placement techniques.

In the literature the S2NRT course has never been defined. We think that; definition of S2NRT is critical for S2 posterior screw placement during posterior instrumentation of the spine or sacral fracture fixation. In our study the course of S2NRT course angle from the midline was 39 degrees. As in USNRT this acute angle of the S2NRT means a bone corridor to the S2 vertebrae corpus. With additional study to definition of this bony corridor; a screw placement technique which does not need to be lateral to the posterior foramens of the sacrum may be defined.

As a conclusion; for sacral screw placement with posterior approach, the definition of the USNRT and S2NRT course is critical. Surgeon must have a clear sense of these anatomic structures. We have demonstrated the USNRT and S2NRT location on coronal plane which means, a bony corridor just superior and inferior of the posterior foramens of the sacrum. We believe that with additional study, there would be a definition of a new posterior screw placement technique for the sacrum.

REFERENCES:

1. Carlson GD, Abitbol JJ, Anderson DR, Krag MH, Kostuik JP, Woo SL, Garfin SR. Screw fixation in the human sacrum. An in vitro study of the biomechanics of fixation. *Spine* 1992; 17: S196–203.
2. Day CS, Prayson MJ, Shuler TE, Towers J, Gruen GS. Transsacral versus modified pelvic landmarks for percutaneous iliosacral screw placement – a computed tomographic analysis and cadaveric study. *Am J Orthop* 2000; 29: 16–21.
3. Ebraheim NA, Lu J, Biyani A. Location of the first and second sacral nerve roots in relation to pedicle screw placement. *Am J Orthop* 2000; 29: 873–877.
4. Esses SI, Botsford DJ, Huler RJ, Rauschning W. Surgical anatomy of the sacrum. A guide for rational screw fixation. *Spine* 1991; 16(6 Suppl): S283-288.
5. Farrell ED, Gardner MJ, Krieg JC, Chip Routt ML Jr. The upper sacral nerve root tunnel: an anatomic and clinical study. *J Orthop Trauma* 2009; 23(5): 333-339.

6. Hasenboehler EA, Stahel PF, Williams A, Smith WR, Newman JT, Symonds DL, Morgan SJ. Prevalence of sacral dysmorphia in a prospective trauma population: implications for a safe surgical corridor for sacro-iliac screw placement. *Patient Saf Surg* 2011; 5: 8.

7. Jackson H, Burke JT. The sacral foramina. *Skeletal Radiol* 1984; 11: 282–288.

8. Licht NJ, Rowe DE, Ross LM. Pitfalls of pedicle screw fixation in the sacrum. A cadaver model. *Spine* 1992; 17(8): 892-896.

9. Mendel T, Noser H, Kuervers J, Goehre F, Hofmann GO, Radetzki F. The influence of sacral morphology on the existence of secure S1 and S2 transverse bone corridors for iliosacroiliac screw fixation. *Injury* 2013; 44(12): 1773-1779.

10. Mirkovic S, Abitbol JJ, Steinman J, Edwards CC, Schaffler M, Massie J, Garfin SR. Anatomic consideration for sacral screw placement. *Spine* 1991; 16(6 Suppl): S289-294.

11. Noojin FK, Malkani AL, Haikal L, Lundquist C, Voor MJ. Cross-sectional geometry of the sacral ala for safe insertion of iliosacral lag screws: a computed tomography model. *J Orthop Trauma* 2000; 14: 31–35.

12. Reilly MC, Bono CM, Litkouhi B, Sirkin M, Behrens FF. The effect of sacral fracture malreduction on the safe placement of iliosacral screws. *J Orthop Trauma* 2003; 17: 88–94.

13. Routt Jr ML, Simonian PT, Agnew SG, Mann FA. Radiographic recognition of the sacral alar slope for optimal placement of iliosacral screws: a cadaveric and clinical study. *J Orthop Trauma* 1996; 10: 171–177.

14. Templeman D, Schmidt A, Freese J, Weisman I. Proximity of iliosacral screws to neurovascular structures after internal fixation. *Clin Orthop Relat Res* 1996; 329: 194–198.

15. Tonetti J, Cloppet O, Clerc M, Pittet L, Troccaz J, Merloz P, Chirossel J. Implantation of iliosacral screws. Simulation of optimal placement by 3-dimensional X-ray computed tomography. *Rev Chir Orthop Reparatrice Appar Mot* 2000; 86: 360–369.

16. Xu R, Ebraheim NA, Robke J, Huntoon M, Yeasting RA. Radiologic and anatomic evaluation of the anterior sacral foramens and nerve grooves. *Spine* 1996; 21: 407–410.

17. Ziran BH, Wasan AD, Marks DM, Olson SA, Chapman MW. Fluoroscopic imaging guides of the posterior pelvis pertaining to iliosacral screw placement. *J Trauma* 2007; 62: 347–356.

Volume: 27, Issue: 3, July 2016 pp: 131/134 ORIGINAL ARTICLE / ORJİNAL MAKALE

COMPARING RADIOLOGICAL OUTCOMES OF SHARP AND ROUND KYPHOSIS PATIENTS

KESKİN VE YUVARLAK KİFOZLU HASTALARIN RADYOLOJİK SONUÇLARININ KARŞILAŞTIRILMASI

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SUMMARY:

Study Design: Retrospective, radiological and clinical analysis of patients with sharp and round thoracic and thoracolumbar kyphosis.

Methods: Whole spine anteroposterior and lateral radiographs of patients with thoracic and thoracolumbar sharp and round kyphosis were obtained before surgery and at the final follow-up. The pelvic and spinal parameters were measured.

Results: 40 patients with kyphosis were included. Mean age was 19.6 and mean follow up period was 26.4 months. Patients divided into two groups as: 20 patients with sharp kyphosis (mean age: 20.1) and 20 with round kyphosis (mean age: 19.6). There was not significant difference for patient age, follow up period and risser scores between two groups. ($p > 0,05$)

Conclusion: In patients with increased thoracal kyphosis with changed pelvic parameters, surgical correction and instrumentation must include both thoracal and lumbar spine

Key words: kyphosis, spinopelvic sagittal alignment, schuermann kyphosis

Level of evidence: Retrospective clinical study, Level III

ÖZET

Çalışma *dizaynı:* Retrospektif, yuvarlak ve keskin açılı torakolomber kifoz hastalarının radyolojik ve klinik analizi

Metod: Tüm spinal AP ve lateral grafiler preoperatif ve son kontrolde alındı. Pelvik ve spinal parametreler ölçüldü.

Bulgular: 40 kifoz hastası çalışmaya dahil edildi. Ortalama yaş 19.6, ortalama takip süresi 26.4 aydı. Hastalar iki gruba ayrıldı: 20 keskin açılı kifoz (ortalama yaş 20.1) ve 20 yuvarlak açılı kifoz(ortalama yaş 19.6). Hasta yaşı, takip süresi ve risser skorları için iki grup arasında belirgin fark yoktu. ($p > 0,05$)

Sonuçlar: Artmış torakal kifoz ve değişen pelvik parametrelere sahip hastalarda, cerrahi düzeltme ve enstrumantasyon torakal ve lomber omurgayı içermelidir.

Anahtar kelimeler: Kifoz, spinopelvik sagittal dizilim, Scheuermann kifozu

Kanıt düzeyi: Retrospektif klinik çalışma, Düzey 3

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INTRODUCTION:

Spine has physiologic kyphosis and lordosis angles as balancing each other. These angles varies in each person[7]. Pelvic parameters identify sagittal pelvic morphology[1,3]. These parameters change in growing period and finally become fixed in adults. In the current literature there are some clinical studies addressing clinical importance of pelvic parameters. Results are negatively affected when these parameters are not considered in correcting spinal deformities[7].

The aim of this study was presenting effects of upper spinal sagittal deformities on pelvic parameters and lumbar lordosis.

PATIENTS AND METHODS:

There were 72 patients evaluated in our hospital for kyphosis and had surgical treatment for kyphosis between October 2009 and March 2011.

40 patients (mean age 19.6 years, mean follow up 26.4 months) fulfilled the inclusion criteria of the present study retrospectively. All included patients had undergone posterior instrumentation with pedicle screws and fusion.

Patients with a history of multiple operations, mental disorder, scoliosis greater than 15 degrees excluded from the study.

After the patients and/or parents provided written informed consent, patients were scheduled for surgical correction of spinal deformities.

Patients were divided into two groups as: Group 1 with sharp angled kyphosis patients (20 patients, mean age 20.1, 7 men and 13 women) and Group 2 with round angled Scheuermann kyphosis patients (20 patients, mean age 19.6, 14 men and 6 women). There was not significant difference for patient age, follow up period and risser scores between two groups. ($p > 0,05$) But, we found female predominance in the sharp kyphosis group and male predominance in the Scheuermann kyphosis group. It was statistically significant (Table-1).

Radiographic measurements and evaluation:

All participants had pure kyphosis on the postero-anterior and lateral radiographs. The cervical lordosis, thoracic kyphosis, lumbar lordosis, scoliosis angles (Cobb method), pelvic tilt, sacral slope, pelvic incidence, coronal balance and sagittal balance were determined on pre- and postoperative radiographs. For the coronal plane balance measurement, the difference between the central sacral vertical line and the line passing through the center of C7 was measured. In the sagittal plane, the difference between the line passing through the center of C7 body and posterior superior angle of the sacrum was measured. Pre- and post-operative x-rays were shown to all patients and informed about the correction amount and cobb angles that achieved with the surgery.

Statistical analysis:

The data were analyzed with statistical software (IBM SPSS Statistics for Windows, Version 22.0, IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean, median, standard deviation (SD) and percentiles for continuous variables, and as number and percentages for categorical variables. Mann Whitney U test was used for comparing continuous variables for two groups when data did not follow a normal distribution. Wilcoxon test was used for non-parametric data comparing two related samples or repeated measurements. Categorical variables were analyzed through the Chi-square and Fisher's exact tests. Statistical significance was established if $p \leq 0.05$.

RESULTS:

All patients had surgical correction with posterior instrumentation with polyaxial pedicle screws and fusion surgery.

In group sharp C2-7 servical lordosis was preop 15.8 and postop 21.1 that there was significantly difference between. In group round C2-7 servical lordosis was preop 20.6 and postop 27.5 that there was significantly difference between too.

Table 1. Patient demographics and followup period

		Group-Sharp			Group-Round			p
		Mean±s.d./n-%	Median	Min-Max	Mean±s.d./n-%	Median	Min-Max	
Age (y)		20,1 ± 7,9	18	8 - 38	19,6 ± 3,9	19	14 - 27	0,703
Sex	Male	6 27,8%			14 70,0%			***0,009***
	Female	14 72,2%			6 30,0%			
Follow-up (mo)		27,6 ± 17,8	24	12 - 84	26,5 ± 8,6	27	6 - 37	0,660
Risser sign		4,1 ± 1,5	5	1 - 5	4,8 ± 0,7	5	2 - 5	0,085

Chi-square test / Independent samples t test

Thoracal kyphosis was evaluated as T2-5, T5-12, T10-L2 locally and T1-12 globally. Pre and postop sagittal parameters of group sharps' values can be seen on Table-2, there was significant difference at only the T10-L2 local kyphosis measure. Pre and postop sagittal parameters of group rounds' can be seen on Table-3, there were significant difference between pre and postop op measurements of T2-5, T5-12 locally and T1-12 globally. There was significant difference at lumbar lordosis of group sharps' but not at group round. There was not any significant difference between pre and postop measurements of Sacral Slope, Pelvic Incidence and Pelvic Tilt in both groups (Table-2,3).

Table 2. Pre and postop sagittal parameters of group sharps' values

Group-Sharp	Pre-Op								Post-Op							p
	Mean±s.d.			Med.	Min-Max				Mean±s.d.			Med.	Min-Max			
Cor, Balance (cm)	-0,8	±	2,8	-0,5	-6,5	-	5,0		-1,4	±	2,4	0,0	-9,0	-	1,3	0,433
CL (C2-C7)	15,8	±	14,0	11	0	-	47		21,1	±	17,9	15,5	3,0	-	74,0	***0,031***
TK (T1-T12)	45,2	±	31,8	42	2	-	123		40,9	±	20,4	36,5	9,0	-	88,0	0,552
T2-T5	10,5	±	12,0	6	1	-	45		14,7	±	14,0	10,0	1,0	-	56,0	0,185
T5-T12	32,6	±	29,8	25	2	-	91		29,8	±	16,1	27,0	11,0	-	68,0	0,983
T10-L2	45,2	±	34,0	45	2	-	135		15,9	±	16,7	10,5	1,0	-	69,0	***0,001***
LL (L1-S1)	44,7	±	17,5	42	10	-	76		41,2	±	11,8	40,5	8,0	-	68,0	0,601
Pelvic Tilt	13,3	±	7,6	13	3	-	30		11,9	±	9,4	10,5	2,0	-	39,0	0,334
Sacral Slope	30,1	±	13,0	29	3	-	55		32,3	±	10,1	34,0	1,0	-	46,0	0,492
Pelvic incidence	50,0	±	14,8	49	29	-	90		45,7	±	10,0	46,0	27,0	-	70,0	0,177
Sg,Balance(cm)	-3,3	±	6,1	-3,0	-22	-	3,4		0,1	±	3,6	1,2	-5,8	-	5,3	0,051

Wilcoxon test

Table 3. Pre and postop sagittal parameters of group rounds' values

Group-Round	Pre-Op								Post-Op							p
	Mean±s.d.			Med.	Min-Max				Mean±s.d.			Med.	Min-Max			
Cor, Balance (CM)	-0,7	±	1,9	0,0	-4,3	-	4,3		0,3	±	2,9	0,0	-3,7	-	10,8	0,053
CL (C2-C7)	20,6	±	13,1	20	2	-	45		27,5	±	15,4	29,0	1,0	-	60,0	***0,046***
TK (T1-T12)	72,9	±	13,1	68	53	-	102		51,7	±	11,5	51,0	28,0	-	73,0	***0,000***
T2-T5	14,9	±	9,4	13	1	-	39		28,7	±	10,7	29,5	11,0	-	46,0	***0,001***
T5-T12	59,3	±	16,1	57	35	-	89		26,0	±	11,7	24,5	7,0	-	56,0	***0,000***
T10-L2	14,7	±	10,8	14	2	-	37		10,7	±	6,4	9,5	1,0	-	26,0	0,155
LL (L1-S1)	57,0	±	15,0	55	29	-	85		43,6	±	13,7	44,0	15,0	-	64,0	***0,001***
Pelvic Tilt	9,7	±	7,1	8	2	-	25		12,4	±	7,5	12,0	2,0	-	32,0	0,126
Sacral Slope	36,9	±	12,1	35	19	-	62		35,1	±	10,1	35,5	20,0	-	53,0	0,313
Pelvic incidence	47,8	±	12,0	47	28	-	72		48,0	±	12,5	46,0	31,0	-	74,0	0,609
Sg,Balance(cm)	2,3	±	5,0	2,8	-8	-	9,0		1,9	±	4,0	1,0	-4,4	-	9,8	0,687

Wilcoxon test

DISCUSSION:

Kyphosis deformity is defined as convexity, which is increased angulation of spine in the sagittal plane. Scoliosis Research Society identifies thoracal kyphosis upper limit of 45 degrees[6]. In the Scheuermann kyphosis, 3 or more spinal segments are affected. In each segment, there are more than 5 degrees of local kyphosis due to endplate irregularities[3,8]. Sharp angled kyphosis is a serious form of kyphosis due to congenital, traumatic or infectious etiology. Three or less spinal segments are affected[3,8].

Radiologic degree of the deformity, clinical and cosmetic complaints and patient age must be considered before surgical correction is determined. Goals of the treatment are restoration of sagittal alignment, cosmetic satisfaction and decompression of neural elements if compressed[5,9]

Increased kyphosis is balanced with increased lordosis[5]. In our study, lumbar lordosis was decreased in both groups but this decrease was statistically significant in round kyphosis group not in sharp kyphosis group.

In the Scheuermann kyphosis group, T1-12 kyphosis angle was decreased postoperatively but there was significant increase in T2-5 kyphosis postoperatively ($p<0.005$).

In the sharp kyphosis group, T1-12 kyphosis angle was decreased postoperatively. T2-5 kyphosis angle increased postoperatively. But this increase was not statistically significant. These are associated with compensation from upper mobile segments. Also, these changes were correlated with more mobile segments available except deformity in the sharp kyphosis group and less mobile segments available except deformity in the round kyphosis group.

In this study we found only statistically significant difference in cervical lordosis (T10-L2) and lower thoracal kyphosis between pre and postoperative periods. We concluded this was associated with T10-L2 location of the deformity apex in the sharp kyphosis patients.

However, there was significant difference for all measured parameters (cervical lordosis, thoracal kyphosis and lumbar lordosis) between pre and postoperative periods except lower lumbar kyphosis.

In group 1 and 2, we identified increased mean cervical lordosis. This increase was statistically significant in both groups ($p<0.005$).

In the literature, pelvic parameters were not associated with kyphosis. Pelvic incidence was associated with lumbar lordosis[3-4]. In our patient cohort, there was not significant difference between pre and postoperative pelvic parameters. With these results we conclude that sagittal correction of thoracal kyphosis, either round or sharp kyphosis, does not affect pelvic parameters.

In patients with increased thoracal kyphosis with changed pelvic parameters, surgical correction and instrumentation must include both thoracal and lumbar spinal segments.

REFERENCES:

1. Albayrak A, Atici Y, Balioğlu MB, Kargin D, Ermiş MN, Akpinar E, Büyük AF. Decision making on sagittal imbalance correction with computer assistance. *J Turk Spinal Surg* 2014: 97–104.
2. Jiang L, Qiu Y, Xu L. Sagittal spinopelvic alignment in adolescents associated with Scheuermann ' s kyphosis : a comparison with normal population. *Eur Spine J* 2014: 1420–1426.
3. Li W, Sun Z, Guo Z, Qi Q, Kim S Do, Zeng Y, et al. Analysis of spinopelvic sagittal alignment in patients with thoracic and thoracolumbar angular kyphosis. *Spine* 2013; 38: E813–818.
4. Lonner BS, Newton P, Betz R, Scharf C, O'Brien M, Sponseller P, Lenke L, Crawford A, Lowe T, Letko L, Harms J, Shufflebarger H, MD. Operative management of Scheuermann' s kyphosis in 78 patients radiographic outcomes, complications, and technique. *Spine* 2007; 32(24): 2644–2652.
5. Macagno AE, O'Brien MF. Thoracic and thoracolumbar kyphosis in adults. *Spine* 2006; 31: S161–170.
6. Miladi L. Round and angular kyphosis in paediatric patients. *Orthop Traumatol Surg Res* 2013; 99: S140–149.
7. Roussouly P, Nnadi C. Sagittal plane deformity : an overview of interpretation and management. *Eur Spine J* 2010; 19(11): 1824–1836.
8. Şar C, Eralp L. Three-stage surgery in the management of severe rigid angular kyphosis. *Eur Spine J* 2002; 11(2): 107–114.
9. Wang Y, Lenke LG. Vertebral column decancellation for the management of sharp angular spinal deformity. *Eur Spine J* 2011; 20: 1703–1710.

Volume: 27, Issue: 3, July 2016 pp: 135/142 ORIGINAL ARTICLE / ORJİNAL MAKALE

SCHOOL SCREENING OF ADOLECENT IDIOPATHIC SCOLIOSIS IN 7928 TURKISH CHILDREN

7928 TÜRK ÇOCUĞUNDA ADOLESAN İDİOPATİK SKOLYOZ OKUL TARAMASI

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SUMMARY:

The aim of the present study was to identify the prevalence of adolescent idiopathic scoliosis in Kartal, which was a sub-province of Istanbul that could represent the overall demographic structure of Turkey that did not have a comprehensive scoliosis-screening program. The study included 60 schools with a mean age of 13. The scoliosis screening covered 7928 students. Screening was done based on the Adam's forward bending test, measurements by a scoliometer, shoulder pelvic obliquity, height and weight as well as arm, leg and body length measurements. 451 of the students were diagnosed with scoliosis (5.68%). The prevalence rate for patients with a 7 to 16 degree-curve was 0.0156%, while the prevalence rate for patients with a curve higher than 10 degrees was found as 0.0065%. 88.4% of the scoliotic patients were girls. In 76% of the scoliotic students vertebral imbalance was on the left side. This study will shed light on the future studies, since it is the first comprehensive scoliosis screening conducted in the Republic of Turkey to cover all schools in the selected district.

Key words: scoliosis, epidemiolgy, school screening.

Level of evidence: epidemioiogic study, Level III.

ÖZET:

Bu çalışmanın amacı Türkiye'nin demografik yapısını temsil edebilecek İstanbul'un Kartal İlçesinde adolesan idiopatik skolyozun prevelansını belirlemektir. Bu çalışmaya 60 okul dahil edildi. Yaş ortalaması 13 olan 7928 çalışmaya dahil edildi. Çalışmada Adam'ın öne eğilme testi, skolyometre ile ölçüm, omuz-pelvis eğikliği, ağırlık, boy dışında kol- bacak ve gövde uzunluğuna da bakıldı. 451 öğrenciye skolyoz tanısı konuldu (%5.68). 7 ile 16 derece arasında eğriliği olanların prevalansı %0.0156, 10 dereceden fazla ğeriliği olanların prevelansı ise %0.0065 olarak belirlendi. Skolyozu olan hastaların %88.4'ü kızdı. Skolyozu olan öğrencilerin %76'sının gövde imbalansı sola doğruydu. Bu çalışma Türkiye Cumhuriyeti'nde ilk kez yapılan okul skolyoz taraması olması nedeni ile gelecekte yapılacak çalışmalara ışık tutacaktır.

Anahtar Kelimeler: Skolyoz, epidemiyoloji, okul taraması

Kanıt Düzeyi: Epidemiyolojik çalışma, Düzey III.

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INTRODUCTION:

The incidence rate of Adolescent Idiopathic Scoliosis (AIS) varies around 0,5 to 3% 18. The incidence rate of curves equal to or greater than 10 degrees varies between 1 to 3%, whereas the incidence rate of curves equal to or greater than 30 degrees, which require treatment, is as low as 0.15 to 0.3%. The ratio of women to men is 1.4/1 for degrees equal to or greater than 10 degrees, while the ratio of women to men increases up to 5/1 in curves equal to or greater than 30 degrees[17]. An asymmetrical body interferes with the shoulder and arm asymmetry[5].

The scoliosis screening revealed some valuable information concerning the prevalence, natural course and aetiology of scoliosis. School screening programmes are useful for the early diagnosis of AIS and collection of data on the aetiology. Use of braces after early diagnosis was reported to provide effective results[5,21].

The optimum age range for the scoliosis screening programme is still controversial. The screening programmes are usually practiced at 10 to 14 years of age[26]. The Adam forward bending test and scoliometer measurements are the easy, fast, effective and cheapest methods for detecting the curve 15.

This study aims at investigating the incidence rate of scoliosis among the 13-year-old junior high school students. This is the first comprehensive scoliosis screening study to cover all schools in the selected district within the Republic of Turkey.

MATERIAL – METHOD:

The study design:

Before the study was initiated, necessary approvals and permits were obtained from the Governorate of Istanbul and Provincial Directorate of National Education. Once the schools to be screened were identified, they were visited and the officials of the schools were informed about the screening to be performed.

For a standard assessment, the study staff 103 was trained about how to perform the scoliosis screening. The physicians performed the scoliometry and the Adam's forward bend test while the assisting medical staff performed the anthropometric measurements. The idiopathic scoliosis screening was applied on 7928 students at the age of 13, attending junior high schools in the Kartal district of Istanbul. The measurements were made by a team comprising of 4 neurosurgeons, 1 orthopaedic surgeon, 4 public health specialists and 6 health-care officers.

Sampling in the scoliosis screening target population the number of girls was comparable to the number of boys. The screening was administered by the specialist doctors and health-care officers. The observers received one-day training on AIS. They were informed about the Adam forward bending test and scoliometric measurement. Information was given about how to measure the shoulder and pelvic obliquity along with the height, weight and arm, leg and body lengths.

The Measurements:

Posterior views of the back, Adam forward bending test and scoliometric measurements (OSI119 scoliometer Orthopaedic Systems Inc, Hayward, California, USA) were used under the student screening programme[29]. Furthermore, all students were measured for their arm, leg and body lengths. They were checked for their height and weight, and body mass indices were calculated.

To investigate the presence of congenital scoliosis, all students were checked for hirsutism in the midline, and for nevus and cafe-au-lait spots, as these are the findings of closing problems at the midline. To investigate any hereditary deformities, all students were checked for family histories of claudication or hunchback.

Diagnosis criteria and treatment Students with Cobb angle > 10° were diagnosed with AIS according to the Scoliosis Research Society diagnosis criteria 26. Patients with a curve of 10 to 20 degrees were planned for follow-up with new plain radiographs 6 months later, whereas patients with Cobb angle > 20 degrees were sent for a new X-Ray to determine the Risser Sign.

Statistical Analysis:

The results were statistically compared. The gender distribution was comparable within the target student population. Numerical data were analyzed using a t-test, while categorical data were analyzed by using a chi-square test.

RESULTS:

The 7928 students screened for scoliosis had a comparable gender distribution. Within the target population, there were 3854 (48.55 %) girls and 4084 (51.45 %) boys. As a result of the screening 451 students were diagnosed with scoliosis (5.7 %). Among the scoliotic student population, there were 399 girls (88.4 %), and 52 boys (11.6 %). A comparison of the gender within the scoliotic student population revealed that scoliosis was more common among girls, and the difference was statistically significant (p<0,001) (Table-1).

87 of the scoliotic students had kin marriage in their parents, whereas 364 did not have the kin marriage history. There was no statistically significant link between kin marriage and the incidence of scoliosis (P=0,113) (Table-2).

A comparison of the scoliotic and non-scoliotic students with family histories of claudication and hunchback did not reveal any significant differences. These values were found as p=0,628 and p=0,835, respectively (Table-3,4).

Table-1. Distrubiton of scoliosis according to gender.

			Scoliosis		Total
			-	+	
Gender	Boy	Number	4027	52	4079
		% within gender	98,7%	1,3%	100,0%
	Girl	Number	3450	399	3849
		% within gender	89,6%	10,4%	100,0%
Total		Number	7477	451	7928
		% within gender	94,3%	5,7%	100,0%

Table-2. Scoliosis and the relationship between kin marriage

			Scoliosis		Total
			-	+	
Kin Marriage	yes	Number	1227	87	1314
		% within KM	93,4%	6,6%	100,0%
	no	Number	6241	364	6605
		% within KM	94,5%	5,5%	100,0%
Total		Number	7468	451	7919
		% within KM	94,3%	5,7%	100,0%

Table-3. Scoliosis and the relationship between family history of huncback

		Scoliosis		Total
		-	+	
FH of huncback	Number	77	3	80
	% within FHH	96,3%	3,8%	100,0%
	Number	7400	448	7848
	% within FHH	94,3%	5,7%	100,0%
Total	Number	7477	451	7928
	% within FHH	94,3%	5,7%	100,0%

Table-4. Scoliosis and the relationship between family history of claudication

		Scoliosis		Total
		-	+	
FH of claudication	Number	139	9	148
	% within FHC	93,9%	6,1%	100,0%
	Number	7340	442	7782
	% within FHC	94,3%	5,7%	100,0%
Total	Number	7479	451	7930
	% within FHC	94,3%	5,7%	100,0%

The physical examination with inspection revealed that the nevus and cafe-au-lait spots, all of which had hair formation in the 451 scoliotic students, were statistically insignificant (Table-5).

449 students with scoliosis had spinal imbalance, while only two of them did not suffer from the spinal imbalance. 347 (76 % of the scoliotic students) students had the spinal imbalance on the right side, while 102 students (22.3 % of the scoliotic students) had it on the left side. The difference between the non-scoliotic population with spinal imbalance and the scoliotic population with spinal imbalance was found statistically significant (p <0,001).

73 (16 %) scoliotic students had right shoulder imbalance, while 349 (77 %) scoliotic patients had left shoulder imbalance (Table-6).

The difference between the non-scoliotic population with shoulder imbalance and the scoliotic population with shoulder imbalance was found statistically significant (p <0,001).

The average body length was 97,89 cm in the scoliotic population, while it was 97,17 cm for the non-scoliotic population. The difference between these two groups was not found statistically significant (p= 0,159).

The average arm length was 152,64 cm in scoliotic population, while the average length for the right leg was 95,66 cm and it was 95,86 cm for the left leg. The non-scoliotic population had an average arm length of 152,28 cm, and an average right leg length of 95,74 cm and a left leg length of 96,68 cm. These values did not reveal any significant differences between the two groups (p values were p= 0,713, p=0,901 and p=0,869, respectively)

The Body Mass Index (BMI) was 20,08 in the 171 scoliotic population, while it was 20,24 in the non-scoliotic population. The two groups did not display a statistically significant difference (Table 7).

Table-5. Scoliosis and the relationship between physical examination

		Scoliosis		Total
		-	+	
	Number	7454	451	7905
	% within PE	94,3%	5,7%	100,0%
	Number	4	0	4
	% within PE	100,0%	,0%	100,0%
	Number	18	0	18
	% within PE	100,0%	,0%	100,0%
Total	Number	7476	451	7927
	% within PE	94,3%	5,7%	100,0%

Table-6. Scoliosis and the relationship between shoulder imbalance

			Scoliosis		Total
			-	+	
Shoulder imbalance	-	Number	1648	2	1650
		% within SI	99,9%	,1%	100,0%
	Right	Number	258	346	604
		% within SI	42,7%	57,3%	100,0%
	Left	Number	95	101	196
		% within SI	48,5%	51,5%	100,0%
Total		Number	2001	449	2450
		% within SI	81,7%	18,3%	100,0%

Table-7. Average of body, arm, right and left leg lenghts and BMI of the screening students.

	Scoliosis		N	Mean
Body Length	dimension1	-	7477	97,1736
		+	451	97,8914
Arm length	dimension1	-	7473	153,2834
		+	451	152,6475
Right Leg Length	dimension1	-	7474	95,7410
		+	450	95,6689
Left Leg Length	dimension1	-	7475	95,6800
		+	451	95,8647
BMI	dimension1	-	7470	20,2437
		+	451	20,0809

DISCUSSION:

The incidence rate of AIS was reported to vary between 1 to 13 %[3,6]. An incidence rate of 0.5 to 3 % is usually reported for the population of school students. The prevalence rates of scoliosis at school screening vary from country to country (Table-8).

The mean prevalence rate in Singapoure at school screening was found to be 0,59 %[31] while it was reported to be 1,47 % in Taipei (Taiwan)[15]. On the other hand, the study on the prevalence of scoliosis in Helsinki (Finland) revealed a very high prevalence rate, which was found to be 12,0 %[23]. Similarly, the prevalence rate was reported to be 6,40 % in Dublin (Ireland)[9-10], 2,03 % in Wisconsin (USA)[11], 3,21 % in Malmo (Sweden)[30], and 2,20 % in Montreal (Canada)[25].

It is underlined that the high prevalence of AIS at northern latitudes beyond 30 degrees might be associated with delayed menarche[12]. Our screening led to a scoliosis incidence rate of 1,5. The prevalence of scoliosis greater than 10 degrees was found to be 0,65 %. There are also other studies conducted in our country in which scoliosis screening has been performed (Table-9)[1,8,16,27,32].

Table-8. Scoliosis prevalence studies

Author	No of Cases	City and Country	Prevalence (%)	Age
Wong HK et al.	72,699	Singapoure	0,59	6-14
Huang SC et al.	33,596	Taipei (Taiwan)	1,47	10-12
Gore DR et al.	8,393	Wisconsin (USA)	2,03	5-10
Rogala EJ et al.	26,947	Montreal (Canada)	2,20	12-14
Willner S et al.	17,181	Malmo (Sweden)	3,21	7-16
Goldberg C et al.	604	Dublin (Ireland)	6,40	10-14
Nissinen M et al.	1,060	Helsinki (Finland)	12,0	10-14

Table-9. Scoliosis screening in Turkey

Author	Place	Year	Method	Number	Prevelans
Adak B et al.	Van	1998	Adams	11983	%0,61
Cilli K et al.	Sivas	2006-2007	Adams ,SP	3175	%0.47
Ugraş A et al.	İstanbul/Fatih	2008-2009	Adams	4259	%0,25
İbişoğlu Y.U. et al	İzmir/Bornova	2008-2009	Adams	8207	%0,48
Yılmaz H et al.	Çanakkale	2010-2011	Adams, SP,S	2604	%0,31

Adams :The forward bending test SP: Spine palpation S: Scoliometer

In a study conducted by Cilli et al[8] 3175 students from 6-8th grades, selected by systematic sampling method from 11 primary schools, were applied Adam's forward bend test along with vertebral palpation and the prevalence was found as 0.47 %. In another school screening study in which Adam's test and vertebral palpation are used, conducted on 8207 students from 57 primary schools by İbişoğlu et al[16]. the prevalence was reported as 0.48 %. A third school screening program was carried out by Yilmaz H. et al. in Çanakkale Turkey by the use of scoliometer and posture analysis. Of 2604 school children between 7-14 years of age from 12 schools, they reported AIS prevalence as 0,31 %[32]. In a different study performed by applying Adam's test in Van, scoliosis prevalence was found as 0,61 % in 11983 students from 10 primary schools[1].

Finally, in a study conducted in Istanbul region, 4259 children from six schools which were randomly selected out of 41 schools were screened by performing physical examination and forward bending test, the prevalence was reported as 0,25 %[27]. Cluster sampling method was used in these limited number of studies that were mainly conducted at local level. In the majority of these studies Adam's forward bend test was performed, whereas in only one study the scoliometer was used. In our study, we screened all 7th grade students at public and private primary schools.

The students in Kartal sub-province of Istanbul represent a diverse demographic structure; therefore, the prevalence in this group can reflect the overall situation of the entire country. Anthropometric measurements were also performed in addition to the Adam's forward bend test and scoliometer. This study conducted in 2007-2008 was the first and the most comprehensive scoliosis screening in Turkey that included all the schools in the sub-province.

The effectiveness of scoliosis screening programmes is still controversial. Some controversial issues include no symptoms observed in majority of the scoliotic cases detected by the screening, high rate of false positive results and measurement variations introduced by different factors[24] Improvement of scoliosis screening programmes will be useful for reducing the amount of false positive results.

The Scoliosis Research Society, American Academy of Orthopaedic Surgeons, the Paediatric Orthopaedic Society of North America, and the American Academy of Paediatrics suggest scoliosis screening, whereas the Canadian Task Force on the Periodic Health examination, the British Orthopaedic Association, and the British Scoliosis Society do not suggest scoliosis screening[24].

The optimum age range for the screening is also controversial 6 School screening programmes are usually run for ages of 10 to 14. Screening must be carried out for the girls during the early years of menstruation, while the boys must follow the girls with one or two years of delay. Adam's forward bending test is the most common and also an easy, fast and cheap method for scoliosis screening. The FBT (Forward bending test) requires the patient to bring both hands together and try to touch his feet by bending forward with straight knees. In the meantime, the observer stands behind the patient and checks for rip hump formation. If there is a rip hump test is positive (+)[29].

The device called the scoliometer was developed to determine the degree of body rotation angle in FBT (+) patients. While the patient is bent forward for scoliometric measurement, the scoliometer is positioned to the apex of the curve and parallel to the ground plane for determining the body rotation angle[5].

The most common method employed in scoliosis screening is the Adam's forward bend test. Although it is a rapid and easy-to-use method, there are debates about its sensitivity and specificity. It was reported in a school screening for scoliosis in Singapore that the Adam's forward bend test might result in 25 % to 82 % of false positivity depending on the screening method and criteria[31]. Goldberg et al[9-10]. argued that this test was very sensitive and its specificity was 0.99 , while Grosman et al[13] stated that the sensitivity varied between the researchers. However, Howell et al[14] reported that the margin of error was 26 % when the nurses performed the screening while it was found to be 13 % when it was performed

by physiotherapists. In another study, 181 patients were referred to the radiology department following the screening performed by an orthopedist experienced in scoliosis, and only 4 of these patients had false positive test results; whereas this rate was reported to be much higher when the school doctor performed the screening[19]. The specificity of the Adam's test was reported to rise from 56 % to % 86 when combined with the scoliometric measurements[4]. It was aimed to minimize the margin of error in our study through the performance of the Adam's forward bend test and the scoliometry by the physicians.

Advanced techniques of measurement help determining the risk of curve progression in immature children. Maturity is radiologically determined by the Risser sign in Adoper's study based on the plain radiograph of the left hand and wrist. The sensitivity and specificity of the screening method for scoliosis detection depend on the person administering the method and degree of the curve. In scoliometric measurements sensitivity applies to cases with a Cobb angle > 20° [29]. The sensitivity of scoliometric measurements for detecting a curve of 5° is 100 %, while specificity is 47 %[28]. Detection of the curve based on visual and forward bending test depends on the degree of the curve 7.

A scoliometric measurement of 7° leads to 3 % referral, while the referral rate goes up to 12 % if 5° is measured[5]. Studies reported that referral rate based on scoliosis screening should be around 2 to 3 %[5,24]. Adopar's study reported a referral rate of 1.5% for measurements conducted on 12-year-olds 2.

There are some studies indicating that body and shoulder imbalance, and differences in arm and leg lengths can also accompany scoliosis[22]. However, measurements made in our study did not reveal any statistically significant body and shoulder imbalance or differences in arm and leg lengths.

The cost of scoliosis screening is yet another controversy. Various ideas have been suggested on the cost of scoliosis screening and the results obtained[20] However, the total cost of scoliosis screening for 7928 junior high school students was not more than 5.000 YTL ($2300). Thus, detection of even one mature case with adolescent idiopathic scoliosis with possible curve progression will cost a lot less than any prospective surgery.

This study will shed light on the future studies, since it is the first comprehensive scoliosis screening conducted in the Republic of Turkey to cover all schools in the selected district. Screening has been useful for the early treatment of scoliotic patients. Early diagnosis and treatment will contribute to the medical, social and economic improvement of scoliotic patients.

REFERENCES:

1. Adak B ÖM, Tekeoğlu İ, Arslan A. Van İli Merkez İlköğretim Okullarında Skolyoz Taraması. *Türkiye Fiz Tıp Reh Derg* 1999; 2: 45-49.
2. Adobor RD, Rimeslatten S, Steen H, Brox JI. School screening and point prevalence of adolescent idiopathic scoliosis in 4000 Norwegian children aged 12 years. *Scoliosis* 2011; 6: 23.
3. Andersen MO, Thomsen K. [Investigation and treatment of idiopathic scoliosis in adolescence]. Tidsskrift for den Norske laegeforening : tidsskrift for praktisk medicin. *Ny Raekke* 2000; 120:2524-2527
4. Ashworth MA, Hancock JA, Ashworth L, Tessier KA. Scoliosis screening. An approach to cost/benefit analysis. *Spine* 1998; 13: 1187-1188.
5. Bunnell WP. Selective screening for scoliosis. Clin Orthop Rel Res 2005; 40-45.
6. Brooks HL, Azen SP, Gerberg E, Brooks R, Chan L. Scoliosis: A prospective epidemiological study. *J Bone Joint Surg* 1975; 57-A: 968-972.
7. Chan A, Moller J, Vimpani G, Paterson 305 D, Southwood R, Sutherland A. The case for scoliosis screening in Australian adolescents. *Med J Australia* 1986; 145: 379-383.
8. Cilli K, Tezeren G, Tas T, Bulut O, Ozturk H, Oztemur Z, Unsaldi T. [School screening for scoliosis in Sivas, Turkey]. *Acta Orthop Traumatologica Turcica* 2009; 43: 426-430.
9. Goldberg C, Thompson F, Dowling F, Regan BF, Blake NS. Pilot study for a scoliosis screening project in South Dublin. *Irish Med J* 1980; 73: 265-268.
10. Goldberg CJ, Dowling FE, Fogarty EE, Moore DP. School scoliosis screening and the United States Preventive Services Task Force. An examination of long-term results. *Spine* 1995; 20: 1368-1374
11. Gore DR, Passehl R, Sepic S, Dalton A. Scoliosis screening: results of a community project. Pediatrics 1981; 67:196-200
12. Grivas TB, Vasiliadis E, Mouzakis V, Mihas C, Koufopoulos G. Association between adolescent idiopathic scoliosis prevalence and age at menarche in different geographic latitudes. *Scoliosis* 2006; 1: 9.
13. Grossman TW, Mazur JM, Cummings RJ. An evaluation of the Adams forward bend test and the scoliometer in a scoliosis school screening setting. *J Pediatr Orthop* 1995; 15: 535-538.
14. Howell JM, Craig PM, Dawe BG. Problems in scoliosis screening. *Canadian J Public* Health 1978; 69: 293-296.

15. Huang SC. Cut-off point of the Scoliometer in school scoliosis screening. *Spine* 1997; 22: 1985-1989.

16. İbişoğlu Y U, Çalış F,A, Yağızon A. İzmir ili Bornova İlçesi İlköğretim Kurumlarında Okuyan 12-14 Yaş Grubu Çocuklarda Skolyoz Prevalansı. *Türkiye Fiziksel Tıp ve Rehabilitasyon Dergisi* 2012; 58: 109-113.

17. James JI. Idiopathic scoliosis; the prognosis, diagnosis, and operative indications related to curve patterns and the age at onset. *J Bone Joint Surg* 1954; 36-B: 36-49

18. Leaver JM, Alvik A, Warren MD. Prescriptive screening for adolescent idiopathic scoliosis: a review of the evidence. International journal of epidemiology 1982; 11: 101-111.

19. Leone A, Aulisa A, Perisano C, Re T, Galli M. Advantages of a two-step procedure for school-based scoliosis screening. *Radiologia Medica* 2010; 115: 238-245.

20. Montgomery F, Persson U, Benoni G, Willner S, Lindgren 339 B. Screening for scoliosis. A cost-effectiveness analysis. *Spine* 1990; 15: 67-70.

21. Nachemson AL, Peterson LE. Effectiveness of treatment with a brace in girls who have adolescent idiopathic scoliosis. A prospective, controlled study based on data from the Brace Study of the Scoliosis Research Society. *J Bone Joint Surg* 1995; 77-A: 815-822.

22. Nery LS, Halpern R, Nery PC, Nehme KP, Stein AT. Prevalence of scoliosis among school students in a town in southern Brazil. Sao Paulo Med J 2010; 128: 69-73.

23. Nissinen M, Heliovaara M, Ylikoski M, Poussa M. Trunk asymmetry and screening for scoliosis: a longitudinal cohort study of pubertal schoolchildren. Acta Paediatrica 1993; 82: 77-82.

24. Pruijs JE, Keessen W, van der Meer R, van Wieringen JC, Hageman MA. School screening for scoliosis: methodologic considerations. Part 1: External measurements. Spine 1992; 17: 431-436.

25. Rogala EJ, Drummond DS, Gurr J. Scoliosis: incidence and natural history. A prospective epidemiological study. *J Bone Joint Surg* 1878; 60-A: 173-176.

26. SRS Terminology Committee and Working Group on Spinal Classification Revised Glossary of Terms. Glossary (for Medical Professionals) 2000.

27. Ugras AA, Yilmaz M, Sungur I, Kaya I, Koyuncu Y, Cetinus ME. Prevalence of scoliosis and cost-effectiveness of screening in schools in Turkey. *J Back Musculoskeletal Rehab* 2010; 23: 45-48.

28. Viviani GR, Budgell L, Dok C, Tugwell P. Assessment of accuracy of the scoliosis school screening examination. *Am J Public Health* 1984; 74: 497-498.

29. WA. Lectures on the pathology and treatment of lateral and other forms of curvature of the spine. London: John Churchill and Sons.1865.

30. Willner S, Uden A. A prospective prevalence study of scoliosis in Southern Sweden. *Acta Orthop Scand* 1982; 53: 233-237.

31. Wong HK, Hui JH, Rajan U, Chia HP. Idiopathic scoliosis in Singapore schoolchildren: a prevalence study 15 years into the screening program. Spine 2005; 30: 1188-1196.

32. Yilmaz H, Zateri C, Uludag A, Bakar C, Kosar S, Ozdemir O. Single-nucleotide polymorphism in Turkish patients with adolescent idiopathic scoliosis: curve progression is not related with MATN-1, LCT C/T-13910, and VDR BsmI. *J Orthop Res* 2012; 30: 1459-1463.

Volume: 27, Issue: 3, July 2016 pp: 143/146 ORIGINAL ARTICLE / ORJINAL MAKALE

ANTERIOR CERVICAL DISCECTOMY: ANALYSIS OF THE RESULTS OF TWO YEARS

ANTERİOR SERVİKAL DİSKEKTOMİ: 2 YILLIK SONUÇLARIN DEĞERLENDİRİLMESİ

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SUMMARY:

Objective: The aim of the study is to analyse the cervical discectomy operations in two years.

Materials and Method: We inspected 175 patients who were operated for cervical disc herniation between June 2014 and June 2016 at Dr.Lütfi Kırdar Kartal Training and Research Hospital Neurosurgery Clinic. The parameters that evaluated are the level of discopathy, side of the disc herniation and type of surgery.

Results: This study included a total of 175 patients, of whom 100 were female (57.1 %) and 75 were male (42.9 %). Mean age was 45.1 ± 9.6 years for males, and 43.3 ± 9.9 for females. There was no statistically significant difference between males and females (p=0.111). The most frequent levels of disorder was at C5-6 (n=68; 38,9 %), and C6-7 (n=53; 30.3 %). More than half of the patients had lesions on left side (n=92; 52.6 %). Most frequent type of operation was total disc replacement (TDR) application (n=127; 72.6 %). Comparisons between males and females regarding level (p=0.311) and side (p=0.463) of lesions, and operation type (p=0.466) showed that both genders were similar for these clinical parameters.

Conclusions: ACDF and TDR showed similar results in terms of efficacy and safety, and these procedures with expectation of better results together with the development of surgical techniques and instruments.

Key Words: Cervical disc herniation, anterior cervical discectomy, analysis of anterior cervical discectomies

Level of evidence: Retrospective clinical study, Level III.

ÖZET:

Amaç: Çalışmamızın amacı iki yıl içerisinde yapılan anterior servikal diskektomi ameliyatlarının analizini çıkartmaktır.

Materyal ve Metod: Haziran-2014 ile Haziran-2016 tarihleri arasında Dr.Lütfi Kırdar Kartal Eğitim ve Araştırma Hastanesi Nöroşirurji Kliniğinde anterior servikal diskektomi ameliyatı yapılmış 175 hasta retrospektif olarak incelendi. İncelenen parametreler diskopati seviyesi, disk hernisinin tarafı ve cerrahinin tipi idi.

Sonuçlar: Çalışmaya katılan popülasyonun ortalama yaşı kadınlarda 43.3 ± 9.9, erkeklerde 45.1 ± 9.6 olarak hesaplandı. 100 hasta kadın (% 57.1) ve 75 hasta erkek idi (% 42.9). Cinsiyet yönünden istatistiksel fark saptanmadı(p=0.111). En çok diskektomi yapılan seviyeler C5-6 (n=68; % 38,9) ve C6-7 olarak bulundu(n=53; % 30.3). Hastaların yarısından fazlasının lezyonu sol tarafta idi(n=92; % 52.6). En çok yapılan ameliyat tipi disk protezi implantasyonu olarak saptandı(n=127; % 72.6). Cinsiyetler arasında yapılan karşılaştırmalarda serviye (p=0.311), taraf (p=0.463) ve operasyon tipi (p=0.466) arasında anlamlı istatistiksel fark bulunmadı.

Çıkarım: Anterior servikal diskektomi füzyon ve disk protezi uygulaması benzer şekilde etkili ve güvenli teknikler olarak bilinirler ve bu prosedürlerden beklentiler cerrahi tekniklerin ve enstrumanların gelişimi ile beraber daha da artmaktadır.

Anahtar kelimeler: Servikal disk hernisi, anterior servikal diskektomi, anterior servikal diskektomilerin analizi

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey III

INTRODUCTION:

Anterior cervical discectomy and fusion (ACDF) has been suggested as an effective and safe treatment for spinal cervical abnormalities such as spondylosis, disc herniations, fractures and neoplastic lesions. Many trials have been carried out to get better results from the procedures, and it was essential to develop new graft materials and implants but these changes could not always guarantee better results[17].

Anterior cervical approach was initially described by Lahey and Warren to expose esophageal diverticula[9]. Smith and Robinson first applied this approach to cervical spine and reported the result of anterior cervical interbody fusion by using a horseshoe-shaped graft harvested from iliac crest but there was no attempt to remove the structure compressing neural structure and simply disc was removed and autologous bone graft was filled in the hollow space to conduct the fusion[16]. Cloward reported interbody arthrodesis by using dowel type graft[2]. It is applied Wiltberger's lumbar interbody dowel fusion technique on cervical spine, and unlike Smith-Robinson technique, it removed not only discs but also all lesions that compressing the neural structure anteriorly under direct visualization, and used a large drill to prepare the area for bone graft[2].

In our study we try to analyse our experience of anterior cervical discectomy procedures for 2 years rethrospectively.

MATERIALS AND METHODS:

We inspected 175 patients who were operated for cervical disc herniation with the anterior cervical discectomy technique between June-2014 and June-2016 at Dr. Lütfi Kırdar Kartal Training and Research Hospital Neurosurgery Clinic (Figure-1).

Cervical stenosis, fractures and spondylopaties excluded from the study.

The informations were collected from the patients file archieves rethrospectively. Radiological data were inspected from the PACS system. The parameters that evaluated are the level of discopathy, side of the disc herniation and type of surgery.

STATISTICAL ANALYSIS:

Descriptive data were presented by using mean and standard deviation, and frequencies and percent. Chi-square and Mann-Whitney U tests were used for comparisons between the independent groups of the study, and statistical significance was evaluated according to a two-sided Type-I error level of 5%. Statistical Package for the Social Sciences (SPSS) 21 software (IBM Corp. in Armonk, NY) was used for all statistical analyses of this research.

Figure-1. Sagittal plain radiography of postoperative C5-6 total disc replacement and C6-7 cage implantation

RESULTS:

This study included a total of 175 patients, of whom 100 were female (57.1 %) and 75 were male (42.9 %). Mean age was 45.1 ± 9.6 years for males, and 43.3 ± 9.9 for females. There was no statistically significant difference between males and females (p=0.111).

The most frequent levels of disorder was at C5-6 (n=68; 38,9 %), and C6-7 (n=53; 30.3 %). More than half of the patients had lesions on left side (n=92; 52.6 %). And, most frequent type of operation was total disc replacement (TDR) application (n=127; 72.6 %). The general characteristics of study population were presented in Table-1.

Comparisons between males and females regarding level (p=0.311) and side (p=0.463) of lesions, and operation type (p=0.466) showed that both genders were similar for these clinical parameters. Between-gender comparisons showed in Table-2.

Table-1. General characteristics

	Mean±SD
Age (years)	44.3±9.8
	n (%)
Sex	
Female	100 (57.1)
Male	75 (42.9)
Level	
C3-4	2 (1.1)
C3-4 and C4-5	1 (0.6)
C3-4 and C5-6	1 (0.6)
C4-5	13 (7.4)
C4-5 and C5-6	8 (4.6)
C5-6	68 (38.9)
C5-6 and C6-7	28 (16)
C6-7	53 (30.3)
C6-7 and C7-T1	1 (0.6)
Side	
Left	92 (52.6)
Right	80 (45.7)
Bilateral	3 (1.7)
Operation	
Total disc replacement (TDR)	127 (72.6)
Cage and TDR	39 (22.3)
Cage	8 (4.6)
Discectomy	1 (0.6)

Table-2. Between gender comparisons

	Female	Male	
	Mean±SD	**Mean±SD**	**p**
Age	45.1±9.6	43.3±9.9	0.111
	n (%)	**n (%)**	**p**
Level			0.311
C3-4	-	2 (2.7)	
C3-4 and C4-5	-	1 (1.3)	
C3-4 and C5-6	-	1 (1.3)	
C4-5	10 (10)	3 (4)	
C4-5 and C5-6	4 (4)	4 (5.3)	
C5-6	36 (36)	32 (42.7)	
C5-6 and C6-7	16 (16)	12 (16)	
C6-7	33 (33)	20 (26.7)	
C6-7 and C7-T1	1 (1)	-	
Side			0.463
Left	50 (50)	42 (56)	
Right	49 (49)	31 (41.3)	
Bilateral	1 (1)	2 (2.7)	
Operation			0.466
Total disc replacement (TDR)	73 (73)	54 (72)	
Cage and TDR	21 (21)	18 (24)	
Cage	6 (6)	2 (2.7)	
Discectomy	-	1 (1.3)	

DISCUSSION:

Cervical degenerative disc disease is a common cause of pain and disability.

Most symptomatic cases present between the ages of 40-60, although many individuals never develop symptoms[7]. Many conservative treatment modalities like physical therapy and injection were described[18]. MRI studies have documented the presence of cervical degenerative disc disease in 60 % of asymptomatic individuals aged greater than 40 years and 80 % of patients over the age of 80 years[10-11].

ACDF surgery has become a standard treatment for cervical disc disease, and it is a proven intervention for patients with myelopathy and radiculopathy as it affords the surgeon the ability to provide direct (from the discectomy) and indirect (through restoration of disc height) decompression and stabilization[5,6]. Various implant and graft devices have been developed for use with ACDF(19). The anatomy of cervical spine must be well known for the better results of the operations[3,8,14].

Complications of ACDF could be exampled as disection injuries (vascular, eosofagial, tracheal), nerve injuries, hyperosteosis, CSF fistula and bone graft site injuries[4,13]. The donor site complication due to the use of host bone led to the morbidity rate of 20 % or higher, and it is presented as pain in the donor site, seroma, hematoma, infection, hip fracture, and meralgia paresthetica[15]. Allogenic bone graft and synthetic devices were suggested to resolve those problems.

TDR has been proposed as an alternative treatment to ACDF. Cervical arthroplasty maintains motion and believed to decrease the adjacent segment disease and reduce the rate of reoperations[1]. Literature have shown similar outcomes for ACDF and TDR[12]. TDR is not indicated for cervical disease at more than 2 levels. These devices are indicated for

skeletally mature patients for reconstruction of disc following discectomy at a single level or adjacent levels for radiculopathy or myelopathy. In our series the most used device was TDR for anterior cervical disc pathologies

ACDF and TDR showed similar results in terms of efficacy and safety, and these procedures with expectation of better results together with the development of surgical techniques and instruments.

REFERENCES:

1. Blumenthal SL, Ohnmeiss DD, Guyer RD, Zigler JE. Reoperations in cervical total disc replacement compared with anterior cervical fusion: results compiled from multiple prospective food and drug administration investigational device exemption trials conducted at a single site. *Spine* 2013; 38(14): 1177–1182.
2. Cloward RB. The anterior approach for removal of ruptured cervical disks. *J Neurosurg* 1958; 15: 602-617.
3. Demirel N, Gül A, Gergin S, Düzkalır HG, Başaran R, Düzkalır AH, Yaltırık CK, Özdoğan S. Craniovertebral junction Morphometric Evaluation with Reconstructive Computed Tomography. *JTSS* 2016; 27(1):13-17.
4. Düzkalır AH, Özdoğan S, Demirel N, Yaltırık CK. Complications of Anterior Cervical Spine Surgery: Review of the Literature. *JTSS* 2015; 26(4): 307-314.
5. Gao Y, Liu M, Li T, F Huang, T Tang, Z Xiang. A meta-analysis comparing the results of cervical disc arthroplasty with anterior cervical discectomy and fusion (ACDF) for the treatment of symptomatic cervical disc disease. *J Bone Joint Surg* 2013; 95-A(6):555–561.
6. Istemen I, Ozdogan S, Duzkalir AH, Senturk S, Yildirim T, Okutan MO. Clinical Results of Median Corpectomy in Cervical Spondylotic Patients with Myelopathy. *Turk Neurosurg* 2016; 26(1): 90-96.
7. Kelly JC, Groarke PJ, Butler JS, Poynton AR, O'Byrne JM. The natural history and clinical syndromes of degenerative cervical spondylosis. *Adv Orthop* 2012; 2012: 393642.
8. Köken M, Özdoğan S, Gergin YE, Aydın SO, Yüce E, Tiryaki M, Tatarlı N, Süslü HT, Hiçdönmez T. Alt servikal bölge disk mesafelerinin yüksekliklerinin ölçümü ve klinikte kullanımı. *JTSS* 2014; 25(3): 189-192.
9. Lehto IJ, Tertti MO, Komu ME, Paajanen HEK, Tuominen J, Kormano MJ. Age-related MRI changes at 0.1 T in cervical discs in asymptomatic subjects. *Neuroradiology* 1994; 36(1): 49–53.
10. Lehto IJ, Tertti MO, Komu ME, Toyama Y, Shiga H. Age-related MRI changes at 0.1 T in cervical discs in asymptomatic subjects. *Neuroradiology 1994; 36(1): 49–53.*
11. Matsumoto M, Fujimura Y, Suzuki N, Traynelis VC, Zdeblick TA. MRI of cervical intervertebral discs in asymptomatic subjects. *J Bone Joint Surg* 1998; 80-B (1): 19–24.
12. Mummaneni PV, Burkus JK, Haid RW, et al. Clinical and radiographic analysis of cervical disc arthroplasty compared with allograft fusion: a randomized controlled clinical trial. *J Neurosurg Spine* 2007; 6(3): 198–209.
13. Özdoğan S, Sabuncuoğlu H, Beriat GK, Tiryaki M, Düzkalır AH. Dysphagia Caused by Anterior Cervical Hyperostosis: Case Report. *JTSS* 2015; 26(3): 237-240.
14. Özdoğan S, Köken M, Gergin YE, Aydın SO, Yüce E, Tiryaki M, Tatarlı N, Süslü HT, Hiçdönmez T. Erişkinlerde ön atlantodental mesafenin bilgisayarlı tomografi ile ölçümü. *JTSS* 2014; 25(3): 193-197.
15. Silber JS, Anderson DG, Daffner SD, et al. Donor site morbidity after anterior iliac crest bone harvest for single-level anterior cervical discectomy and fusion. *Spine* 2003; 28:134-139.
16. Smith GW, Robinson RA. The treatment of certain cervical-spine disorders by anterior removal of the intervertebral disc and interbody fusion. *J Bone Joint Surg* 1958; 40-A: 607-624.
17. Song KJ, Choi BY. Current concepts of anterior cervical discectomy and fusion: a review of literature. *Asian Spine J* 2014; 8(4): 531-539.
18. Süslü H, Düzkalır HG, Özdoğan S, Şenol Ö, Tatarlı N, Düzkalır AH, Yaltırık CK. Fluoroscopy guided transforaminal steroid injection on cervical radicular pain. *JTSS* 2015; 26(2): 127-133.
19. Xie JC, Hurlbert RJ. Discectomy versus discectomy with fusion versus discectomy with fusion and instrumentation: a prospective randomized study. *Neurosurgery* 2007; 61(1): 107–116.

Volume: 27, Issue: 3, July 2016 pp: 147/152 ORIGINAL ARTICLE / ORJINAL MAKALE

EVALUATION OF THORACIC AND LUMBAR INSTRUMENTATION

TORAKAL VE LOMBER ENSTRÜMANTASYONUN DEĞERLENDİRİLMESİ

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SUMMARY:

Objective: The aim of the study is to analyse the thoracal and lumbar instrumentation operations in two years.

Materials and Method: We inspected 160 patients who were operated for thoracal and lumbar instrumentation operations between June 2014 and June 2016 at Dr. Lütfi Kırdar Kartal Training and Research Hospital Neurosurgery Clinic.

Results: This study included a total of 160 patients, of whom 110 were female (68.8 %) and 50 were male (31.3 %). Mean age was 55.6 ± 11.5 years for males, and 52.1 ± 11.6 for females. There was no statistically significant difference between males and females (p=0.098). The most frequent diagnosis was spinal stenosis (n=99; 61.9 %), and most frequent type of operation was L3-4-5 TPV (n=28; 17.5%).

Conclusions: Spinal instrumentation is the most common surgical technique used for spinal instability. Spinal stenosis, fractures and spondylolysthesis are the most common diagnosis for the causes of spinal instability.

Key Words: Lumbar spinal stenosis, thoracolumbar instrumentation, thoracic and lumbar fractures

Level of evidence: Retrospective clinical study, Level III

ÖZET:

Amaç: Çalışmamızın amacı iki yıl içerisinde yapılan torakal ve lomber enstrümantasyon ameliyatlarının değerlendirilmesini sağlamaktır..

Materyal ve Metod: Haziran-2014 ile Haziran-2016 tarihleri arasında Dr.Lütfi Kırdar Kartal Eğitim ve Araştırma Hastanesi Nöroşirurji Kliniğinde torakal ve lomber enstrumeantasyon ameliyatı yapılmış 160 hasta retrospektif olarak incelendi.

Sonuçlar: 110 hasta kadın (% 68.8) ve 50 hasta erkek idi (% 31.3). Çalışmaya katılan popülasyonun ortalama yaşı kadınlar için 52.1 ± 11.6, erkekler için 55.6 ± 11.5 olarak hesaplandı. Cinsiyet yönünden istatistiksel anlamlı fark saptanmadı(p=0.098). En sık konulan tanı spinal stenoz (n=99; % 61.9) ve en çok yapılan ameliyat L3-4-5 TPV (n=28; % 17.5) olarak bulundu..

Çıkarım: Spinal enstrumentasyon, spinal instabilite ameliyat teknikleri içinde en çok kullanılan tekniktir. Spinal stenoz, kırıklar ve spondilolistezis spinal instabiliteye sebep olan en sık konulan tanılardır.

Anahtar kelimeler: Lomber spinal stenoz, Torakolomber enstrumantasyon, Torakal ve lomber kırıklar

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey III

INTRODUCTION:

For several years, spinal instability has been defined in terms of biomechanical alteration to any spinal element that could affect the vertebral column stability[1]. The best treatment choice for spinal instability is still a challenge for the medical and scientific community whether conservative modalities like physiotherapy, injection and radiofrequency treatments or surgery[6,16-18,21-22].

The purpose of instrumentation is to stabilize the spine and fusion for the treatment of spinal stenosis, neoplasms, infections, fractures and spondylolysthesis[11-12,14]. Hadra et al had stabilized the spine of a patient who was diagnosed as Pott disease with wiring the spinous processes in 1891[8]. Spinal fusion was made by Fred Albee and Russel Hibbs at the same time in 1911[9]. First complex posterior stabilization system was used by Paul Harrington in 1962 for a spinal deformity surgery.

The aim of our study is to evaluate the thoracal and lumbar instrumentation operations in two years by diagnoses and type of surgeries.

MATERIALS AND METHODS:

We inspected 160 patients who were operated for thoracal and lumbar instrumentation operations between June 2014 and June 2016 at Dr.Lütfi Kırdar Kartal Training and Research Hospital Neurosurgery Clinic (Figure-1). The informations were collected from the patients file archieves rethrospectively. Radiological data were inspected from the PACS system. The parameters that evaluated are diagnosis and type of surgery.

STATISTICAL ANALYSIS:

Descriptive data were presented by using mean and standard deviation, and frequencies and percent. Mann-Whitney U test, and Chi-square test were used for comparisons between the independent groups of the study, and statistical significance was evaluated according to a two-sided Type-I error level of 5%. Statistical Package for the Social Sciences (SPSS) 21 software (IBM Corp. in Armonk, NY) was used for all statistical analyses of this research.

RESULTS:

This study included a total of 160 patients, of whom 110 were female (68.8 %) and 50 were male (31.3 %). Mean age was 55.6 ± 11.5 years for males, and 52.1 ± 11.6 for females. There was no statistically significant difference between males and females (p=0.098).

The most frequent diagnosis was spinal stenosis (n=99; 61.9 %), and most frequent type of operation was L3-4-5 TPV (n=28; 17.5 %). The general characteristics of study population were presented in Table-1.

Comparisons between males and females regarding disease and operation type were presented in Table-2. Between-gender comparisons could not be analyzed due to heterogeneity of the parameters.

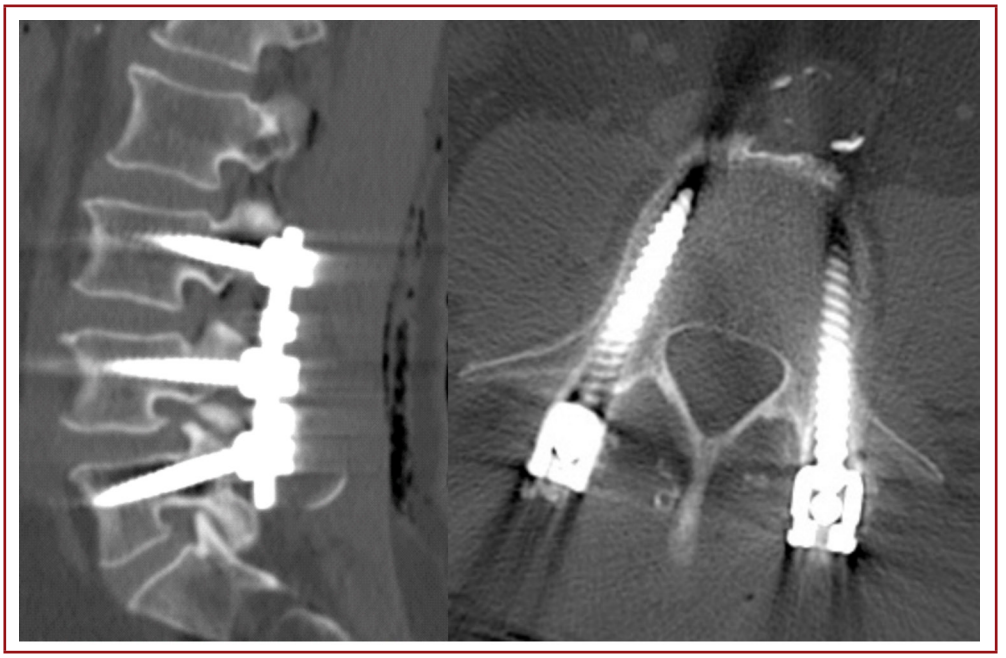

Figure-1. Sagittal and axial computed tomography postoperative images of L3-4-5 transpedicular screw instrumentation

Table-1. General characteristics (TPS: Trans pedicular screw, PLIF: Posterior lumbar interbody fusion, XLIF: Lateral lumbar interbody fusion)

	Mean±SD
Age (years)	54.5±11.6
	n (%)
Sex	
Female	110 (68.8)
Male	50 (31.3)
Diagnosis	
Spinal Stenosis	99 (61.9)
Spondylolisthesis	30 (18.8)
L1 Fracture	10 (6.3)
L2 Fracture	8 (5)
L3 Fracture	4 (2.5)
T11 Fracture	3 (1.9)
T12 Fracture	2 (1.3)
Lumbar Disc Herniation	1 (0.6)
T10 Fracture	1 (0.6)
T5 Fracture	1 (0.6)
T7 Fracture	1 (0.6)
Operation	
L1-2-3-4-5 TPS	1 (0.6)
L2-3 TPS	1 (0.6)
L2-3-4 TPS	4 (2.5)
L2-3-4-5 TPS	17 (10.6)
L2-3-4-5 TPS and PLIF	7 (4.4)
L2-3-4-5-S1 TPS	5 (3.1)
L3-4 TPS	2 (1.3)
L3-4-5 and PLIF	1 (0.6)
L3-4-5 TPS	28 (17.5)
L3-4-5 TPS and PLIF	15 (9.4)
L3-4-5-S1 TPS	12 (7.5)
L3-4-5-S1 TPS and PLIF	1 (0.6)
L4-5 TPS	9 (5.6)
L4-5 TPS and PLIF	3 (1.9)
L4-5-S1 TPS	15 (9.4)
L4-5-S1 TPS and PLIF	1 (0.6)
L4-5-TPS and XLIF	1 (0.6)
L5-S1 TPS	6 (3.8)
L5-S1 TPS and XLIF	1 (0.6)
T10-11-12-L1 TPS	1 (0.6)
T10-11-12-L1-2 TPS	1 (0.6)
T10-11-12-L1-2-3 TPS	1 (0.6)
T11-12-L1-2 TPS	7 (4.4)
T11-12-L1-2-3 TPS	2 (1.3)
T11-12-L1-2-3-4 TPS	2 (1.3)
T11-12-L1-2-3-4-5-S1 TPS	2 (1.3)
T11-12-L2-3 TPS	2 (1.3)
T12-L1-2 TPS	1 (0.6)
T12-L1-2-3 TPS	4 (2.5)
T12-L1-2-3-4 TPS	1 (0.6)
T12-L1-2-3-4-5 TPS	1 (0.6)
T4-5-6 TPS	1 (0.6)
T5-6-7-8 TPS	1 (0.6)
T8-9-10-11-12-L1 TPS	1 (0.6)
T9-10-11-12-L1 TPS	2 (1.3)

Table-2. Between gender comparisons (TPS: Transpedicular screw, PLIF: Posterior lumbar interbody fusion, XLIF: Lateral lumbar interbody fusion)

	Female	Male	p
	Mean±SD	**Mean±SD**	
Age	55.6±11.5	52.1±11.6	0.098
	n (%)	**n (%)**	**p**
Diagnosis			-
Spinal Stenosis	73 (66.4)	26 (52)	
Spondylolisthesis	23 (20.9)	7 (14)	
L1 Fracture	5 (4.5)	5 (10)	
L2 Fracture	4 (3.6)	4 (8)	
L3 Fracture	1 (0.9)	3 (6)	
T11 Fracture	1 (0.9)	2 (4)	
T12 Fracture	1 (0.9)	1 (2)	
Lumbar Disc Herniation	1 (0.9)	-	
T10 Fracture	-	1 (2)	
T5 Fracture	-	1 (2)	
T7 Fracture	1 (0.9)	-	
Operation			-
L1-2-3-4-5 TPS	1 (0.9)	-	
L2-3 TPS	1 (0.9)	-	
L2-3-4 TPS	1 (0.9)	3 (6)	
L2-3-4-5 TPS	12 (10.9)	5 (10)	
L2-3-4-5 TPS and PLIF	4 (3.6)	3 (6)	
L2-3-4-5-S1 TPS	4 (3.6)	1 (2)	
L3-4 TPS	2 (1.8)	-	
L3-4-5 and PLIF	1 (0.9)	-	
L3-4-5 TPS	18 (16.4)	10 (20)	
L3-4-5 TPS and PLIF	11 (10)	4 (8)	
L3-4-5-S1 TPS	9 (8.2)	3 (6)	
L3-4-5-S1 TPS and PLIF	1 (0.9)	-	
L4-5 TPS	7 (6.4)	2 (4)	
L4-5 TPS and PLIF	3 (2.7)	-	
L4-5-S1 TPS	13 (11.8)	2 (4)	
L4-5-S1 TPS and PLIF	1 (0.9)	-	
L4-5-TPS and XLIF	1 (0.9)	-	
L5-S1 TPS	4 (3.6)	2 (4)	
L5-S1 TPS and XLIF	-	1 (2)	
T10-11-12-L1 TPS	-	1 (2)	
T10-11-12-L1-2 TPS	1 (0.9)	-	
T10-11-12-L1-2-3 TPS	1 (0.9)	-	
T11-12-L1-2 TPS	3 (2.7)	4 (8)	
T11-12-L1-2-3 TPS	1 (0.9)	1 (2)	
T11-12-L1-2-3-4 TPS	2 (1.8)	-	
T11-12-L1-2-3-4-5-S1 TPS	2 (1.8)	-	
T11-12-L2-3 TPS	1 (0.9)	1 (2)	
T12-L1-2 TPS	-	1 (2)	
T12-L1-2-3 TPS	2 (1.8)	2 (4)	
T12-L1-2-3-4 TPS	-	1 (2)	
T12-L1-2-3-4-5 TPS	1 (0.9)	-	
T4-5-6 TPS	-	1 (2)	
T5-6-7-8 TPS	1 (0.9)	-	
T8-9-10-11-12-L1 TPS	-	1 (2)	
T9-10-11-12-L1 TPS	1 (0.9)	1 (2)	

DISCUSSION:

Spinal stenosis is the most common diagnosis that was made for our operations. The clinical entity lumbar spinal stenosis is the most common reason for spinal surgery in patients 65 years of age and older[4]. includes Lower extremity pain which may occur with or without low back pain is the clinical definition[23]. Neurogenic claudication is the main complaint of patients that caused by compression of intraforaminal nervous structures[10]. The management of spinal stenosis is still controversial. Conservative treatment seems to be the natural choice although controlled clinical studies comparing conservative and surgical treatments[2].

When symptoms are severe and conservative treatment has failed, surgery is suggested[3]. Decompression which is defined as the relief of pressure on one or many pinched nerves of the spinal column seems to be the logical procedure that has the potential to give the patient immediate relief[2,5].

White and Panjabi defined criteria for diagnosing instability from flexion-extension radiographs as sagittal plane translation greater than 4.5 mm or greater than 15 % of the vertebral body width, or sagittal plane rotation of greater than 15° at L1/L2, L2/L3 or L3/L4, greater than 20° at L4/L5, or greater than 25° at L5/S1[7,24].

However, instability of the spine is a potential consequence that needs to be considered. The additional value of decompression and arthrodesis compared to decompression is debated[3]. Toracal and lumbar anatomy must be evaluated well before the surgery[13,19-20]. Fusion is defined as a surgical technique used to join two or more vertebrae. Bone graft, either from the patient, a donor or bone substitute is used in conjunction with the body's natural bone growth processes to fuse the vertebrae. Fusion with instrumentation utilizes stainless steel, titanium or non-metallic devices to stabilize the spine.

Spinal instrumentation is the most common surgical technique used for spinal instability. Spinal stenosis, fractures and spondylolysthesis are the most common diagnosis for the causes of spinal instability.

REFERENCES:

1. Akan B, Benli T, Karagüven D, Köken M, Bülbül Ö, Yıldırım T, Özdoğan S. Taze dana torakal ve lomber omurgasında serbest el tekniği ile transpediküler vida uygulamasında açısal güvenli zonun araştırılması. *JTSS* 2009; 20 (3): 11-22.
2. Amundsen T, Weber H, Nordal HJ, Magnaes B, Abdelnoor M, Lilleas F. Lumbar spinal stenosis: conservative or surgical management?: a prospective 10-year study. *Spine* 2000; 25: 1424–35. Discussion: 1435–1426.
3. Carragee EJ. Single-level posterolateral arthrodesis, with or without posterior decompression, for the treatment of isthmic spondylolisthesis in adults.A prospective, randomized study. *J Bone Joint Surg* 1997;79-A: 1175–1180.
4. Ciol MA, Deyo RA, Howell E, Kreif S. An assessment of surgery for spinal stenosis: time trends, geographic variations, complications, and reoperations. *J Am Geriatr Soc* 1996; 44: 285–90.
5. Dictionary AH. *The American Heritage Medical Dictionary*. Mifflin Company, Houghton 2007; p:700-750.
6. Düzkalır AH, Özdoğan S, İştemen İ. Radyofrekans termokoagülasyon ile faset eklem denervasyonu. *JTSS* 2014; 25(1): 33-37.
7. Fritz JM, Piva SR, Childs JD. Accuracy of the clinical examination to predict radiographic instability of the lumbar spine. *Eur Spine J* 2005; 14: 743–50.
8. Hadra BE. The classic: wiring of the vertebrae as a means of immobilization in fracture and Potts'disease. Berthold E. Hadra. Med Times and Register 22, May 23, 1891. *Clin Orthop Relat Res* 1975; 112: 4-8.
9. Hibbs R. An operation for progressive spinal deformities. *NY Med J* 1911; 93: 1013-1016.
10. Kalichman L, Cole R, Kim DH, Li L, Suri P, Guermazi A, Hunter DJ. Spinal stenosis prevalence and association with symptoms: the Framingham study. *Spine J* 2009; 9: 545–550.
11. Kış N, Kapmaz M, Düzkalır AH, Özdoğan S. Brucellar and tuberculous spondylodiscitis: comparison of magnetic resonance imaging iindings. *JTSS* 2015; 26(4): 285-290.
12. Ozdogan S, Gergin YE, Senol O, Tiryaki M, Suslu HT, Tatarlı N, Hicdonmez T. Thoracic disk herniation mimicking spinal mass lesion:An illustrative case and review of the literature. *Neurosurg Q* 2016 (In press).
13. Özdoğan S, Gergin YE, Düzkalır AH, Demirel N, Köken M. Measurement of lumbar vertebral disc heights by computed tomography:Morphometric study. *JTSS* 2015; 26(4): 291-294.
14. Özdoğan S, Gür E, Süslü H, Tiryaki M, Düzkalır AH, Yaltırık CK. Failed back surgery syndrome. *JTSS* 2015; 26(3): 249-254.
15. Özdoğan S, Yaltırık CK, Atalay B, Tiryaki M, Düzkalır AH, Süslü H. Unilateral approach for bilateral spinal microdecompression in lumbar spinal stenosis:short term results. *JTSS* 2015; 26(3): 205-209.

16. Özdoğan S, Gergin YE, Şenol Ö, Tiryaki M, Düzkalır AH, Hiçdönmez T. Torakal disk hernilerine pratik yaklaşım. *JTSS* 2014; 25(4): 309-312.

17. Özdoğan S, Düzkalır AH, İştemen İ. Lomber diskojenik ağrı tedavisinde alternatif yöntem: Disk içi elektrotermal tedavi (IDET - Intradiscal electrothermal therapy. *JTSS* 2013; 24(2): 131-134.

18. Özdoğan S, Düzkalır AH, İştemen İ. Kronik bel ağrısı tedavisinde faset eklem denervasyonu ile faset eklem enjeksiyonunun karşılaştırılması. *JTSS* 2013; 24(3): 219-222.

19. Şerifoğlu L, Gül A, Gergin S, Düzkalır HG, Başaran R, Düzkalır AH, Özdoğan S. Lumbar intervertebral foraminal morphometry. *JTSS* 2016; 27(1): 19-22.

20. Şerifoğlu L, Erol AT, Gergin S, Düzkalır HG, Başaran R, Düzkalır AH, Aydoğmuş E, Özdoğan S. Lumbar spinal canal morphometry. *JTSS* 2016; 27(1): 23-27.

21. Süslü H, Köken M, Özdoğan S, Tiryaki M, Düzkalır AH. Coccydinia: pain management with radiofrequency thermoablation of ganglion impar. *JTSS* 2015; 26(3):229-236.

22. Süslü H, Yaltırık CK, Özdoğan S, Şenol Ö, Tatarlı N, Düzkalır AH, Düzkalır HG. Epiduroscopy usage for pain management of failed back surgery syndrome. *JTSS* 2015; 26(2):127-133.

23. Watters W, Baisden J, Gilbert T, Kreiner D, Resnick D, Bono C, et al. *Evidence Based Clinical Guidelines for Multidisciplinary Spine Care: Diagnosis and Treatment of Degenerative Lumbar Spinal Stenosis*. North American Spine Society, Burr Ridge 2007; pp:19–121.

24. White AA, Panjabi MMA. *Clinical Biomechanics of the Spine*. 2nd ed. Lippincott Williams & Wilkins, Philadelphia 1990; p: 1–115.

Volume: 27, Issue: 3, July 2016 pp: 153/158 ORIGINAL ARTICLE / ORJINAL MAKALE

THORACOLUMBAR FRACTURES: SHOULD THEY BE OPERATED ACCORDING TO THORACOLUMBAR INJURY CLASSIFICATION AND SEVERITY SCORE (TLICS)?

TORAKOLOMBER KIRIKLAR: TORAKOLOMBER YARALANMA VE DERECELENDİRME SKOR SİSTEMİNE (TLICS) GÖRE AMELİYAT EDİLMELİ MİYDİ?

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SUMMARY:

Objective: The aim of the study is to evaluate patients who were operated for thoracal and lumbar fractures were match up with the thoracolumbar injury classification and severity score (TLICS) surgical criterias.

Materials and Method: We inspected 38 patients who were operated for thoracal and lumbar fractures between June-2014 and June-2016 at Dr. Lütfi Kırdar Kartal Training and Research Hospital Neurosurgery Clinic. The informations were collected from the patients file archieves rethrospectively. We calculated the TLICS scores of the operated patients and evaluated that surgery decision was correct or not according to TLICS.

Results: We inspected 17 female and 21 male patients. 13 patients were operated for thoracal and 25 patients were operated for lumbar fractures. According to TLICS scores 17 patients(44.7%) calculated as surgical, 15 patients(39.4%) as surgeon's choice and 6 patients(15,7%) as non-surgical of total 38 patients.

Conclusions: TLICS focuses on three important aspects of thoracolumbar fractures and may be useful to choose conservative treatment or surgery according to the final score. The non-surgical treatment recommendation for the TLICS scores has limitations in some patients who may need to receive operative treatment in the future because of a progressive symptomatology.

Key Words: Thoracolumbar fractures, TLICS, Burst fractures.

ÖZET:

Amaç: Çalışmamızın amacı iki yıl içerisinde yapılan torakolomber kırık ameliyatlarının TLICS skorlamasına göre ameliyat kriterlerine uygun olup olmadığının analizini çıkartmaktır.

Materyal ve Metod: Haziran-2014 ile Haziran-2016 tarihleri arasında Dr.Lütfi Kırdar Kartal Eğitim ve Araştırma Hastanesi Nöroşirurji Kliniğinde torakolomber kırık ameliyatı yapılmış 38 hasta retrospektif olarak incelendi. Ameliyat edilen hastaların TLICS skorları hesaplanarak ameliyat kriterlerine uygun olup olmadığı karşılaştırıldı.

Sonuçlar: 17 kadın ve 21 erkek hasta incelendi. 13 hasta torakal, 25 hasta ise lomber kırıktan ameliyat edilmişti. Toplam 38 hastada TLICS skorlarına göre 17 hasta (% 44.7) cerrahi karar, 15 hasta (% 39.4) cerrahın kararına bırakılmış ve 6 hasta (% 15,7) ise cerrahiye gerek yok olarak sınıflandırılmıştır.

Çıkarım: TLICS torakolomber kırıkların önemli üç noktasına odaklanarak final skora göre konservatif tedavi ile cerrahi tedavi arasında seçim yapmaya yardımcı olmaktadır. Cerrahi olmayan tedavi önerilen TLICS skor değerlerinde bazı hastalarda gelecekte semptomların progresyon gösterebileceği sebebi ile kısıtlı kalabilmektedir.

Anahtar kelimeler: Torakolomber kırıklar, TLICS, Patlama kırıkları.

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey III

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INTRODUCTION:

The thoracolumbar spine is the most common site of spinal fractures on account of its location on a junction of spinal biomechanics, furthermore, up to 20 % of all thoracolumbar injuries are burst fractures[1]. Given this substantial morbidity and mortality, various recommendations for medical decision-making have been made for the treatment of thoracolumbar trauma[13].

Vaccaro et al proposed a new classification of thoracolumbar injuries that considered the neurologic status, and the authors proposed an injury severity score that could help surgeons in the decision making process[14]. The Thoracolumbar Injury Classification and Severity Score System (TLICS) is based upon three critical injury characteristics; the morphology of the injury determined by the radiologic patterns, the integrity of the posterior ligamentous complex and the neurologic status of the patient[14]. The final calculated score can be utilized to guide conservative (<4 points) or surgical treatment (>4 points), whereas a score of 4 points can be managed according to surgeon's preference[15].

TLICS is a theoretical proposal to help management of the thoracolumbar traumas. The purpose of our study is to compare our surgery decicions with TLICS based upon our rethrospective cases.

MATERIALS AND METHODS:

We inspected 38 patients who were operated for thoracal and lumbar fractures between June 2014 and June 2016 at Dr.Lütfi Kırdar Kartal Training and Research Hospital Neurosurgery Clinic. The informations were collected from the patients file archieves rethrospectively. Radiological data were inspected from the PACS system. We calculated the TLICS scores of the operated patients and evaluated that surgery decision was correct or not according to TLICS (Table-1).

RESULTS:

17 female and 21 male patients were evaluated. 13 patients were operated for thoracal and 25 patients were operated for lumbar fractures. According to TLICS scores 17 patients (44.7 %) calculated as surgical, 15 patients (39.4 %) as surgeon's choice and 6 patients (15.7 %) as non-surgical of total 38 patients (Table-2).

Table-1. Thoracolumbar injury severity score system (TLICS).

		TLICS 3 INDEPENDENT PREDICTORS		
1	**Morphology** Immediate stability	• Compression • Burst • Translation / Rotation • Distraction	1 2 3 4	Radiographs CT
2	**Integrity of PLC** Long term stability	• Intact • Suspected • Injured	0 2 3	MRI
3	**Neural Status**	• Intact • Nerve root • Complete cord • Incomplete cord • Cauda equina	0 2 2 3 3	Physical examination
	Predicts	Need for surgery	0-3 4 ≥ 5	Non-surgical Surgeon choice Surgical

Table-2. Thoracal and lumbar fractures classified according to TLICS score and surgical decision criterias.

Gender	Age	Fracture Level	TLICS Score	TLICS Decision
F	51	T12	10	Surgical
F	41	L2	7	Surgical
M	35	T5	4	Surgeon's Choice
M	46	L1	5	Surgical
F	20	L3	9	Surgical
F	61	L1-L3	6	Surgical
F	69	L1	4	Surgeon's Choice
M	52	L3	7	Surgical
M	45	T10	10	Surgical
F	25	L1	3	Non Surgical
M	57	L3	5	Surgical
F	52	L1	5	Surgical
F	67	L1	5	Surgical
M	26	L2	5	Surgical
M	62	L3	3	Non Surgical
M	52	L3	4	Surgeon's Choice
M	18	L1	3	Non Surgical
F	49	L2	3	Non Surgical
M	61	L4	4	Surgeon's Choice
M	57	L3	4	Surgeon's Choice
F	58	T12	4	Surgeon's Choice
F	68	L1	5	Surgical
M	47	T11	4	Surgeon's Choice
M	63	L1	7	Surgical
M	66	T12	4	Surgeon's Choice
M	38	T12	3	Non Surgical
M	44	T12	4	Surgeon's Choice
F	57	L1	7	Surgical
M	26	T12	5	Surgical
F	15	T12	4	Surgeon's Choice
M	74	L1	4	Surgeon's Choice
F	78	T12	4	Surgeon's Choice
F	61	L1	3	Non Surgical
M	71	L1	4	Surgeon's Choice
M	46	T12	5	Surgical
M	58	L4	6	Surgical
F	36	T12	4	Surgeon's Choice
F	18	L1	4	Surgeon's Choice

DISCUSSION:

An ideal spine injury classification system is able to both guide treatment and facilitate clear communication between the surgeons, researchers, and trainees. Early classifications such as the Denis classification and Magerl classification described the thoracolumbar spine and were later extended to describe cervical spine injuries[2,9].

Spine Trauma Study Group develop an algorithm to guide the clincial decision between operative treatment and conservative treatment. TLICS is using a numerical scoring system derived from the injury morphology, posterior ligamentous complex integrity and neurological status[14]. It is the first quantitative scoring system that can be used as a practical algorithm to orient the clinical decision-making between conservative and surgical management and some reports have shown this classification to be both valid and reproducible[4,10-11].

Specifically, although the need for early decompression in patients with an injury leading to a neurologic deficit in the thoracic and lumbar spine is clear, the role for an urgent formal decompression in fractures at the lumbosacral junction is debated[3].

When we review the literature we recognised that TLICS had inconsistencies with the treatment of burst fractures without neurologic deficits as our study[5-8]. Fifty five percent of our patients were operated for stable burst fractures but 15.7 % of them were described as non-surgical according to TLICS. Reasons for the inconsistencies may be different surgical indications for treatment of stable burst fractures like loss of vertebral body height and kyphosis[12]. The TLICS did not consider any one of these factors for guiding surgical treatment.

TLICS focuses on three important aspects of thoracolumbar fractures and may be useful to choose conservative treatment or surgery according to the final score. The non-surgical treatment recommendation for the TLICS scores has limitations in some patients who may need to receive operative treatment in the future because of a progressive symptomatology.

REFERENCES:

1. Bensch FV, Koivikko MP, Kiuru MJ, Koskinen SK. The incidence and distribution of burst fractures. *Emerg Radiol* 2006; 12: 124–129.
2. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. *Spine* 1983; 8(8): 817–831.
3. Fehlings MG, Vaccaro A, Wilson JR, Singh A, Cadotte D, Harrop JS, Aarabi B, Shaffrey C, Dvorak M, Fisher C, Arnold P, Massicotte EM, Lewis S, Rampersaud R. Early versus delayed decompression for traumatic cervical spinal cord injury: results of the Surgical Timing in Acute Spinal Cord Injury Study (STASCIS). *PLoS ONE* 2012; 7(2): e32037.
4. Harrop JS, Vaccaro AR, Hurlbert RJ, Wilsey JT, Baron EM, Shaffrey CI. Intrarater and interrater reliability and validity in the assessment of the mechanism of injury and integrity of the posterior ligamentous complex: a novel injury severity scoring system for thoracolumbar injuries. *J Neurosurg Spine* 2006; 4: 118–122.
5. Joaquim AF, Lawrence B, Daubs M. Measuring the impact of the Thoracolumbar Injury Classification and Severity Score among 458 consecutively treated patients. *J Spinal Cord Med* 2014; 37(1): 101–106.
6. Joaquim AF, Daubs MD, Lawrence BD. Retrospective evaluation of the validity of the Thoracolumbar Injury Classification System in 458 consecutively treated patients. *Spine J* 2013; 13(12):1760–1765.
7. Joaquim AF, Fernandes YB, Cavalcante RA, Fragoso RM, Honorato DC, Patel AA. Evaluation of the thoracolumbar injury classification system in thoracic and lumbar spinal trauma. Spine 2011; 36(1): 33–36.
8. Machino M, Yukawa Y, Ito K, Kanbara S, Kato F. The complement of the load-sharing classification for the thoracolumbar injury classification system in managing thoracolumbar burst fractures. *J Orthop Sci* 2013; 18(1): 81–86.
9. Magerl F, Aebi M, Gertzbein SD, Harms J, Nazarian S. A comprehensive classification of thoracic and lumbar injuries. *Eur Spine J* 1994; 3(4): 184–201.
10. Patel AA, Vaccaro AR, Albert TJ, Hilibrand AS, Harrop JS, Anderson DG. The adoption of a new classification system: time-dependent variation in interobserver reliability of the thoracolumbar injury severity score classification system. *Spine* 2007; 32: E105–110.
11. Rampersaud YR, Fisher C, Wilsey J, Arnold P, Anand N, Bono CM. Agreement between orthopedic surgeons and neurosurgeons regarding a new algorithm for the treatment of thoracolumbar injuries: a multicenter reliability study. *J Spinal Disord Tech* 2006; 19:477–482.
12. Schroeder GD, Kepler CK, Koerner JD, Oner FC, Fehlings MG, Aarabi B, Schnake KJ, Rajasekaran S, Kandziora F, Vialle LR, Vaccaro AR. Can a Thoracolumbar Injury Severity Score Be Uniformly Applied from T1 to L5 or Are Modifications Necessary? *Global Spine J* 2015; 5: 339–345.

13. Shen J, Xu L, Zhang B, Hu Z. Risk Factors for the Failure of Spinal Burst Fractures Treated Conservatively According to the Thoracolumbar Injury Classification and Severity Score (TLICS): A Retrospective Cohort Trial. *PLoS ONE* 2015; 10(8): e0135735.

14. Vaccaro AR, Lehman RA Jr, Hurlbert RJ. A new classification of thoracolumbar injuries: the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. *Spine* 2005; 30(20): 2325–2333.

15. West C, Roosendaal S, Bot J, Smithuis F. Spine injury - TLICS Classification. Radiology Assistant, http://www.radiologyassistant.nl.

Volume: 27, Issue: 3, July 2016 pp: 159/164 CASE REPORT / OLGU SUNUMU

VERTEBRAL BODY FRACTURE IN THE MIDDLE OF FUSED SEGMENTS AFTER REMOVAL OF PEDICLE SCREWS WITHOUT A HISTORY OF INJURY: A REPORT OF TWO CASES

TRAVMA ÖYKÜSÜ OLMAKSIZIN PEDİKÜL VİDALARININ ÇIKARTILMASI SONRASINDA OLUŞAN FÜZYONE SEGMENTİN ORTASINDA YER ALAN VERTEBRAL CİSİM KIRIĞI: 2 OLGU SUNUMU

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SUMMARY:

While the risks of pedicle screw insertion in the management of a wide variety of spinal disorders are well established, there is a paucity of reports on complications associated with implant removal after short-segmented spinal fusion. We report two rare cases of acute osteoporotic vertebral body fractures that occurred within fused segments due to the pedicle screw removal in two female patients previously treated for the degenerative spinal disorders. One patient had experienced the critical motional pain at low back and motor weakness of left leg, and the other patient had experienced the severe low back pain after spinal fusion surgery at the adjacent segment due to osteoporotic vertebral body fracture within fused segments. Patients must be thoroughly informed of potential risks after the spinal implant removal, particularly in cases of osteoporosis. Vertebral body fracture in solid fused segments may occur as one of the complications of the previous implant removal. If the previous spinal implant removal would be needed, surgeons should be careful about this critical complication.

Key Words: Spinal fusion; implant removal; spinal fracture; complication

Level of evidence: Case report, Level IV

ÖZET:

Birçok omurga problemindeki pedikül vida uygulamalarının riskleri literatürde iyi tanımlanmış olmasına rağmen, kısa-segment spinal füzyonndan sonra implant çıkartılmasıyla ilgili komplikasyonlar hakkında kısıtlı sayıda yayın mevcuttur. Biz bu vaka bildiriminde daha önce dejeneratif spinal problemler nedeniyle ameliyat edilmiş iki kadın hastada, pedikül vida çıkartılmasına bağlı gelişen füze edilmiş segmentlerde oluşan akut iki adet osteoporotik vertebra kırığı vakası bildirmekteyiz. Bir hasta hareket ile ilişkili kritik düzeyde bel ağrısı ve sol bacakta motor güçsüzlük, diğer hasta ise spinal füzyon sonrası füze edilen bölümdeki osteoporotik vertebra kırığına bağlı, komşu segmetteki bel ağrısı ile başvurmuştur. Özellikle osteoporotik hastalar spinal implantların çıkartılması sonrası oluşabilecek potansiyel riskler konusunda ayrıntılı olarak bilgilendirilmelidirler. Solid füzyon segmenti içinde vertebra cisim kırığı implant çıkartılması sonrası komplikasyon olarak gelişebilir. Eğer spinal implant çıkartılması gerekiyorsa cerrahlar bu önemli komplikasyon konusunda dikkatli olmalıdırlar.

Anahtar Kelimeler: Spinal füzyon, implant çıkartılması, omurga kırığı, komplikasyon

Kanıt Düzeyi: Olgu sunumu, Düzey IV.

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INTRODUCTION:

Posterior spinal fusion is one of the most common types of spine surgeries and is a valuable tool in the management of a wide variety of spinal disorders in which there are short-term risks such as neural injury, wound problems, pseudoarthrosis and implant failure[9-10].

However, the long-term effects of spinal fusion still remain incompletely documented[9-10]. Among the various long-term risks of spinal fusion, the symptomatic adjacent segment disease (ASD) and progressive local osteoporosis in the spine have been a concern of spinal surgeons for a long time.

Many surgeons have a dilemma as to whether screws should be reinserted into the previous existing screw holes during treatment of the symptomatic ASD after short-segment spinal fusion. The effects of the previous spinal implant removal continue to be confused regarding the management of the symptomatic ASD after short-segmented spinal fusion. Accordingly, many clinical and biomechanical studies have been conducted on degeneration or fractures occurring at adjacent segments[1,3,5,11].

However, few reports are available regarding the complications occurring within fused segments after implant removal[4,5,13]. We report two rare cases of acute osteoporotic vertebral body fractures that occurred within fused segments due to pedicle screw removal in two female patients previously treated for the degenerative spinal disorders.

CASE REPORTS:

Case-1:

A 76-year-old woman visited our institute with low back pain and radiating pain in both legs, which were aggravated during walking. Her medical history revealed wide decompressive laminectomy and posterolateral fusion with pedicle screws from L3 to S1 at another institute in 2000. She was satisfied with the surgery and performed her own activity without restrictions. Eleven years later, she underwent a decompressive laminectomy with instrumented fusion of L2-L3 for spinal stenosis adjacent to the fused segments in our institute (Fig. 1. a-b).

Qauntitative computed tomography (QCT) showed osteoporosis of -5.7 SD on L1 and L2 vertebral bodies. At that time, plain radiography and computed tomography (CT) showed solid union at the previous fused segments from L3 to S1 with bilateral screws fracture at S1, and gross union was confirmed during the operation time. After removal of the previously inserted instruments, decompressive laminectomy, transforaminal lumbar interbody fusion and re-instrumentation from L2 to L3 were performed (Fig. 1. c), and after revision surgery, the radiating pain into both legs was resolved. We recommended an LSO custom brace for 3 months after surgery.

However, on the 7th postoperative day, the patient experienced acute low back pain and motor weakness at the left leg without history of trauma.

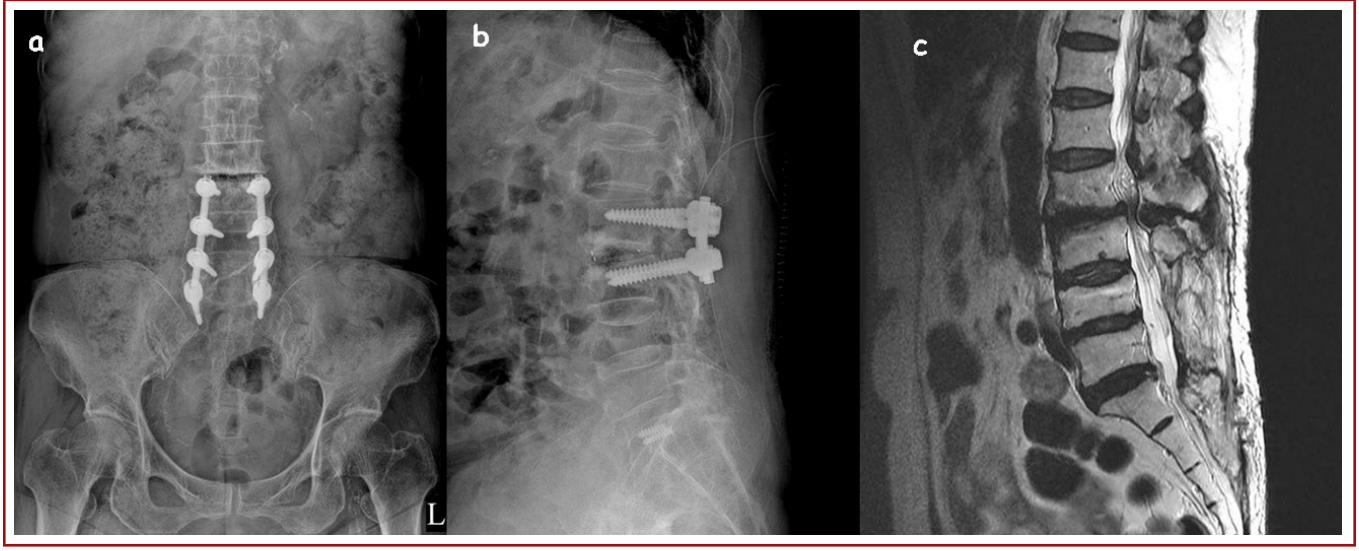

Figure-1. a) Preoperative radiograph of 76-year-old female showed a solid posterolateral fusion from L3 to S1. **b)** Preoperative magnetic resonance imaging (MRI) scan showed a severe spinal stenosis at L2. **c)** After spinal implant removal, decompressive laminectomy and reimplantation were performed from L2-L3.

Knee flexion and extension power of left leg revealed grade II by manual muscle power test.

And ankle dorsiflexion of left leg was grade II to III. A physical examination showed severe low back tenderness. Plain radiographs demonstrated compression fracture at L4 (Fig. 2. a).

A magnetic resolution imaging (MRI) scan performed to evaluate the fusion and the position of pedicle screws showed a bursting fracture at L4 with epidural hematoma and a compression fracture at L5 (Fig. 2. b, c). She underwent extended laminectomy at 62 L4, removal of epidural hematoma, and pedicle screw re-instrumentation from L2 to S1 (Fig. 2. d). After 3rd postoperative day of revision surgery, she experienced full-recovery of motor power and reduced low back pain.

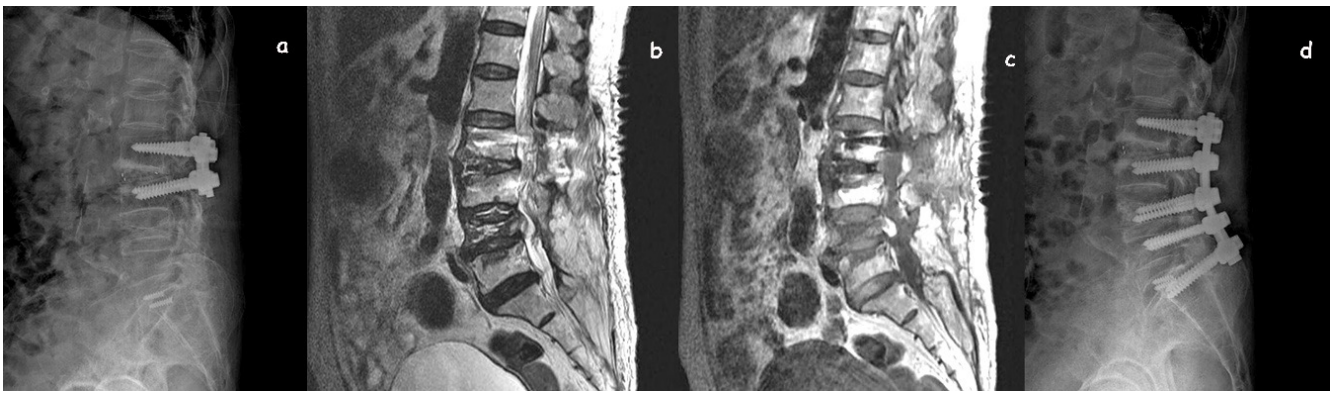

Figure-2. a) At 7 days after surgery, decreased vertebral body height in lateral plain X-ray was found at L4. **b-c)** At 7 days after surgery, MRI scans showed a bursting fracture at L4 with epidural hematoma and a compression fracture at L5. **d)** She underwent extended laminectomy at L4, removal of epidural hematoma, and re-instrumentation with pedicular screws from L2 to S1.

Case-2:

A 73-year-old woman with low back pain and radiating pain in right leg, which were aggravated by walking, visited in our institute. Her medical records revealed wide decompressive laminectomy and posterolateral fusion with pedicle screws from L3 to L5 at another institute in 2000. She was satisfied with the surgery and performed her own activity without restrictions.

Qauntitative computed tomography (QCT) showed osteoporosis of -5.2 SD on L1 and L2 vertebral body. With the impression of the adjacent segment degeneration, several studies, including CT and MRI, were performed. Degeneration and stenosis were found at L2-L3, the level adjacent to the fused segments (Fig. 3. a-b).

At that time, plain radiography and computed tomography (CT) showed solid union at the previous fused segments from L3 to L5, and gross union was confirmed during the operation time. We performed a revision decompressive laminectomy with instrumented fusion of L2-L3 for spinal stenosis adjacent to the fused segments after removal of the previously inserted instruments (Fig. 3. c).

After the revision surgery, the radiating pain into b 78 oth legs was resolved. We recommended an LSO custom brace for 3 months after surgery. However, she revisited our institute 5 months later with severe low back pain and radiating pain in both legs without no history of trauma. A physical examination showed severe low back tenderness. Plain radiographs demonstrated L4 compression fracture (Fig. 4. a).

A magnetic resolution imaging (MRI) scan performed to evaluate the fusion and the position of pedicle screws showed compression fractures at T12 and L4 vertebral bodies without another problems (Fig. 4. b-c).

She underwent percutaneous vertebroplasty with polymethyl metacrylate (PMMA) at T12 and L4 vertebral bodies (Fig. 4. d). After revision surgery, her low back pain and radiating pain on both legs were reduced.

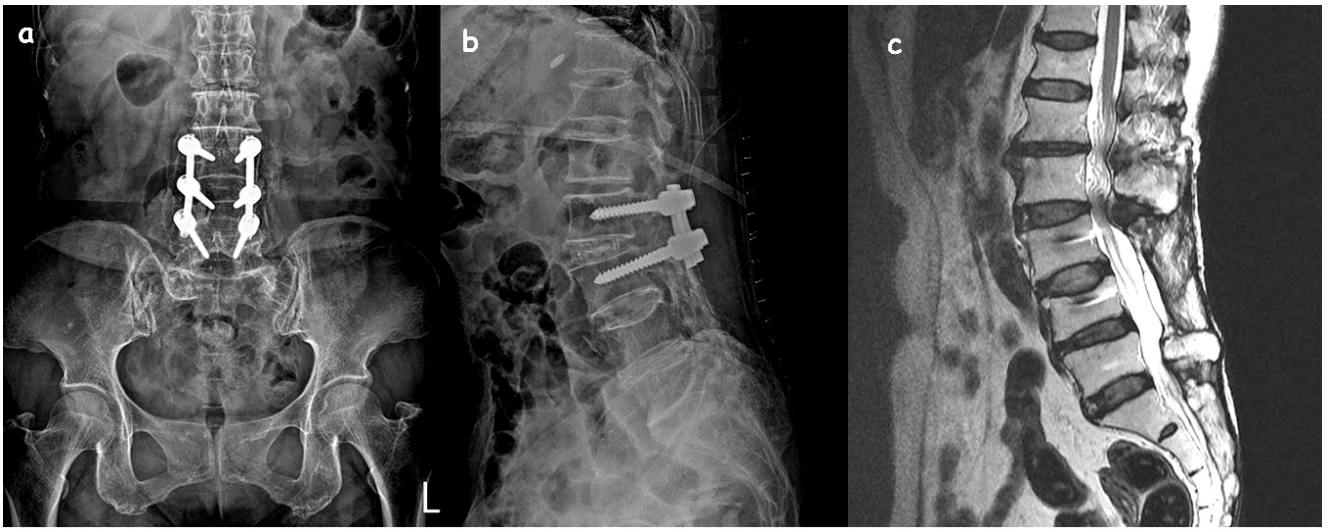

Figure-3. a) Preoperative radiograph of 73-year-old female showed a solid posterolateral fusion from L3 to L5. **b)** Preoperative MRI showed a severe spinal stenosis at L2-3. **c)** After spinal implant removal, decompressive laminectomy and reimplantation were performed from L2-3.

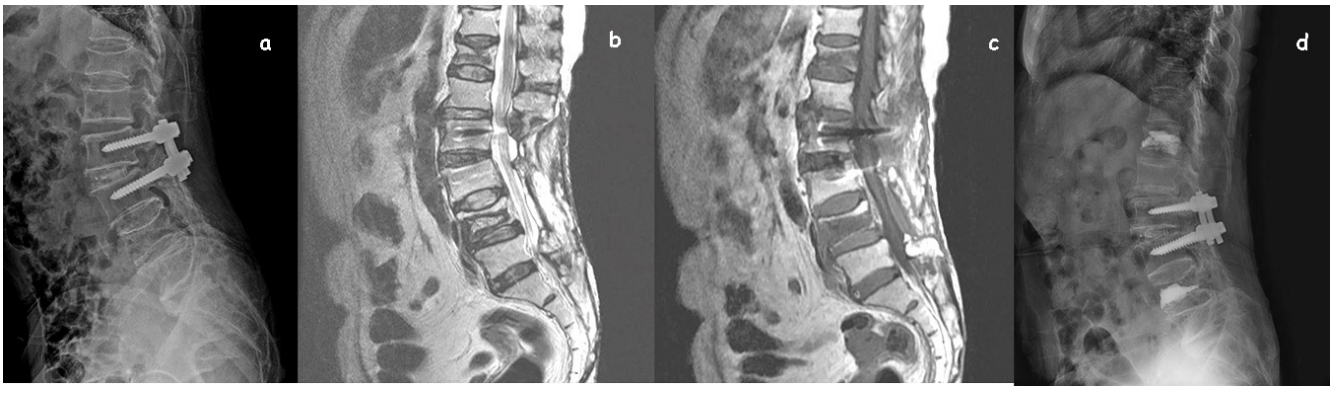

Figure-4. a) At 5 months after surgery, decreased vertebral body height in lateral plain X-ray was found at T12 and L4. **b-c)** At 5 months after surgery, MRI scans showed a compression fracture at T12 and L4. **d)** She underwent percutaneous vertebroplasty with polymethyl metacrylate (PMMA) at T12 and L4.

DISCUSSION:

Posterior spinal fusion is still one of the effective treatment options for various spinal problems. However, the decreased number of motion segments as a result of fusion would suggest some problems, such as adjacent segment diseases and stress fracture of the neural arch[4,7]. Spinal implant removal is sometimes inevitable for the management of adjacent segment degeneration or diseases. But, it is sometimes difficult to decide whether screws should be reinserted into the screw holes previously made by short-segment spinal fusion.

In our cases, removal of instrument was performed because it was thought that solid fusion was achieved at the previous fusion site. Consequently, vertebral body fractures in the middle of fused segment were occurred. Our cases have some interesting points. The fractures in our cases were occurred within the fused segment, not in adjacent fusion segments or unfused segments.

Although the causes of vertebral body fractures among fused segments have not been determined, solid fusion on lateral flexion and extension radiographs allows some sagittal motion of 3° to 5°[5-6]. Ha et al suggested in their case report that bilateral pedicle stress fractures could be caused by stress resulting from cantilever motion in the anterior disc portion after posterolateral lumbar fusion[4].

Previous studies have reported that vertebral body osteopenia may occur as a result of an instrumented spinal fusion[8-9,13]. The use of rigid posterior instrumentation, including pedicle screws, may shield the vertebral body from adequate compression force, preventing proper remodeling and causing decreased bone density[2,12]. After implant removal, a fracture of the posterolateral fusion mass or an undetected pseudoarthrosis may lead to occur vertebral body fracture in the fused segments.

Waelchi et al described that the upper most vertebral fractures in fused segments after implant removal might result from a subcortical substance defect of screw tracks with weakening of osteoporotic vertebral bodies[13].

Initially, this area is protected by the posterior instrumentation. Deckey et al described that the long posterior fusion may function as a large lever, leading to collapse at the junction between fused and unfused anterior segments after implant removal[2]. Our cases were similar to those reported cases, but the fracture in our cases were developed within middle of fused segments.

The most important concern is the stress-shielding effect of rigid implants. Anterior disc can move to an extent despite solid posterolateral fusion. In addition, the previously inserted holes left in the vertebral body after pedicle screw removal could have acted as stress raisers in the vertebral body, which could have been aggravated by anterior motion[5]. In addition, we may consider various treatment options in the patients who have vertebral body fracture at the middle of fused segments after removal of spinal implants. When the patients' symptoms are mild, we may provide the conservative care. However, if the patients have severe low back pain or neurologic deficits, we should consider the additional surgery such as percutaneous vertebroplasty using PMMA or extended spinal fusion.

Vertebral body fractures in the middle of fused segments after implant removal may be developed by persistent anterior disc motion after posterolateral lumbar fusion, osteopenia or osteoporosis, and a subcortical substance defect of the screw holes made by implant removal. Patients must be thoroughly informed of the rare but potential risks of implant removal, particularly if they have osteoporosis. If removal of the previously inserted implant is needed, surgeons should be aware of this significant complication.

REFERENCES:

1. Aota Y, Kumano K, Hirabayashi S. Postfusion instability at the adjacent segments after rigid pedicle screw fixation for degenerative lumbar spinal disorders. *J Spinal Disord* 1995; 8: 464-473.
2. Deckey JE, Court C, Bradford DS. Loss of sagittal plane correction after removal of spinal implants. *Spine* 2000; 25: 2453-2460.
3. Etebar S, Cahill DW. Risk factors for adjacent-segment failure following lumbar fixation with rigid instrumentation for degenerative instability. *J Neurosurg* 1999; 90: 163-169.
4. Ha KY, Kim YH. Bilateral pedicle stress fracture after instrumented posterolateral lumbar fusion: a case report. Spine 2003; 28: E158-160.
5. Ha KY, Kwon SE, Kim KW, Oh IS, Lee YM. Vertebral compression fracture in the middle of fused segments without a history of injury: a case report. Spine 2010; 35: E137-139.
6. Larsen JM, Rimoldi RL, Capen DA, Nelson RW, Nagelberg S, Thomas JC Jr. Assessment of pseudarthrosis in pedicle screw fusion: a prospective study comparing plain radiographs, flexion/extension radiographs, CT scanning, and bone scintigraphy with operative findings. *J Spinal Disord* 1996; 9:117-120.
7. Lee CK. Accelerated degeneration of the segment adjacent to a lumbar fusion. *Spine* 1988; 13: 375-377.
8. McAfee PC, Farey ID, Sutterlin CE, Gurr KR, Warden KE, Cunningham BW. 1989 Volvo Award in basic science. Device-related osteoporosis with spinal instrumentation. *Spine* 1989;14: 919-926.
9. Myers MA, Casciani T, Whitbeck MG Jr, Puzas JE. Vertebral body osteopenia associated with posterolateral spine fusion in humans. *Spine* 1996; 21: 2368-2371.
10. Ohlin A, Karlsson M, Düppe H, Hasserius R, Redlund-Johnell I. Complications after transpedicular stabilization of the spine. A survivorship analysis of 163 cases. Spine 1994; 19: 2774-2779.
11. Park P, Garton HJ, Gala VC, Hoff JT, McGillicuddy JE. Adjacent segment disease after lumbar or lumbosacral fusion: review of the literature. *Spine* 2004; 29: 1938-1944.
12. Smith KR, Hunt TR, Asher MA, Anderson HC, Carson WL, Robinson RG. The effect of a stiff spinal implant on the bone-mineral content of the lumbar spine in dogs. *J Bone Joint Surg* 1991; 73-A:115-123.
13. Waelchli B, Min K, Cathrein P, Boos N. Vertebral body compression fracture after removal of pedicle screws: a report of two cases. *Eur Spine J* 2002; 11: 504-506.

Volume: 27, Issue: 3, July 2016 pp: 165/170 CASE REPORT / OLGU SUNUMU

MULTIPLE MENINGEAL CYSTS: CASE REPORT

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SUMMARY:

Multiple extradural meningeal cysts of the spine are uncommon. A 58-year-old male presented with multiple meningeal cysts arising along the whole craniospinal axis, manifesting as back pain and truncal ataxia persisting for 6 months. A 72-year-old female presented with multiple thoracic extradural spinal meningeal cysts, manifesting as back pain. Two cases of the thoracic spinal extradural meningeal cysts were treated surgically with costotransversectomy and cyst was removed totally. Histological examination confirmed the diagnosis of meningeal cysts.

Key words: Leptomeningeal cyst, spinal extradural meningeal cyst, perineural cyst

Level of evidence: Case report, Level IV

ÖZET:

Omuriliğin çoklu ekstradural meningeal kistleri nadir görülür. Sırt ağrısının ve gövde ataksisinin 6 aydır devam ettiği ve tüm omurilik boyunca çoklu meningeal kistleri bulunan biri 58 yaşında erkek, sırt ağrısı şikayeti olan ve torakal ekstradural çoklu meningeal kistleri bulunan diğeri 72 yaşında bayan olgular sunuldu. iki olguya cerrahi olarak kostatransversektomi ile kistin total eksizyonu uygulandı. Histopatolojik incelemeler meningeal kist tanısını onaylıyordu.

Anahtar Sözcükler: Leptomeningeal kistler; Spinal ekstradural meningeal kistler; perinöral kist

Kanıt Düzeyi: Olgu sunumu, Düzey IV

INTRODUCTION:

Multiple spinal meningeal cysts are uncommon and rarely cause of neural compression. Meningeal cysts classification were presented extradural meningeal cyst, leptomeningeal cyst, perineural cyst, meningeal diverticulum, prolonged subarachnoid space over root[1]. After then, Nabors et al.[2] was presented spinal meningeal cysts simplify classification. Spinal meningeal cysts are described between % 1-3 of all spinal cord lesion[3]. Likewise, cranial arachnoid cysts most commonly occurs in the middle cranial fossa, followed by the suprasellar and quadrigeminal cisterns, posterior fossa, cerebral convexities, and interhemispheric fissure[3].

Multiple intracranial arachnoid cysts located at different sites are extremely rare. Tsutsumı et al.[3] are presented case of rare multiple cranial arachnoid cysts and multiple spinal meningeal cyst. We have described two patients with multiple meningeal cyst, firstly patient cervical, thoracic, lumbar multiple meningeal cysts and with concomitant multiple intracranial arachnoid cysts, second patient thoracic multiple meningeal cysts.

CASE REPORTS:

Case-1:

58 year old male patient, severe back pain for 6 months had increased. Neurological examination was unremarkable. Direct radiographs showed T10 foraminal enlargement and Neural sheath tumors were considering radiological investigations. Torakolumbar magnetic resonance imaging (MRI), T1- weighted images hypointense, T2-weighted images hyperintense left ekstraforaminal paravertebral area at the level of T10-11 intervertebral disc lesions 3 cm in diameter were seen (Figure-1).

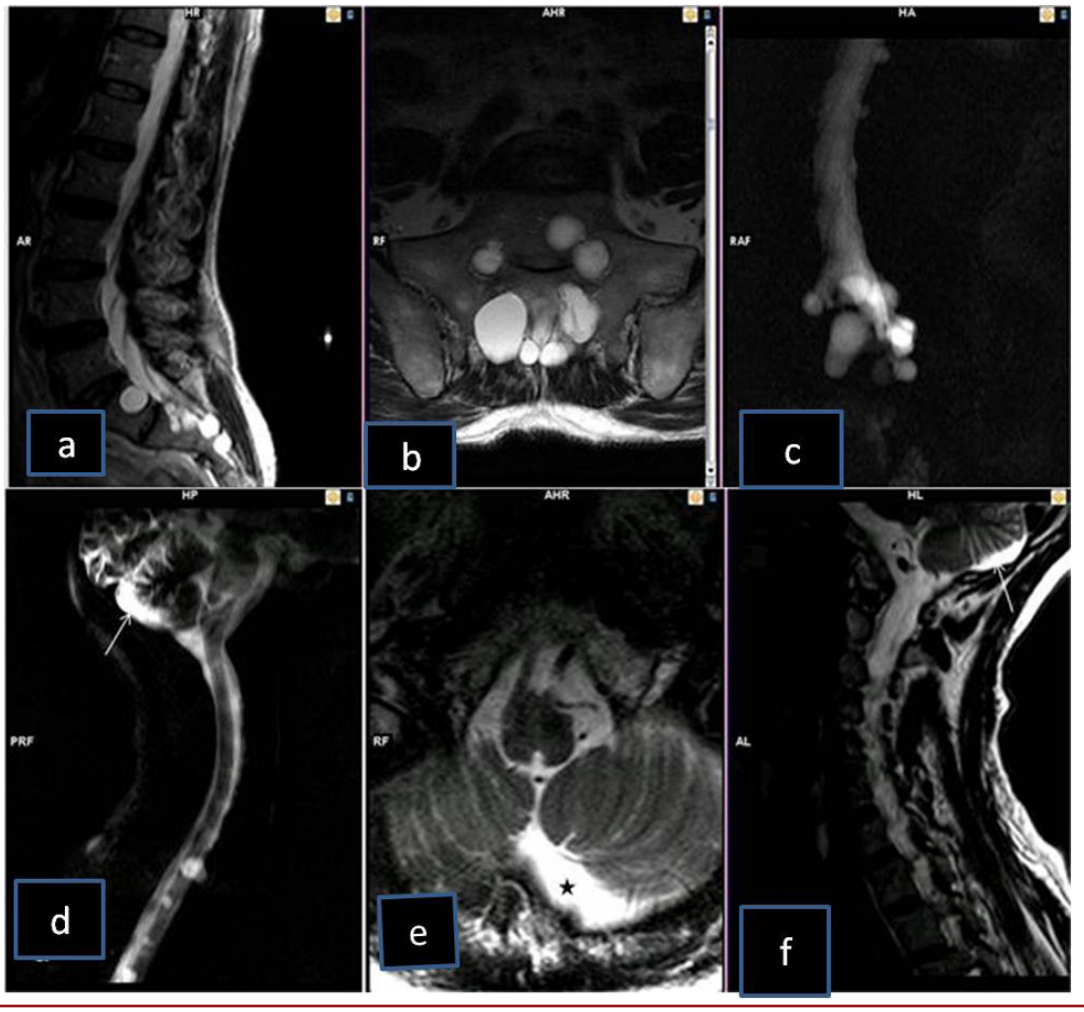

Figure-1. a-b-c. Case-1. Lumbar L5-S1 MRI T2 Image showed spinal extradural, foraminal / extraforaminal, corpus vertebrae eroded appearance of the perineurial cyst. **d-e-f:** Arachnoid cyst on the left side view of the left cerebellar hemisphere and pons.

The mass had a smooth-edged image without contrast enhancement. MR myelography examination, we are a large number of different locations along the vertebral column perineural / meningeal cysts have seen. L5-S1 Lumbar MRI showed bone erosion of the perineurial cysts (Figure-2).
The patient was evaluated for a systemic connective tissue diseases, but pathological finding was not detected.

Cranial MRI images were consistent with an arachnoid cyst on the left retroserebellar small region (Fig1). All along the spinal axis and the cranial region of the patient with multiple cysts were detected. Operation was planned because the patient had pain unresponsive to analgesics. The patient underwent a posterior approach costo-transversectomy left T10 level. Extraforaminal extradural cystic lesion was detected surrounding tissue freed and neck of the cyst was found, by combining them with silk suture was excised totally. Fluid-filled cystic lesion was similar in the CSF completely clear. Biochemistry was consistent with CSF. The histological diagnosis was arachnoid cysts consisting of multilayered mesodermal cells lining the collagenous membrane and arachnoid cells lining the iner surface of the wall, with few blood vessels (Figure-3).

The patient's pain complaints were reduced and patients were followed for the other lesions.

Case-2:

72-year-old female patient, Available for 10 years, complained of shortness of breath and cough was admitted. Due to increases in the last 10 days, the patient complains of chest diseases clinic by thoracic CT taken application. Thoracic computerize tomography (CT), right lateral of the T10 vertebral lesion 3x2 cm with smooth margins was seen. Thoracic MRI showed, multple levels foraminal / extra foraminal, isointense with CSF, or nerve root on the smooth contours of meningeal cyst had enlarged subarachnoid space views. (Figure-4).

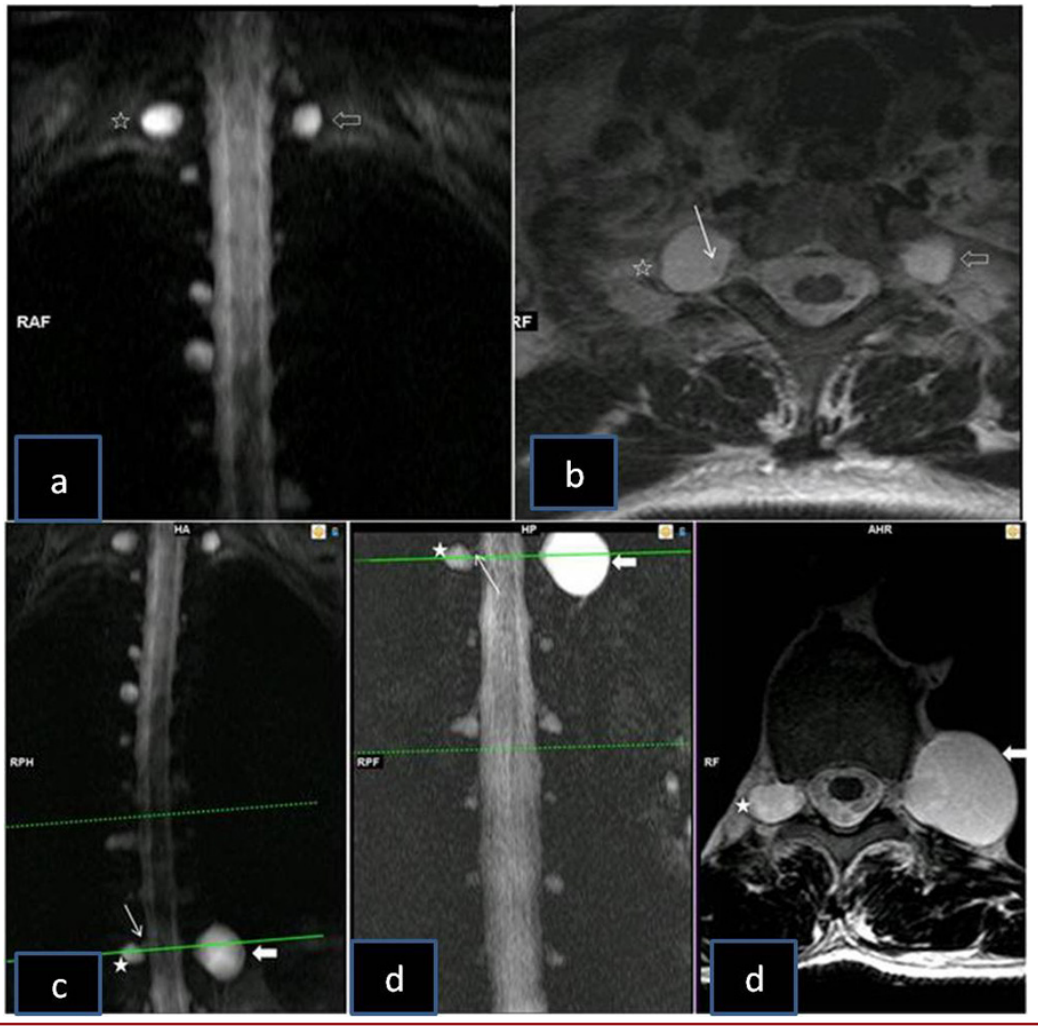

Figure-2. Case 1. C7-T1 Extraforaminal bilateral extradural meningeal cyst, prolongation of the subarachnoid space over the region of multiple thoracic nerve root, meningeal diverticulum. T10 left foraminal, extraforaminal meningeal cyst.

The patient did not respond to analgesics localization of the largest cyst had a complaint of back pain. The patient underwent a posterior approach costo-transversectomy left T10 level. Intercostal nerve was seen and follow-up, the cyst was separated from the root level of foremen, were evaluated as CSF fluid from the cyst puncture was performed. Then connected to the neck of the cyst was totally removed. Postoperative radiographs were showed the cyst was completely removed (Figure-4). Histopathologic examination of the meningeal cyst was diagnosed (Figure-3).

DISCUSSION:

A spinal extradural meningeal cysts represents a rare disease. Meningeal cysts initially develop as outpouchigs from the subaracnoid space.

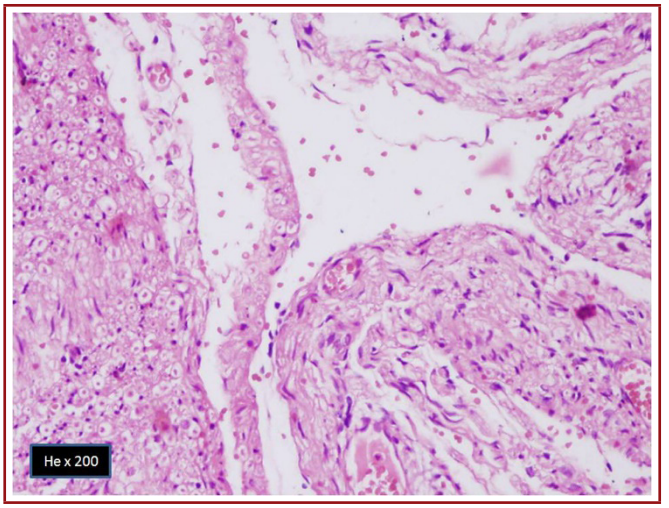

Figure-3. Histopathologic examination of the meningeal cyst. Hematoksilen eozin x200.

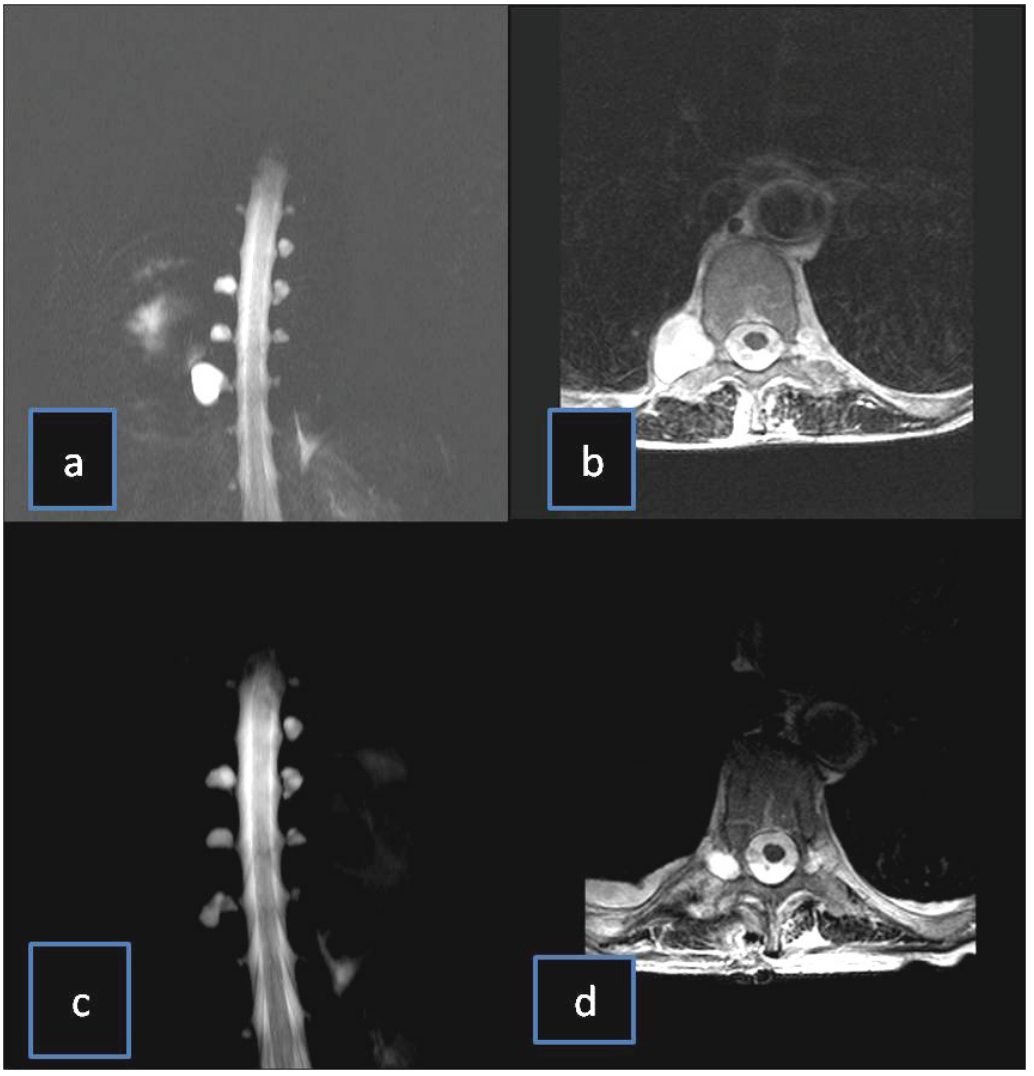

Figure-4. a-b. Case-2. T10 right foraminal, extraforaminal meningeal cyst, Prolongation of the subarachnoid space over the region of multiple thoracic nerve root, the meningeal diverticulum.

They may be either extradural, in which case they have a fibrous wall lined with arachnoid mater, or intradural and hence leptomeningeal. The extradural variety may be spontaneous or less commonly traumatic. Commonly they lie posterior to the cord at the thecal sac–nerve root sleeve junction, the dorsal midline, or the nerve root sleeve itself, but they manifest in anterior positions within the spinal canal as well[1]. A few have been reported to extend into or through a neural foramen[8].

We are presented foraminal/extraforaminal cysts rarely seen. Spinal extradural meningeal cysts most frequently develop in the thoracic spine (% 65); thereafter, in descending order, they are found in the lumbar and lumbosacral spine (% 13), the thoracolumbar spine (% 12), the sacral spine (% 6.6), and the cervical spine (% 3.3)[6].

Reports of multiple spinal extradural meningeal cysts are extremely rare. To the best of our knowledge, there have been only seven other reported cases of multiple extradural arachnoid cysts in the world literature[7,9,11,14,17].

The origin of spinal extradural meningeal cysts is uncertain. A congenital origin is further supported by the fact that previous investigators have described a familial tendency [(3,16)] orassociated congenital abnormalities[8]. Extradural arachnoid cysts may also be caused by acquired factors such as inflammation or trauma, or by iatrogenic factors such as surgery or repeated lumbar punctures[8]. In all cases, however, the disease results from the herniation of the arachnoid through a defective or fragile dura mater regardless of whether this dural rent is acquired, congenital, or idiopathic in nature.

Spinal meningeal cysts communicated with the subarachnoid space. More debated are the mechanisms by which to explain the enlargement of extradural meningeal cysts. The exact mechanism of formation and enlargement is not known[8]. Many authors have described slitlike communications with the subarachnoid space and therefore support a valvelike mechanism with which to explain the continuous enlargement of the lesion[4,5,10,13]. This valve mechanism, which would make intracystic pressure greater than normal CSF pressure, could explain the incidence of bone erosion at the site of spinal extradural meningeal cysts[8].

Meningeal cysts firstly classification were presented extradural meningeal cyst, leptomeningeal cyst, perineurıal cyst, meningeal diverticulum, prolonged subarachnoid space over root[15]. Nabors et al[12] proposed a classification of spinal meningeal cysts in to three major categories: extradural cysts without nerve root fibers (Type-I); extradural cysts with nerve root fibers (Type-II); and intradural cysts (Type-III). We cases are type 1 meningeal cysts.

The clinical symptoms are related to the compression of the spinal cord or nerve roots. Patients usually present clinically with progressive spastic or flaccid para- or tetraparesis. Bowel or bladder dysfunction may occur in individuals with sacral cysts[8]. The disease frequently manifests with mild but intractable back pain and then with additional clinical symptoms over months or years. The intermittent exacerbations of pain and neurological symptoms are explained by postural changes and Valsalva maneuvers[2]. We cases presently clinically with intractable back pain.

In general, asymptomatic patients do not need surgery. Surgery is usually recommended in cases involving a large cyst exerting a mass effect and with associated symptoms [(6)]. Although in all of these options favorable results have been reported, most authors recommend extirpating the cyst to eradicate the valvelike mechanism[4-5,13]. Because of we cases presently intractable back pain, cysts were extirpated of the costotransversectomy.

Multiple spinal extradural meningeal cysts are extremely rare. The origin of the cysts in our cases are believed to be congenital. Magnetic resonance imaging is the investigation of choice. We believe that removal of the cyst, as performed in our cases, is the primary treatment in symptomatic patients. The diagnosis is established based on imaging, intraoperative, and histopathological findings.

REFERENCES:

1. Cilluffo JM, Gomez MR, Reese DF, Onofrio BM, Miller RH. Idiopathic ("congenital") spinal arachnoid diverticula. A clinical diagnosis and surgical results. *Mayo Clin Proc* 1981; 56: 93–101.
2. Cloward RB. Congenital spinal extradural cysts: case report with review of literature. *Ann Surg* 1968; 168**:** 851–864.
3. Durmaz R, Özturk Z, Delen E, Çiftci E, Atasoy M. A. Symptomatic foraminal extradural meningeal cyst. *Turkish Neurosurgery* 2009; 19(1): 91-95.
4. Gortvai P, El-Gindi S. Spinal extradural cyst. Case report. *J Neurosurg* 1967; 26**:** 432–435.
5. Gortvai P. Extradural cysts of the spinal canal. *J Neurol Neurosurg Psychiatry* 1963; 26**:** 223–230.
6. Goyal RN, Russell NA, Benoit BG, Belanger JM. Intraspinal cysts: a classification and literature review. *Spine* 1987; 12**:** 209–213
7. Kronborg O. Extradural spinal cysts. A literature survey and a case of multiple extradural cysts. *Dan Med Bull* 1967; 14: 46–8
8. Marbacher S, Barth A, Arnold M, Seiler RW. Multiple spinal extradural meningeal cysts presenting as acute paraplegia: Case report and review of the literature. *J Neurosurgery Spine* 2007; 6(5): 465-472.

9. Masana Y, Yamada K, Ozaki K, Ushio Y, Hayakawa T, Mogami H, Mitomo M, Kawai R Spinal multiple extradural cyst. Case report. *Neurol Med Chir* 1986; 26: 405–408.

10. McCrum C, Williams B. Spinal extradural arachnoid pouches. Report of two cases**.** *J Neurosurg* 1982; 57**:** 849–852

11. Myles LM, Gupta N, Armstrong D, Rutka JT. Multiple extradural arachnoid cysts as a cause of spinal cord compression in a child. Case report. *J Neurosurg* 1999; 91: 116–120.

12. Nabors MW, Pait TG, Byrd EB, Karim NO, Davis DO, Kobrine AI, Rizzoli HV. Updated assessment and current classification of spinal meningeal cysts. *J Neurosurg* 1988; 68: 366-377.

13. Rohrer DC, Burchiel KJ, Gruber DP. Intraspinal extradural 135 meningeal cyst demonstrating ball-valve mechanism of formation. Case report. *J Neurosurg* 1993; 78**:** 122–125.

14. Takagaki T, Nomura T, Toh E, Watanabe M, Mochida J. Multiple extradural arachnoid cysts at the spinal cord and cauda equina levels in the young. *Spinal Cord* 2006; 44: 59–62.

15. Tarlov IM. Spinal perineurial and meningeal cysts. *J Neurol Neurosurg Psychiat* 1970; 33: 833-843.

16. Tei R, Morimoto T, Miyamoto K. Dural repair for intraspinal extradural meningeal cyst. *Neurol Med Chir* 2007; 47(9): 434-437.

17. Tsutsumi S, Yasumoto Y, Ito M. Multiple meningeal cysts affecting the whole craniospinal axis. Case report. *Neurol Med Chir* 2009; 49(8): 374-376.

Volume: 27, Issue: 3, July 2016 pp: 171/176 CASE REPORT / OLGU SUNUMU

A RARE PRESENTATION OF POLYOSTOTIC FIBROUS DYSPLASIA IN CERVICAL, THORACIC AND LUMBAR SPINE

SERVİKAL, TORAKAL VE LOMBER OMURGAYI BİRLİKTE TUTAN NADİR BİR POLİOSTOTİK FİBRÖZ DİSPLAZİ OLGUSU

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SUMMARY:

A 30 years old male applied to our institution with the complaint of back pain due to polyostotic fibrous dysplasia (PFD) involving the posterior elements of C5 vertebra and the bodies of T5, T10, T12, L1 and L5 vertebrae, left iliac bone and right proximal femur. He had a previous history of open nonspecific T12 biopsy and three level posterior spinal instrumentation. Re-biopsy was performed and PFD diagnosis was confirmed. In the same session with open biopsy, spinal instruments were extracted due to local pain caused by their superficial position under the skin. Following the procedure, pain relieved. The patient remains asymptomatic at 26 months postoperatively

There are few studies demonstrating PFD in the spinal column. Cervical, thoracic and lumbar spine, pelvis and proximal femur involvement altogether is rare. This is the first report of polyostotic fibrous dysplasia involving cervical, thoracic and lumbar spine together with pelvis and proximal femur.

Key words: Fibrous dysplasia, polyostotic variant, cervical, thoracic, lumbar, spine.

Level of evidence: Case report, Level IV.

ÖZET:

Otuz yaşında bir erkek hasta hastanemize C5 vertebranın arka elemanlarını ve T5, T10, T12, L1 ve L5 vertebraların cisimlerini, sol iliak kemik ve sağ proksimal femuru tutan polyostotik fibröz displaziye (PFD) bağlı sırt ve bel ağrısıyla hastanemize başvurdu. Hastanın anamnezinde daha önce dış merkezde yapılmış olan T12'den açık nonspesifik bir biyopsi ve bu seviyenin bir üst ve altı dahil olmak üzere 3 seviye spinal enstrümentasyon hikayesi mevcuttu. Hastaya cerrahi müdahalede bulunuldu. Açık re-biyopsi yapıldı ve aynı seansta tüm spinal implantlar ciltaltında yüzeyel yerleşim sebebiyle ağrıya sebep olduklarından dolayı çıkartıldı. İşlem sonrası hastanın ağrıları azaldı. Yirmi altı aylık takip sonunda son kontrolde hasta ağrısızdı.

Literatürde omurgada PFD'ye ilişkin az sayıda çalışma bulunmaktadır. Servikal, torasik ve lomber omurgayla birlikte aynı zamanda iliak kemik ve proksimal femur tutulumu olan bu olgu literatürde bildirilen ilk vakadır

Anahtar kelimeler: Fibröz displazi, polyostotik varyant, torasik, lomber, omurga.

Kanıt düzeyi: Olgu sunumu, Düzey IV.

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INTRODUCTION:

Fibrous dysplasia (FD) is a benign bone lesion characterized with irregularly shaped, fibroblastic tissue that contains metaplastic woven bone tissue[8,9]. Disease is subcategorized on the basis of number of bone involvement. Monostotic fibrous dysplasia (MFD) is the one bone involved form and seen more frequently, whereas polyostotic fibrous dysplasia (PFD) is the multiple bone involved form. FD occurs commonly in the extremities. Axial skeleton is rarely affected. PFD commonly effects the skull bones[13,27]. Both MFD and PFD limited to the spine have been reported in the literature[1-2,14,16-18,20,22,25-26,30-32]. The spine is reported to be involved in 1,4 % to 5,5 % of fibrous dysplasia cases[3,12,23]. Vertebral bone involvement is rarely (~4%) seen in PFD[17]. Spinal cases with PFD are generally asymptomatic and diagnosed co-incidentally[10,26].

Both MFD and PFD limited to the spine have been reported in the literature[1,14,17-18,20,22,25-26,30-31]. The spine is reported to be involved in 1,4% to 5,5% of fibrous dysplasia cases[3,12,23]. Vertebral bone involvement is rare (~4%)[17]. Spinal PFD is generally asymptomatic and often picked up incidentally[10,26]. The unique aspect of this report is that, this is the first demonstrated case of PFD involving multi-level spine, pelvis and proximal femur.

CASE REPORT:

A 30 year old male presented to the clinic with left groin and back pain of 1 year duration. He had a history of a nonspecific T12 biopsy performed in another institution 8 years before. Following biopsy, T11-L1 short segment posterior spinal instrumentation was performed for fusion in the same institution.

On physical examination, a thoracolumbar 6 cm long previous operation scar was noted. The pain flared up with bending, flexion and extension motion of the trunk and palpation on the left iliac crest and the incision site. There was no neurological deficit.

Direct radiographies followed by magnetic resonance imaging (MRI) of the whole spinal column and pelvis were performed. A mild sagittal imbalance was observed on lateral whole spinal column radiography. Osseous lesions involving the posterior elements of C5 vertebra, the bodies of T5, T10, T12, L1 and L5 vertebrae were detected on MRI. MRI also revealed non-destructing lesions in the iliac bone and femur cortices. A bone scan demonstrated increased uptake in the body of L5 vertebra, bilateral sacroiliac joints and the right iliac crest but not in the other lesions revealed by MRI (Figure-1).

All laboratory test results were within normal ranges.

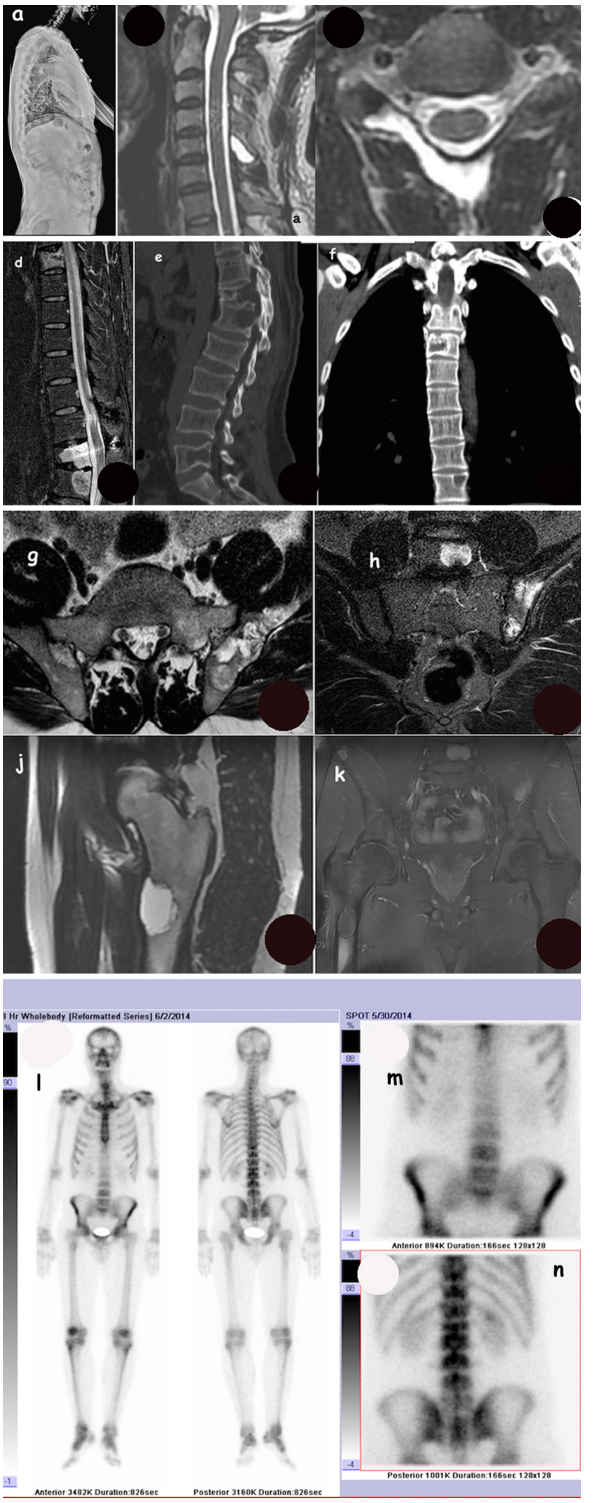

Figure 1. a) Preoperative lateral direct radiograph of the patient. Note the mild sagittal imbalance. **b-c)** Sagittal and axial MRI revealing the lesion in C5 vertebra. **d-e-f)** Sagittal MRI and CT reveal the lesions in T5 and T10, **g-h-j-k)** T12 and L1 and L5 vertebrae. Pelvic lesions demonstrated in axial and coronal MRI and right proximal femoral lesions demonstrated in sagittal and coronal MRI. **l-m-n)** The bone scan performed in the patient.

Open re-biopsy was performed from the bodies of T12 and L1 vertebrae and previous posterior instrumentation was removed in the same session because of the superficial position of the implants under the skin, leading local pain. Posterior fusion was observed during surgery and as the spinal column was found stable a new instrumentation was not performed.

The histopathological evaluation confirmed PFD with multiple bone involvement after positive pathology with cellular fibrous matrix and poorly oriented bony trabeculae.

Following the surgery, although there was mild sagittal imbalance, back pain relieved and groin pain was controlled with medications. No post operative complication was observed. The patient remains asymptomatic at 26 months postoperatively (Figure-2).

Figure-2. Lateral radiograph obtained at the end of the 26th postoperative month.

DISCUSSION:

Fibrous dysplasia is a benign neoplastic lesion characterized with the replacement of medullary normal trabecular bone with immature fibro-osseous tissue. Generally the lesions progress slowly. Genetical mutation in the GNAS1 gene which encodes alpha subunit of stimulatory G protein is reported[24]. The disease has two forms: monostotic and polyostotic form. MFD is more common than polyostotic form[25]. PFD is associated with McCune-Albright syndrome in which, cutaneous and endocrine manifestations are accompanied with fibrous dysplasia[4].

FD is generally an asymptomatic disease. It is usually diagnosed co-incidentally on radiographies[22]. In few symptomatic patients, pain, swelling and deformity are the main manifestations. In a small percentage of patients pathologic fractures may be seen[2,12,19]. Malignant formation occurs with a incidence of 0.5 % in MFD but in McCune Albright syndrome this ratio rises up to 4 %[12]. In our case, back and groin pain were the main symptoms.

Radiographic findings of fibrous dysplasia include a matrix "ground glass" apperance of marginal sclerosis near the lytic zones[7]. Only radiographic findings are not sufficient for a definite diagnosis of fibrous dysplasia. A needle biopsy is used to rule out hemangioma, giant cell tumor and aneurysmal bone cyst diagnosis. In the elderly, multiple myeloma and metastatic carcinoma should also be considered[7].

Computerized tomography (CT) scan can be the best imaging modality to demonstrate the radiographic characteristics of FD[13]. A CT scan confirms decreased cancellous bone and cortical thinning, ballooning, or collapse of vertebrae[13]. In our case CT scan revealed lithic lesions in the cervical, thoracic and lumbar segments both in the posterior elements and the vertebral bodies (Figure-3).

MRI is useful as it reveals the extent of tumor involvement, extent of neural compression, and contributes for the differential diagnosis. FD appears as a homogeneous hypo-intense lesion on T1-weighted imaging unless there is a pathologic fracture. On T2-weighted imaging, the lesion is heterogeneous depending on the amount of fibro-osseous tissue, cellularity, cystic alterations, hemorrhage, and thus, FD appears hypo-intense on both T1 and T2-weighted imaging, and uniformly enhances after intravenous gadolinium. MRI revealed similar findings also in our patient. A bone scan may also help for diagnosing PFD, as in our case[29].

Due to the rarity of PFD in spinal column, the optimal treatment options are unclear. Treatment options may include nonoperative and operative treatments. Nonoperative treatment include calcitonin, biphosphonates, mitramycin and pamidronate[28].

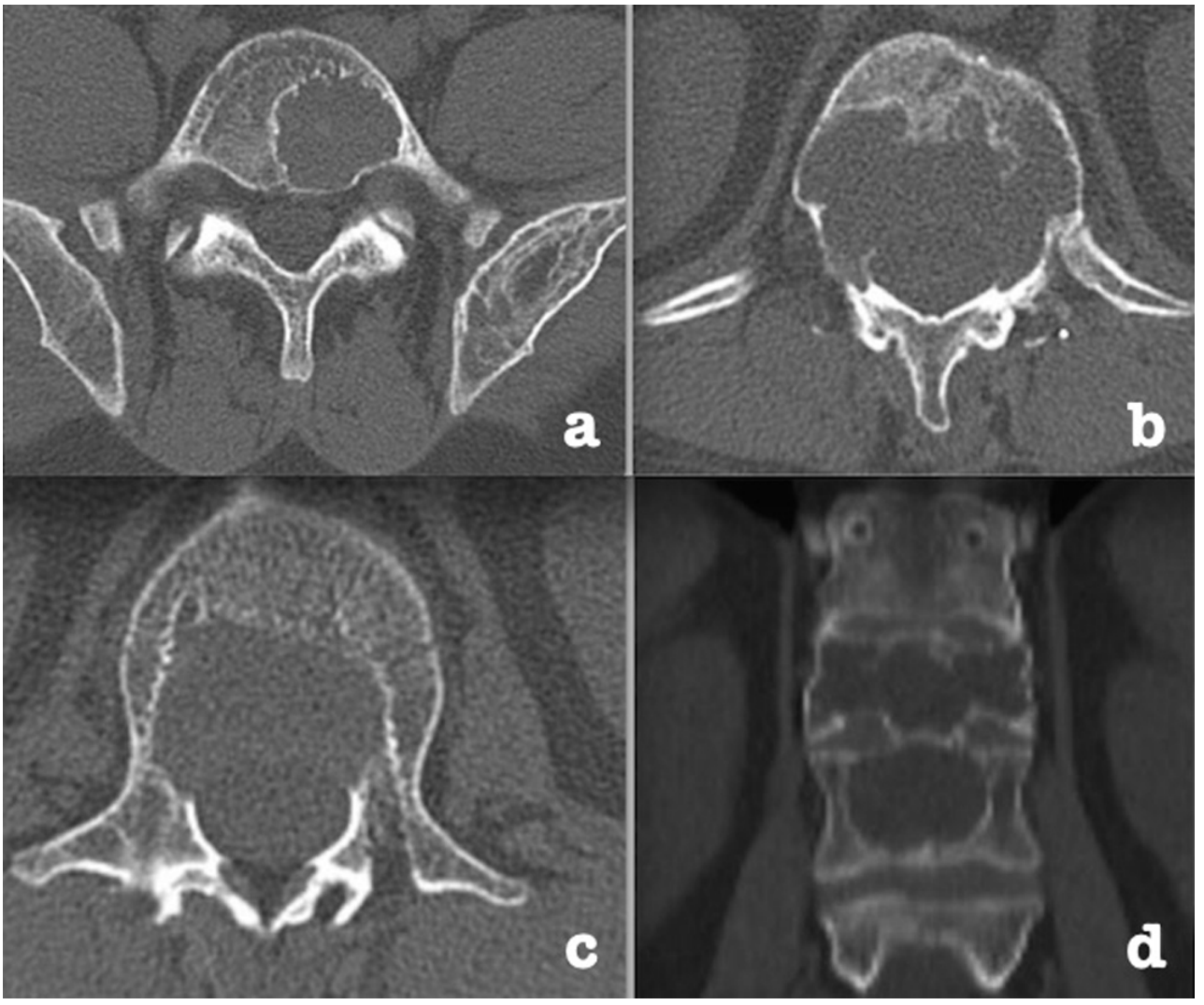

Figure-3. Axial and coronal CT images revealing **a)** the lesions in L5, **b-c-d)** T12 - and L1 vertebrae.

Curettage, internal fixation and bone grafting are the operative treatment modalities[28]. Agressive resection and rigid fixation with fusion are suggested by some authors[18,21,30]. However FD becomes silent or rarely regress after the end of the bone growth. Thus, this approach is controversial[1,22,28]. In the more common case of FD involving the non-axial skeleton, many cases have been managed conservatively, even following pathological fracture[10-11].

Indeed, some have also advocated conservative management for vertebral FD[28,31], in particular with PFD, where such lesions are frequently asymptomatic. For example, Smith et al. conservatively managed a patient with multilevel cervical spine PFD for over 30 years, during which time several vertebrae had spontaneously fused[26].

Surgery, however, is usually indicated in cases with fracture[6,17], neurological deficit[32], progressive deformity[14,16] or persistent pain[5].

The cases with cervical, thoracal and lumbar involvement are reported in polyostotic fibrous dysplasia before[14,16-17]. In this case, polyostotic fibrous dysplasia involves theposterior elements of C5 vertebra, the bodies of T5, T10, T12, L1 and L5 vertebrae, left iliac bone and the right proximal femur. The main complaint of the patient was back and left groin pain. After removal of previous posterior spinal instrumentation, back pain mostly relieved and left groin pain was controlled with medications.

Fibrous dysplasia of the spine is a rare condition. Multiple spinal segments can be involved. Polyostotic fibrous dysplasia may be a part of systemic disease. This patient had multisegment spinal, pelvic and right femur involvement. After implant removal, patient's pain relieved and did not need any radical surgery. At the 26 months follow up, patient did not have any complaints about pain or sagittal imbalance.

REFERENCES:

1. Alvares LC, Capelozza AL, Cardoso CL, Lima MC, Fleury RN, Damante JH. Monostotic fibrous dysplasia: a 23-year follow-up of a patient with spontaneous bone remodeling. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009; 1*07*(2): 229-234.
2. Arazi M, Guney O, Ozdemir M, Uluoglu O, Uzum N. Monostotic fibrous dysplasia of the thoracic spine: clinopathological description and follow up. Case report. *J Neurosurg* 2004; 100(4 Suppl.): 378-381.
3. Bianco P, Riminucci M, Majolagbe A, Kuznetsov SA, Collins MT, Mankani MH, Robey PG. Mutations of the GNAS1 gene, stromal cell dysfunction, and osteomalacic changes in non-McCune-Albright fibrous dysplasia of bone. *J Bone Miner Res* 2000; 15(1): 120-128.
4. Boyce AM, Collins MT. Fibrous Dysplasia/McCune-Albright Syndrome. In: Pagon RA, Adam MP, Ardinger HH, Wallace SE, Amemiya A, Bean LJH, Bird TD, Dolan CR, Fong CT, Smith RJH, Stephens K (Eds.). *Gene Reviews*. University of Washington Press, Seattle 1993.
5. Chen G, Yang H, Gan M, Li X, Chen K, Nalajala B, Wang G. Polyostotic fibrous dysplasia of the thoracic spine: case report and review of the literature. *Spine* 2011; 36(22): E1485-1488.
6. Deen HG, Fox TP. Balloon kyphoplasty for vertebral compression fractures secondary to polyostotic fibrous dysplasia. Case report. *J Neurosurgery Spine* 2005; 3(3): 234-237.
7. DiCaprio MR, Enneking WF. Fibrous dysplasia. Pathophysiology, evaluation, and treatment. *J Bone Joint Surg* 2005; 87-A(8): 1848-1864.
8. Firat D, Stutzman L. Fibrous dysplasia of the bone. Review of twenty-four cases. *Am J Med* 1968; 44(3): 421-429.
9. Gibson MJ, Middlemiss JH. Fibrous dysplasia of bone. *Br J Radiol* 1971; 44(517): 1-13.
10. Harris WH, Dudley HR, Barry RJ. The natural history of fibrous dysplasia. An orthopaedic, pathological, and roentgenographic study. *J Bone Joint Surg* 1962; 44-A: 207-233.
11. Henry A. Monostotic fibrous dysplasia. *J Bone Joint Surg* 1969; 51-B(2): 300-306.
12. Ippolito E, Bray EW, Corsi A, De Maio F, Exner UG, Robey PG, Bianco P. Natural history and treatment of fibrous dysplasia of bone: a multicenter clinicopathologic study promoted by the European Pediatric Orthopaedic Society. *J Pediatr Orthop* 2003; 12(3): 155-177.
13. Lambert PR, Brackmann DE. Fibrous dysplasia of the temporal bone: the use of computerized tomography. *Otolaryngol Head Neck Surg* 1984; 92(4): 461-467.
14. Leet AI, Magur E, Lee JS, Wientroub S, Robey PG, Collins MT. Fibrous dysplasia in the spine: prevalence of lesions and association with scoliosis. *J Bone Joint Surg* 2004; 86-A(3): 531-537.
15. MacDonald-Jankowski DS. Fibro-osseous lesions of the face and jaws. *Clin Radiol* 2004; 59(1): 11-25.
16. Mancini F, Corsi A, De Maio F, Riminucci M, Ippolito E. Scoliosis and spine involvement in fibrous dysplasia of bone. *Eur Spine J* 2009; 18(2): 196-202.
17. Marshman LA, David KM, O'Donovan DG, Chawda SJ. Fibrous dysplasia of the cervical spine presenting as a pathological fracture. *Br J Neurosurg* 2004; 18(5): 527-533.
18. Mezzadri JJ, Acotto CG, Mautalen C, Basso A. Surgical treatment of cervical spine fibrous dysplasia: technical case report and review. *Neurosurgery* 1999; 44(6): 1342-1346; discussion: 1346-1347.
19. Parekh SG, Donthineni-Rao R, Ricchetti E, Lackman RD. Fibrous dysplasia. *J Am Acad Orthop Surg* 2004; 12(5): 305-313.
20. Proschek D, Orler R, Stauffer E, Heini P. Monostotic fibrous dysplasia of the spine: report of a case involving a cervical vertebra. *Arch Orthop Trauma Surg* 2007; 127(2): 75-79.
21. Przybylski GJ, Pollack IF, Ward WT. Monostotic fibrous dysplasia of the thoracic spine. A case report. *Spine* 1996; 21(7): 860-865.
22. Rosenblum B, Overby C, Levine M, Handler M, Sprecher S. Monostotic fibrous dysplasia of the thoracic spine. *Spine* 1987; 12(9): 939-942.
23. Saglik Y, Atalar H, Yildiz Y, Basarir K, Erekul S. Management of fibrous dysplasia. A report on 36 cases. *Acta Orthop Belg* 2007; 73(1): 96-101.
24. Shenker A, Weinstein LS, Sweet DE, Spiegel AM. An activating Gs alpha mutation is present in fibrous dysplasia of bone in the McCune-Albright syndrome. *J Clin Endocrinol Metab* 1994; 79(3): 750-755.
25. Singer J, Sundaram M, Merenda G, Joyce PF. Fibrous dysplasia of thoracic vertebra arising de novo: cheirurgogenic in origin? *Orthopedics* 1991; 14(3): 355-358.
26. Smith MD, Bohlman HH, Gideonse N. Fibrous dysplasia of the cervical spine: a fatal complication of treatment. A case report. *J Bone Joint Surg* 1990; 72-A(8): 1254-1258.

27. Song JJ, Jung HH, Lee HM, Hwang SJ. Monostotic fibrous dysplasia of temporal bone: report of two cases and review of its characteristics. *Acta Otolaryngol* 2005; 125(10): 1126-1129.

28. Stephenson RB, London MD, Hankin FM, Kaufer H. Fibrous dysplasia. An analysis of options for treatment. *J Bone Joint Surg* 1987; 69-A(3): 400-409.

29. Stompro, B. E., Alksne, J. F., Press, G. A.. Diagnosis and treatment of an odontoid fracture in a patient with polyostotic fibrous dysplasia: case report. *Neurosurgery* 1989; 24(6): 905-909.

30. Tezer M, Erturer E, Ozturk C, Aydogan M, Hamzaoglu A. Symptomatic polyostotic fibrous dysplasia of the thoracic spine. *Joint Bone Spine* 2006; 73(6): 742-744.

31. Troop JK, Herring JA. Monostotic fibrous dysplasia of the lumbar spine: case report and review of the literature. *J Pediatr Orthop* 1988; 8(5): 599-601.

32. Wu FL, Liu ZJ, Liu XG, Yang SM, Jiang L, Wei F, Yu M. Polyostotic fibrous dysplasia involving the thoracic spine with myelopathy: case report and review of the literature. *Spine J* 2014; 14(1): e11-15.

Volume: 27, Issue: 3, July 2016 pp: 177/184 REVIEW ARTICLE / DERLEME

RECENT ADVENCES IN MEDICAL TREATMENT OF OSTEOPOROSIS

OSTEOPOZUN MEDİKAL TEDAVİSİNDE GÜNCEL GELİŞMELER

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SUMMARY:

Osteoporosis is the most common bone disease, associated with low bone mineral density (BMD) and pathological fractures which lead to significant morbidity. It is defined clinically by a BMD of 2.5 standard deviations or more below the young adult mean (T-score = −2.5). Osteoporosis is also a huge global problem both socially and economically. Therefore preventative and therapeutic approaches are key to managing this problem within the aging population of today. Pharmacologic therapy for osteoporosis includes the use of antiresorptive agents to decrease bone resorption, such as bisphosphonates, the selective estrogen-receptor modulator (SERM) raloxifene, calcitonin, and denosumab. In addition, there are anabolic steroids that promote bone formation in patients with osteoporosis, such as teriparatide. Also new drugs are emerging for the treatment of osteoporosis, characterized by acting on very specific bone cell physiology.

Key words: Osteoporosis, medical treatment, new medicines.

Level of evidence: Review Article, Level V.

ÖZET:

Osteoporoz, düşük kemik mineral yoğunluğu ve patolojik kırıklarla seyreden ve belirgin morbiditelere yolaçan en sık görülen kemik hastalığıdır. Tanım olarak kemik mineral yoğunluğunun genç erişkinlere göre 2,5 standart sapma daha daha düşük olması olarak tarif edilebilir. Osteoporoz gerek sosyal, gerek ekonomik olarak da global bir problem halindedir ve bu nedenle giderek yaşlanan popülasyonumuzda koruyucu ve tedavi edici yaklaşımlar son derece önemli bir hale gelmiştir. Osteoporozun farmakololojik tedavisinde, kemik rezorbsiyonunu azaltan, bifosfonatlar, selektif östrojen modülatörü raloksifen, kalsitonin ve denosumab ile kemik yapımını arttıran teriparatid gibi ajanlar kullanılmaktadır. Son dönemde antisklerostin antikoru, katepsin K inhibitörü gibi kemik hücre fizyolojisi üzerine etkileri olan ilaçlar üzerine yapılan çalışmaların artması, osteoporoz tedavisinde daha iyi sonuçlara ulaşılacağını da düşündürmektedir.

Anahtar kelimeler: Osteoporoz, tıbbi tedavi, bifosfonatlar.

Kanıt Düzeyi: Derleme, Düzey V.

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INTRODUCTION:

Osteoporosis is defined by the World Health Organization as a value for bone mineral density (BMD) 2.5 standard deviations or more below the young female adult mean, referred to as a T-score of –2.5, where a T-score of zero is equal to the young female adult mean[8]. For the year 2000, there were an estimated 9 million new osteoporotic fractures, of which 1.6 million were at the hip, 1.7 million were at the forearm and 1.4 million were clinical vertebral fractures.

By 2005, the worldwide incidence of hip fracture in men is projected to increase by 310 % and 240 % in women. Europe and the Americas accounted for 51 % of all these fractures, while most of the remainder occurred in the Western Pacific region and Southeast Asia[16]. Although Turkey is still among the countries with low hip fracture rates in Europe, the incidence has increased markedly in the last 20 years.

In 2009, there were approximately 24,000 hip fractures estimated in Turkey, 73 % of which were found in women. Assuming no change in the age- and sex-specific incidence, the number of hip fractures was expected to increase to nearly 64,000 in 2035[33]. Osteoporosis takes a huge personal and economic toll. In Europe, the disability due to osteoporosis is greater than that caused by cancers (with the exception of lung cancer) and is comparable or greater than that lost to a variety of chronic noncommunicable diseases, such as rheumatoid arthritis, asthma and high blood pressure related heart disease[16].

Identifying and treating patients at risk of fracture, but who have not yet sustained a fracture, will substantially reduce the long term burden of osteoporosis. Reducing the risk of first fracture from 8 % to 2 % can reduce the 5-year fracture incidence from approximately 34 % to 10 % [21]. Treatment of established osteoporosis is cost-effective irrespective of age and therapies with proven rapid efficacy may offer important value to healthcare payers, providers and patients[17]. There is a range of drug treatment available for postmenopausal osteoporosis. Different studies have consistently shown that, depending on the drug and the patient population, treatment reduces the risk of vertebral fracture by between 30-70 %, nonvertebral fractures by between 15-20 %, and hip fractures up to 40 %[18].

Postmenopausal women and men age 50 and older presenting with the following should be considered for treatment: A hip or vertebral fracture (clinically apparent or found on vertebral imaging). T-score ≤–2.5 at the femoral neck, total hip, or lumbar spine.

Low bone mass (T-score between –1.0 and –2.5 at the femoral neck or lumbar spine) and a 10-year probability of a hip fracture ≥3 % or a 10-year probability of a major osteoporosis-related fracture ≥20 % based on the FRAX calculation[1]. All patients being considered for treatment of osteoporosis should also be counseled on risk factor reduction including the importance of calcium, vitamin D, and exercise as part of any treatment program for osteoporosis.

All patients with low bone mass should have an adequate daily intake of calcium and vitamin D in addition to what ever bone strengthening medication they may be using. It is generally recommend a daily calcium intake of 1,200 mg with most of the calcium derived from dietary sources if possible[7]. There is no evidence that calcium intake in excess of these amounts confers additional bone strength. There have been a number of studies questioning the cardiovascular safety of calcium supplementation, but a recent analysis of the Women's Health Initiative data involving over 93,000 postmenopausal women failed to find evidence for an adverse influence of calcium and vitamin D supplementation on the risk for myocardial infarction, coronary heart disease, total heart disease, stroke, or total cardiovascular disease[27]. While there are a number of different recommendations for daily vitamin D intake, the recommended daily vitamin D dose to a level that provides an adequate serum level (30 ng/ml and above), a goal that is usually met with daily vitamin D intake of 1,000 to 2,000 IU[15].

The prescription drugs approved for the treatment of fracture prevention are often classified by whether they reduce bone loss (antiresorptive) or promote bone growth. All of the approved drugs have been shown to improve bone mineral density and to prevent some fragility or osteoporosis related fractures. The approach to treatment is tailored to the clinical needs of each individual patient. Treatment decisions should be individualized according the patient's age, bone density values, prior fracture history, underlying general health, and concomitant medications.

Current FDA-approved pharmacologic options for the prevention and/or treatment of osteoporosis include, in alphabetical order: bisphosphonates (alendronate, alendronate plus D, ibandronate, risedronate and zoledronic acid), calcitonin, estrogens (estrogen and/or hormone therapy), estrogen agonist/antagonist (raloxifene), tissue-selective estrogen complex (conjugated estrogens/bazedoxifene), parathyroid hormone (PTH [1–34], teriparatide), and the receptor activator of nuclear factor kappa-B (RANK) ligand (RANKL) inhibitor denosumab[8].

BISPHOSPHONATES:

Bisphosphonates are the most commonly used drugs for the treatment of osteoporosis. They avidly bind to bone and are internalized by osteoclasts to inhibit resorption. Alendronate is the most commonly prescribed drug for the treatment of postmenopausal osteoporosis and is associated with increased BMD . Alendronate sodium is approved by the FDA for the prevention and treatment of postmenopausal osteoporosis. Alendronate is also approved for treatment to increase bone

mass in men with osteoporosis and for the treatment of osteoporosis in men and women taking glucocorticoids[30]. It increases spine and hip bone mineral density and reduces the relative risk of fracture of the spine, hip, and wrist by about 50 %[3]. Risedronate was introduced several years after alendronate and is a widely used oral bisphosphonate. It is approved for use of osteoporosis in men and women. Risedronate has been shown to reduce vertebral fractures by 41 % and nonvertebral fractures by 39 % over 3 years[14].

Ibandronate sodium is approved by the FDA for the treatment of postmenopausal osteoporosis. Ibandronate reduces the incidence of vertebral fractures by about 50 % over 3 years, but reduction in risk of nonvertebral fracture with ibandronate has not been documented[6]. Zoledronic acid is approved by the FDA for the prevention and treatment of osteoporosis in postmenopausal women. It is also approved to improve bone mass in men with osteoporosis and for the prevention and treatment of osteoporosis in men and women expected to be on glucocorticoid therapy for at least 12 months. Zoledronic acid is also indicated for the prevention of new clinical fractures in patients (both women and men) who have recently had a low- trauma (osteoporosis-related) hip fracture. Zoledronic acid reduces the incidence of vertebral fractures by 70 % (with significant reduction at 1 year), hip fractures by 41 %, and nonvertebral fractures by 25 % over 3 years in patients with osteoporosis defined by prevalent vertebral fractures and osteoporosis by BMD of the hip[5].

Contraindications to bisphosphonate therapy include hypersensitivity or hypocalcemia. Bisphosphonates should be used with caution, if at all, in patients with reduced kidney function (glomerular filtration rate below 30 mL/ min for risedronate and ibandronate or below 35 mL/min for alendronate and zoledronate)[19].

Orally administered bisphosphonates should be used with caution in patients with active upper GI disease, inability to follow the dosing regimen for oral use (that is, inability to remain upright for 30 to 60 minutes), or presence of anatomic or functional esophageal abnormalities that might delay transit of the tablet (for example, achalasia or stricture). Intravenous administration of nitrogen-containing bisphosphonates, such as pamidronate, ibandronate and zoledronate, circumvented this problem. Intravenous bisphosphonates are generally well tolerated, and the most commonly observed side effect is self-limiting flu-like symptoms which persist for about 3 days following the first administration. Osteonecrosis of the jaw is a rare but recognized side effect resulting from long-term bisphosphonate use[20]. It is most prevalent in individuals who have received high dose IV bisphosphonate therapy for malignant disease and rare in osteoporotic patients. Although rare, low-trauma atypical femur fractures (subtrochanteric or femoral shaft) may be associated with the long-term use of bisphosphonates diagnosed upon presentation with a characteristic combination of features to distinguish from typical femoral fractures[32].

The limited trial data available regarding long-term treatment with bisphosphonates has raised questions about the optimal length of treatment with these medications. This issue has become more important, given newly recognized complications of bisphosphonate use, including osteonecrosis of the jaw and atypical femur fractures. In 2016, the American Society for Bone and Mineral Research published guidelines on long-term bisphosphonate treatment that included the following recommendations[1]:

a. After 5 years of oral bisphosphonates or 3 years of intravenous bisphosphonates, reassessment of risk should be considered.

b. In women at high risk (eg, older women, those with a low hip *T*-score or high fracture risk score, those with previous major osteoporotic fracture, or those who fracture on therapy), continuation of treatment for up to 10 years (oral) or 6 years (intravenous), with periodic evaluation, should be considered.

c. The risk of atypical femoral fracture, but not osteonecrosis of the jaw, clearly increases with the duration of bisphosphonate therapy, but such rare events are outweighed by vertebral fracture risk reduction in high-risk patients.

d. For women not at high fracture risk, a drug holiday of 2 to 3 years can be considered after 3 to 5 years of BP treatment.

CALCITONIN:

Calcitonin is a naturally occurring peptide hormone synthesized and secreted by the thyroidal C-cells. Mature osteoclasts express calcitonin receptors and, in vitro, calcitonin acts directly on osteoclasts to inhibit resorption. Calcitonin reduces vertebral fracture occurrence by about 30 % in those with prior vertebral fractures but has not been shown to reduce the risk of nonvertebral fractures. In 2013, an FDA post-marketing review was prompted after studies showed increased risk of malignancies in calcitonin-treated patients. In a meta-analysis of 21 randomized, controlled clinical trials with calcitonin-salmon (nasal spray or investigational oral formulations), the incidence of malignances in calcitonin-treated patients was 4.1 %, versus 2.9 % in placebo-treated patients. The data were not sufficient for further analysis by specific malignancies and a definitive causal relationship between calcitonin use and malignancies could not be established. The FDA has recommended that health care professionals assess a patient's need for osteoporosis therapy as well as benefits and risk of

available treatments[26]. Calcitonin is an option for patients who are not candidates for other available osteoporosis treatments.

SELECTIVE ESTROGEN RECEPTOR MODULATORS (SERMS)

Selective estrogen receptor modulators (SERMs) are considered to provide the beneficial effects of estrogen without the potentially adverse outcomes. Raloxifene is a selective estrogen receptor modulator and inhibits bone resorption. It is approved for the treatment and prevention of osteoporosis in postmenopausal women, at a dose of 60 mg daily. Raloxifene reduces the risk of vertebral fractures by about 30 % in patients with a prior vertebral fracture and by about 55 % in patients without a prior vertebral fracture over 3 years[11]. Reduction in risk of nonvertebral fracture with raloxifene has not been documented. Raloxifene is also indicated for the reduction in risk of invasive breast cancer in postmenopausal women with osteoporosis[2].

Pooled mortality data from large clinical trials of raloxifene (60 mg/day) were analyzed by Grady et al in 2010. When compared with placebo, all-cause mortality was 10% lower in older postmenopausal women receiving raloxifene. The primary reduction was in noncardiovascular, noncancer deaths[13].

The combination product of bazedoxifene, a SERM, and conjugated estrogens (CEs) was approved by the FDA in October 2013 for prevention of osteoporosis and treatment of vasomotor symptoms in postmenopausal women. Combining a SERM with CEs lowers the risk of uterine hyperplasia caused by estrogens. This eliminates the need for a progestin and its associated risks (eg, breast cancer, myocardial infarction, venous thromboembolism). In clinical trials, this combination decreased bone turnover and bone loss in postmenopausal women at risk for osteoporosis. Bone mineral density increased significantly more with all bazedoxifene/CE doses compared with placebo at the lumbar spine and total hip and with most bazedoxifene/CE doses compared with raloxifene at the lumbar spine[22].

PARATHYROID HORMONE:

Parathyroid hormone (PTH) 1-34 and PTH 1-84 are peptides of the parathyroid hormone family. They represent the intact molecule (1-84) or the 1-34 N-terminal fragment (teriparatide). Unlike endogenous PTH which leads to mobilisation of calcium from skeletal sites (loss of bone mineral) the intermittent exposure to once daily exogenous PTH increases bone formation more than bone resorption resulting in an anabolic effect and increased bone mass. The exact mechanism leading to the anabolic effect of teriparatide is not fully understood, but it has been shown to enhance osteoblast formation from its circulating precursors and prevent osteoblast apoptosis[10]. The effects of parathyroid hormone are maximal at skeletal sites which are predominantly composed of trabecular bone such as the spine.

Teriparatide (Forteo) is a recombinant human parathyroid hormone (1-34) (PTH [1-34]) and is the only available anabolic agent for the treatment of osteoporosis. It is indicated for the treatment of women with postmenopausal osteoporosis who are at high risk of fracture, who have been intolerant of previous osteoporosis therapy, or in whom osteoporosis treatment has failed to increase bone mass. It is indicated in men with idiopathic or hypogonadal osteoporosis who are at high risk of fracture, who have been intolerant of previous osteoporosis therapy, or in whom osteoporosis therapy has failed. Teriparatide is also approved for the treatment of patients with glucocorticoid-induced osteoporosis. The approved dosage of teriparatide is 20 μg once daily injected subcutaneously. Teriparatide is dispensed in a glass cartridge that is preassembled into a disposable multiple-dose pen syringe device designed to provide 28 doses[28].

It is contraindicated in patients with pre-existing hypercalcemia, severe renal impairment, pregnancy, breast-feeding mothers, history of bone metastases or skeletal malignancies, and patients who are at an increased baseline risk for osteosarcoma including those with Paget disease, unexplained elevated alkaline phosphatase, children and young adults with open epiphyses or prior radiotherapy of the skeleton[28]. Patients with monoclonal gammopathies of uncertain significance (MGUS) should also not be given teriparatide. Before treatment with teriparatide, levels of serum calcium, PTH, and 25(OH)D need to be monitored.

Teriparatide is given for a maximum of 2 years, Initial studies using a combination of concurrent PTH and bisphosphonate therapy showed decreased benefit compared with therapy with either agent alone; therefore, the general recommendation is that these drugs be given separately and in sequence[12]. When use of teriparatide is stopped, bone density declines quickly during the following year, although fracture reduction may persist for 1 or 2 years. Use of alendronate after teriparatide therapy prevents this loss and in some cases will be associated with a further increase in BMD[4].

Most studies with PTH have been performed on women. The medication decreases the risk of vertebral and nonvertebral fractures to the same extent as bisphosphonates. It has been shown to increase bone mineral density at the spine and hip and to reduce the relative risk of vertebral fractures by 65 % and nonvertebral fractures by 55 % over 18 months compared to placebo[24].

A study performed by an Austrian group using PTH 1-84 to treat pelvic fractures in postmenopausal women with osteoporosis demonstrated that this anabolic agent has

the ability to both increase the rate of union and enhance the speed of the process. In addition to improved fracture healing, treatment with PTH 1-84 was also associated with a significant decrease of pain and improved function over the placebo arm. This clinical study supports the extensive animal data that predicted a clear role for PTH in fracture repair[25].

DENOSUMAB:

Denosumab (Prolia) is a humanized monoclonal antibody directed against the receptor activator of the nuclear factor-kappa B ligand (RANKL), which is a key mediator of the resorptive phase of bone remodeling. It decreases bone resorption by inhibiting osteoclast activity. Denosumab is approved by the FDA for the treatment of osteoporosis in postmenopausal women at high risk of fracture. Denosumab reduces the incidence of vertebral fractures by about 68 %, hip fractures by about 40 %, and nonvertebral fractures by about 20 % over 3 years[9]. Denosumab is also indicated to increase bone mass in men at high risk of fracture, treat bone loss in women with breast cancer on aromatase inhibitor therapies, and to treat bone loss in men receiving gonadotropin-reducing hormone treatment for prostate cancer who are at high risk for fracture. Because the overactivity of RANKL is a major factor in bone loss in patients with autoimmune and inflammatory disorders, such as ulcerative colitis, denosumab may become first-line therapy for these patients[31]. No dose adjustment is required in patients with renal impairment. Hypocalcaemia should be corrected by adequate intake of calcium and vitamin D before initiating therapy. Side-effects include skin infection, predominantly cellulitis, and hypocalcaemia.

STRONTİUM RANELATE:

Strontium ranelate is not approved by the FDA, but is licensed (oral formulation of 2 g/day) for restricted use for the prevention of vertebral and nonvertebral osteoporotic fractures in the EU, in patients where bisphosphonate treatment has failed or is contraindicated. Divalent strontium ions have the capacity to substitute for calcium within bone without adversely affecting mineralization. Strontium ranelate (Protelos) increases BMD and reduces the risk of vertebral and nonvertebral fractures[23]. Because of an increase in the risk of myocardial infarction in individuals taking strontium ranelate, this drug should only be used to treat severe osteoporosis in postmenopausal women and men at high risk of fracture, for whom treatment with other approved drugs is not possible. It should not be used in patients with established, current or past history of ischaemic heart disease, peripheral arterial disease and/or cerebrovascular disease, or those with uncontrolled hypertension[29].

THE NEXT GENERATION THERAPEUTICS:

It is demonstrated that further therapeutic advances are continuing in the management of osteoporosis. The long-term follow studies with denosumab give comfort that treatment up to 10 years will show continued benefits in terms of bone mass and structural changes with, in all likelihood, maintained antifracture efficacy. Studies presented examining the potential for the antiresorptive agents, odanacatib (Cathepsin K Inhibitor) and abaloparatide,(Recombinant PTHrP analogue) suggest that these new treatments may well have a role in the clinic very soon when approved by licensing authorities. There are some very encouraging results about the romosuzumab, the antisclerostin antibody, as being the new anabolic therapy.

REFERENCES:

1. Adler RA, El-Hajj Fuleihan G, Bauer DC, Camacho PM, Clarke BL, Clines GA, Compston JE, Drake MT, Edwards BJ, Favus MJ, Greenspan SL, McKinney R Jr, Pignolo RJ, Sellmeyer DE. Managing Osteoporosis in Patients on Long-Term Bisphosphonate Treatment: Report of a Task Force of the American Society for Bone and Mineral Research. *J Bone Miner Res* 2016; 31 (1): 16-35.
2. Barrett-Connor E, Mosca L, Collins P, Raloxifene Use for The Heart (RUTH) Trial Investigators Effects of raloxifene on cardiovascular events and breast cancer in postmenopausal women. *N Engl J Med* 2006; 355(2): 125–137.
3. Black DM, Thompson DE, Bauer DC, Ensrud K, Musliner T, Hochberg MC, Nevitt MC, Suryawanshi S, Cummings SR; Fracture Intervention Trial. Fracture risk reduction with alendronate in women with osteoporosis: the Fracture Intervention Trial. FIT Research Group. *J Clin Endocrinol Metab* 2000; 85(11): 4118-4124.
4. Black DM, Bilezikian JP, Ensrud KE, Greenspan SL, Palermo L, Hue T, Lang TF, McGowan JA, Rosen CJ;. PaTH Study Investigators. One year of alendronate after one year of parathyroid hormone (1–84) for osteoporosis. *N Engl J Med* 2005; 353: 555– 565.
5. Black DM, Delmas PD, Eastell R, Reid IR, Boonen S, Cauley JA, Cosman F, Lakatos P, Leung PC, Man Z, Mautalen C, Mesenbrink P, Hu H, Caminis J, Tong K, Rosario-Jansen T, Krasnow J, Hue TF, Sellmeyer D, Eriksen EF, Cummings SR; HORIZON Pivotal Fracture Trial. Once-yearly zoledronic acid for treatment of postmenpausal osteoporosis. *N Engl J Med* 2007; 356(18): 1809–1822.

6. Chesnut CH 3rd, Skag A, Christiansen C, Recker R, Stakkestad JA, Hoiseth A, Felsenberg D, Huss H, Gilbride J, Schimmer RC, Delmas PD. Oral Ibandronate Osteoporosis Vertebral Fracture Trial in North America and Europe (BONE). Effect of oral ibandronate administered daily or intermittently on fracture risk in postmenopausal osteoporosis. *J Bone Miner Res* 2004; 19(18): 1241–1249.

7. Committee to Review Dietary Reference Intakes for Vitamin D and Calcium, Food and Nutrition Board, Institute of Medicine. Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: *National Academy Press,* 2010.

8. Cosman F, de Beur SJ, LeBoff MS, Lewiecki EM, Tanner B, Randall S, Lindsay R; National Osteoporosis Foundation. Clinician's Guide to Prevention and Treatment of Osteoporosis. *Osteoporos Int* 2014; 25(10): 2359-2381.

9. Cummings SR, San Martin J, McClung MR,Siris ES, Eastell R, Reid IR, Delmas P, Zoog HB, Austin M, Wang A, Kutilek S, Adami S, Zanchetta J, Libanati C, Siddhanti S, Christiansen C. Denosumab for prevention of fractures in postmenopausal women with osteoporosis. *N Engl J Med* 2009; 361(8): 756–765.

10. D'Amelio P, Tamone C, Sassi F, D'Amico L, Roato I, Patanè S, Ravazzoli M, Veneziano L, Ferracini R, Pescarmona GP, Isaia GC. Teriparatide increases the maturation of circulating osteoblast precursors. *Osteoporos Int* 2012; 23(4): 1245–1253.

11. Ettinger B, Black DM, Mitlak BH, Knickerbocker RK, Nickelsen T, Genant HK, Christiansen C, Delmas PD, Zanchetta JR, Stakkestad J, Glüer CC, Krueger K, Cohen FJ, Eckert S, Ensrud KE, Avioli LV, Lips P, Cummings SR. Reduction of vertebral fracture risk in postmenopausal women with osteoporosis treat- ed with raloxifene: results from a 3-year randomized clinical trial. Multiple Outcomes of Raloxifene Evaluation (MORE) Investigators. *JAMA* 1999; 282(7): 637-645.

12. Finkelstein JS, Hayes A, Hunzelman JL, Wyland JJ, Lee H, Neer RM. The effects of parathyroid hormone, alendronate, or both in men with osteoporosis. *N Engl J Med* 2003. 349(13): 1216-1226.

13. Grady D, Cauley JA, Stock JL, Cox DA, Mitlak BH, Song J, Cummings SR. Effect of Raloxifene on all-cause mortality. *Am J Med* 2010; 123(5): 469. e1-7.

14. Harris ST, Watts NB, Genant HK, McKeever CD, Hangartner T, Keller M, Chesnut CH 3rd, Brown J, Eriksen EF, Hoseyni MS, Axelrod DW, Miller PD. Effects of risedronate treatment on vertebral and nonvertebral fractures in women with postmenopausal osteoporosis. *JAMA* 1999; 282(14): 1344-1352.

15. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, Murad MH, Weaver CM; Endocrine Society. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab* 2011; 96(7): 1911-1930.

16. Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. *Osteoporos Int* 2006; 17(12): 1726-1733.

17. Kanis JA, Borgstrom F, Zethraeus N, Johnell O, Oden A, Jönsson B. Intervention thresholds for osteoporosis in the UK. *Bone* 2005; 36(1): 22-32.

18. Kanis JA, Burlet N, Cooper C, Delmas PD, Reginster JY, Borgstrom F, Rizzoli R; European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO). European guidance for the diagnosis and management of osteoporosis in postmenopausal women. *Osteoporos Int* 2008; 19(4): 399-428.

19. Khosla S, Burr D, Cauley J, Dempster DW, Ebeling PR, Felsenberg D, Gagel RF, Gilsanz V, Guise T, Koka S, McCauley LK, McGowan J, McKee MD, Mohla S, Pendrys DG, Raisz LG, Ruggiero SL, Shafer DM, Shum L, Silverman SL, Van Poznak CH, Watts N, Woo SB, Shane E; American Society for Bone and Mineral Research. American Society for Bone and Mineral Research. Bisphosphonate-associated osteonecrosis of the jaw: report of a task force of the American Society for Bone and Mineral Research. *J Bone Miner Res* 2007; 22: 1479–1491.

20. Kidney Disease: Improving Global Outcomes (KDIGO) CKD-MBD Work Group. KDIGO clinical practice guideline for the diagnosis, evaluation, prevention, and treatment of chronickidney disease-mineral and bone disorders (CKD-MBD). *Kidney Int Suppl* 2009; 76(suppl 113): S1–S130.

21. Lindsay R, Pack S, Li Z. Longitudinal progression of fracture prevalence through a population of postmenopausal women with osteoporosis. *Osteoporos Int* 2005; 16(3): 306-312.

22. Lindsay R, Gallagher JC, Kagan R, Pickar JH, Constantine G. Efficacy of tissue-selective estrogen complex of bazedoxifene/conjugated estrogens for osteoporosis prevention in at-risk postmenopausal women. *Fertil Steril* 2009; 92(3): 1045-1052.

23. Meunier PJ, Slosman DO, Delmas PD, Sebert JL, Brandi ML, Albanese C, Lorenc R, Pors-Nielsen S, De Vernejoul MC, Roces A, Reginster JY. Strontium ranelate: dose-dependent effects in established postmenopausal vertebral osteoporosis – a 2-year randomized placebo controlled trial. *J Clin Endocrinol Metab* 2002; 87(5): 2060–2066.

24. Neer RM, Arnaud CD, Zanchetta JR, Prince R, Gaich GA, Reginster JY, Hodsman AB, Eriksen EF, Ish-Shalom S, Genant HK, Wang O, Mitlak BH. Effect of parathyroid hormone (1-34) on fractures and bone mineral density in postmenopausal women with osteoporosis. *N Engl J Med* 2001; 344(19): 1434-1441.

25. Peichl P, Holzer LA, Maier R, Holzer G. Parathyroid hormone 1-84 accelerates fracture-healing in pubic bones of elderly osteoporotic women. *J Bone Joint Surg* 2011; 93-A(17): 1583-1587.

26. Postmark Drug Safety Information for Patients and Providers-Questions and Answers: Changes to the Indicated Population for Miacalcin (calcitonin-salmon). U.S. Food and Drug Administration, 2014.

27. Prentice RL, Pettinger MB, Jackson RD, Wactawski-Wende J, Lacroix AZ, Anderson GL, Chlebowski RT, Manson JE, Van Horn L, Vitolins MZ, Datta M, LeBlanc ES, Cauley JA, Rossouw JE P. Health risks and benefits from calcium and vitamin D supplementation: Women's Health Initiative clinical trial and cohort study. *Osteoporos Int* 2013; 24(2): 567-580.

28. Quattrocchi E, Kourlas H. Teriparatide: a review. *Clin Ther* 2004; 26(6): 841-854.

29. Reginster JY. Cardiac concerns associated with strontium ranelate. *Expert Opin Drug Saf* 2014; 13(9): 1209-1213.

30. Saag KG, Emkey R, Schnitzer TJ, Brown JP, Hawkins F, Goemaere S, Thamsborg G, Liberman UA, Delmas PD, Malice MP, Czachur M, Daifotis AG. Alendronate for the prevention and treatment of glucocorticoid-induced osteoporosis. Glucocorticoid-Induced Osteoporosis Intervention Study Group. *N Engl J Med* 1998; 339(5): 292-299.

31. Schwarz EM, Ritchlin CT. Clinical development of anti-RANKL therapy. *Arthritis Res Ther* 2007; 9 (Suppl.1): S7.

32. Thompson RN, Phillips JR, McCauley SH, Elliott JR, Moran CG. Atypical femoral fractures and bisphosphonate treatment: experience in two large United Kingdom teaching hospitals. *J Bone Joint Surg* 2012; 94-B(3): 385–390.

33. Tuzun S, Eskiyurt N, Akarirmak U, Saridogan M, Senocak M, Johansson H, Kanis JA; Turkish Osteoporosis Society. ncidence of hip fracture and prevalence of osteoporosis in Turkey: the FRACTURK study. *Osteoporos Int* 2012; 23(3): 949-955.

Volume: 27, Issue: 3, July 2016 pp: 185/194 REVIEW ARTICLE / DERLEME

REHABILITATION FOR PATIENTS WITH PARAPLEGIA

PARAPLEJİK HASTALARDA REHABİLİTASYON

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SUMMARY:

Paraplegia is an impairment in motor and/or sensory function of the lower extremities as a result of spinal cord injury. Spinal cord injury (SCI) is a devastating condition that requires intensive and specialized clinical rehabilitation. The area of the spinal canal which is affected in paraplegia is either the thoracic, lumbar, or sacral regions. Rehabilitation of these injuries has an increasingly important role. The primary goals of rehabilitation are prevention of secondary complications, maximization of physical functioning, and reintegration into the community. Frequent complications after SCI include neurogenic bladder, neurogenic bowel, urinary tract infections, pressure ulcers, orthostatic hypotension, fractures, deep vein thrombosis, spasticity, heterotrophic ossification, contractures, autonomic dysreflexia, pulmonary and cardiovascular problems, and depressive disorders.

The interdisciplinary approach of the rehabilitation team is important for the optimal care of individual with SCI. The treatment team may include a physiatrists, physical therapist, occupational therapist, orthotist, nurse, and mental health provider. A comprehensive rehabilitation program is essential to optimize functional independence. The program should address functional goals related to mobility, transfer, and self care as well as issues related to health maintenance and self advocacy.

Key Words: Paraplegia, spinal cord injury, rehabilitation

Level of Evidence: Review Article, Level V

ÖZET:

Parapleji omurilik yaralanması sonucu gelişen alt ekstremitedeki motor ve / veya duyusal fonksiyonlarında bir bozulmadır. Spinal kord yaralanması (SKY), yoğun ve özellikli rehabilitasyon gerektiren yıkıcı bir durumdur. Paraplejide spinal kanalın torakal, lomber veya sakral bölgesi etkilenir. Bu yaralanmalarda rehabilitasyonun rolü giderek artmaktadır. Rehabilitasyonun birincil hedefleri, sekonder komplikasyonların önlenmesi, fiziksel fonksiyonun arttırılması ve bireyin topluma yeniden kazandırılmasıdır. Nörojenik mesane ve bağırsak, idrar yolu enfeksiyonları, basınç ülserleri, ortostatik hipotansiyon, kırıklar, derin ven trombozu, spastisite, Heterotopik ossifikasyon, kontraktürler, otonomik disrefleksi, pulmoner ve kardiyovasküler problemler ve depresif bozukluklar SKY sonrasında sık görülen komplikasyonlardır.

SKY'lı ile bireyin rehabilitasyondan optimal yararlanımı için rehabilitasyon ekibinin uyum içinde yaklaşımı önemlidir. Tedavi ekibi fizik tedavi uzmanı, fizyoterapist, iş-uğraşı terapisti, ortotist, hemşire ve psikologdan oluşabilir. Kapsamlı bir rehabilitasyon programında, fonksiyonel bağımsızlığı en iyi duruma getirmek gereklidir.

Rehabilitasyon programı, sağlık bakımı ve kendini savunma ile ilgili konuların yanı sıra mobilite, transfer ve kendine bakım ile ilgili fonksiyonel hedefleri de ele almalıdır.

Anahtar Kelimeler: Parapleji, spinal kord yaralanması, rehabilitasyon.

Kanıt Düzeyi: Derleme, Düzey V.

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INTRODUCTION:

Paraplegia is a medical condition involving impairment in motor or sensory function of the lower extremities, which is a classification of paralysis, the universal term to describe the loss of movement or sensation following damage to a nerve in the body[9,12,24,33].

Spinal cord injury (SCI) occurs through various countries throughout the world with an annual incidence of 15 to 40 cases per million. Paraplegia is predominantly the result of a spinal cord injury. Traumatic causes are between 70 % and 80 % of the total number of spinal cord injuries. Car accidents are the most common causes, followed by sports accidents, suicide attempts, gunshot and stabbing injuries[20,25].

CLASSIFICATION:

The extent of the paralysis depends on the level of the spinal cord at which the damage occurs. The area of the spinal canal that is affected in paraplegia is either the thoracic, lumbar, or sacral regions. The condition occurs due to damage to the cellular structure of the spinal cord within the spinal canal. An injury to the upper thoracic (T1 to T8), which is approximately adjacent to the chest, often results in poor trunk control. This can include impairment in breathing. Lower thoracic injuries (T-9 to T-12) retain good truck control and good abdominal muscle control. The sitting balance of people with lower spinal cord injuries is usually very good. Lumbar and sacral injuries result in decreased control of the hip flexors and legs.

There is a strong relationship between functional status, type of injury (complete or incomplete) and level of injury. Complete injury is an injury where there is a complete loss of motor and sensory functions at the distal level of injury. In incomplete injury, sensory and motor functions below the neurological level and in the lower sacral segments are partially preserved. This allows deep anal sensation and/or anal mucocutaneous superficial sense to be preserved. The status of the lesion is not definite until the end of the spinal shock period. An increase in reflex activity is a positive indicator even though signs indicating the end of this period are disputed.

Classification of spinal cord injuries is made by American Spinal Injury Association (ASIA) according to motor and sensory functions. In 2011 ASIA Disorder Scale was revised. The term "deep anal pressure" took the place of "deep anal sense". In the latest "International Standards for Neurological Classification of Spinal Cord Injury (ISNCSC)", the term skeletal level is not included[10-11].

- **A- Complete:** No motor or sensory function is preserved in the sacral segments S4-S5.
- **B- Incomplete:** Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4–S5.
- **C- Incomplete:** Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.
- **D- Incomplete:** Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more.
- **E- Normal**

MECHANISMS OF INJURY:

Spinal cord blood flow has decreased significantly in the 15 minutes following the spinal cord trauma and will keep decreasing in the first following days. Injuries can be aggravated by blood pressure disorders. In addition, white cells gather at the level of injury in 8 to 24 hours. These inflammatory phenomena are causing edema that aggravates injuries. They also occur during the healing process. Furthermore, there are various interactions between complex biochemical phenomena that can be described. They end up causing the progressive destruction of the nerve tissue[5].

SIGNS AND SYMPTOMS:

There are many signs and symptoms of damage to the spinal cord related to its physiology[9,12,33].

They include

- Motor disorders:
- Sensory disorders
- Pain
- Urethral and anal sphincter disorders
- Genital and sexual disorders
- Respiratory disorders
- Autonomic nervous system disorders
- Other associated disorders

Motor disfunctions:

Paralysis or paresis is a result of damage in voluntary motor control. Distribution of paralysis depends on the injury level. Autonomic motor control is occurs in two forms. Hypertonia is an increase in muscle activity which is due to disruption between the spinal cord and central nervous centers regulating motor control. This is followed by mobilization of limbs and spasticity in which with increased speed stiffening against muscle stretching occurs. Hypotonia, flaccid paralysis, is a loss of tonus triggering the flaccid state of muscles. This state is due to complete or partial injury associated with specific root levels. It can be temporary or permanent state[9,12].

Sensory disfunctions:

Spinal cord injuries affect superficial and deep sensibility. Multiple levels of damage may be present in patient. When tactile sensibility is preserved and pain sensation is totally lost, risk of unintentional injury or burn can occur even without

noticing. In case of total loss of sensibility, there is increased risk of developing pressure sores. Knowledge of the exact position of the body in space, pressure and shear force exerted on the skin is determined by deep sensibility. Deep sensibility disorders lead to, trunk balance problems, associated with paralysis of abdominal muscles, and feelings of "vertigo" or fear of heights[12].

Pain:

There are two main categories of pain as injury pain (at the injury level), through radicular pain (nerve root injury) depending on the spinal injury and pain arising on the visceral, vascular and muscular parts that are below the injury level[30].

Urethral and anal sphincter disfunctions:

Urinary bladder disorders are caused by impaired motor control, sensibility and reflexes. If there is a delay in treatment of initial period of total retention, urinary and fecal overflow may occur. Over filling of bladder and rectum which cannot be emptied fully cause involuntary overflow of small amounts of urine and feces. For this reason, it is necessary to use aids for evacuation of bladder and bowel[2,13,29].

Genital and sexual disorders:

Genital and sexual function are deeply changed. When the injury is complete and located in the sacral segment of the spinal cord, the reflex erection potential is compromised. However, psychogenic erection potential is preserved. Through using appropriate stimulation techniques and physical stimuli, it is possible to achieve erections in other cases. When segmental levels D11, D12, and L1 are far from the damaged level, ejaculation is to be considered. Otherwise, appropriate techniques are implemented, often requiring an appointment with a paraplegia specialist.

In women, sensations during sexual intercourses are affected by complete analgesia of the perineum. As long as lumbosacral reflex pathways are intact, orgasm remains possible. After sustaining traumatic spinal cord injuries, women become fertile again after 1 to 9 months without periods and can get pregnant and carry their pregnancies to term. Rigorous monitoring is necessary. Delivery can be achieved through natural or vaginal birth. Especially if there is a risk of hyperreflexia, epidural anesthesia may be performed. When the mother's abdominal muscles are paralyzed, forceps are used. The decision of using contraception is considered after a careful overall physical assessment due to the increased risk of phlebitis and infections[17,23].

Respiratory disorders:

Impairment of respiratory muscles such as, abdominal and intercostal muscles lead to respiratory disorders.

***Circulatory disorders*:**

Impaired venous drainage of the blood returning to the heart lead to circulatory disorders with cardiovascular deconditioning during physical effort. Flaccid paralysis, leads to a venous stasis aggravated by a vasoplegic syndrome.

Forced immobilization leads to bone demineralization, or osteoporosis, and increased risk of urinary calculi.

REHABILITATION:

Specialized rehabilitation care is prepared by physiatrist and a rehabilitation team. The goal of the treatment is to enable the injured individual to regain the fullest level of independence possible, using all the residual force potential of the muscles located above the level of injury, and learning to control residual functions located at the level of injury and below. In addition, the patient care during the early stages of the disorder must be particularly concerned with preventing complications that may stand in the way of successful rehabilitation[9,12,15,33].

Trauma caused by SCI has a long, expensive treatment and rehabilitation process which results in biophysical, psychosocial and economic problems. Treatment of SCI is a long time treatment which starts with acute interventions and early surgical procedures[32].

In the beginning of the treatment patient cannot perform daily activities by themselves. With physiotherapy patients range of motion in the joints will improve and muscle atrophy will be avoided. Physiotherapy will help to maintain muscle function at the highest possible level that can be expected.

According to the level of injury expected functions in the treatment[12]:

T11-T12 levels:

Patients are independent in daily living activities, bowel-bladder care, using a manual wheelchair and transferring. The target is therapeutic ambulation in upper thoracic injury patients. They cannot socially ambulate. Body control is present in lower thoracic injury patients and they may be ambulant at home with lower extremity orthoses and a walker.

L1-L2 levels:

They are fully independent in activities of daily living and personal care. They may be ambulatory with long leg walking device for short distances but they need a wheelchair for a long distance.

L3-L4 levels:

Patients can lock the knee fully and dorsiflexion of the ankle can be partly made. Patients can ambulate socially with elbow

crutches and ankle foot orthoses. They are independent in bowel and bladder care.

L5 and lower:

They are independent in all activities.

Functional recovery can be measured by various outcome measures including the Modified Bartel Index (MBI), the Quadriplegia index of function (QIF), the Functional Independence Measure (FIM) and the Spinal cord independence measure (SCOM) to name but a few. The above measures are objective tools that do not take into consideration the patient's opinion and needs. In addition they measure activity and do not include participation measures such as community integration and employment[1].

Positioning:

For to protect the articular structure and maintain the optimal muscle tonus positioning of joints is important. The extent of the paralysis and the preference of the health care provider determine the type of the bed to be used in patient with paraplegia. Patients with spinal cord injuries must be turned frequently and receive special skin care to avoid the development of pressure ulcers[3,16].

Proper positioning of the feet and legs will help prevent contractures, foot drop, and ankylosis. Sand bags and pillows are useful in positioning. Positioning can also be achieved with plaster splints or more rigid orthotics. Ankle foot orthosis, knee-ankle foot orthosis or static ankle foot orthosis are mainly used for positioning[33].

In the end of bed rest, corsets are used for fixation and supporting the spine when patient moves to sitting position. Thoracic and upper lumbar region fractures are treated with hyperextension corsets or plaster plastic body jackets. A knight-type corset is preferred to support the fractures at the lower of L2 vertebrae. Knight-Taylor type corsets restrict flexion and extension of the trunk without effecting rotation. Plaster or plastic body jacket corsets should be used to restrict movements in all directions[21].

Therapeutic exercise:

Therapies generally focus on reducing muscle tone, maintaining or improving range of motion and mobility, increasing strength and coordination, and improving comfort. There are specific programs applied to avoid complications such as frozen joints, contractures or bedsores. Physical therapists will assess joint motion, muscle strength and endurance, posture, pain, heart and lung function and performance of daily living activities to develop an individualized program. Therapies may include stretching, aerobic exercises and strengthening. They may also include gait training and appropriate use of assistive devices, such as canes, braces, and walkers; balance and coordination activities; transfer training such as how to get from bed to wheelchair or from wheelchair to car; and training in how to fall to minimize possible damage. Massage, ultrasound, electrical stimulation or whirlpool can also be used in therapies. Sessions with a physical therapist generally last just a few months or less. Emphasis usually is on the establishment of a home program with periodic follow-up sessions (Figure-1)[4,8,24].

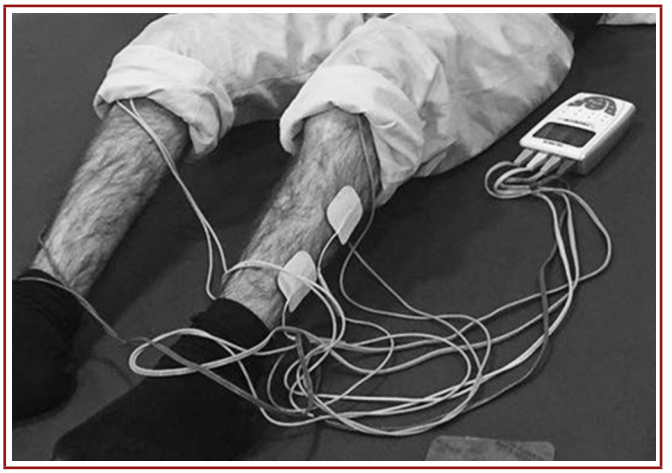

Figure-1. Application of electrical stimulation to a patient with paraplegia

Treatment is carried out progressively with a set of customized routine exercises based on the individual's capacity. A program of therapeutic exercise, including passive and active exercises, is initiated to maintain any remaining muscle function and to restore as much muscle activity in the affected parts as possible[8,12].

Passive exercises should be done intensively to resolve contractures, muscle atrophy and pain during the acute period of hospitalization in patients with complete injury. These exercises should be done in a flaccid period at least once a day and at least 2-3 times a day in the presence of spasticity.

Active exercise has three types:

a) Stretching/Flexibility Exercises:

These exercises are slow, sustained lengthening of the muscle. Stretching improves flexibility through their full range of motion. Stretching also can reduce muscle spasticity and cramps and may also reduce problems such as tendonitis and bursitis. To be effective, stretching routines must be done regularly, usually once or twice a day. Stretch as far as you can and hold the stretch for 10 seconds and then ease back. Stretching should be performed slowly. Stretching also should

be done before and after other exercises to prevent muscle strain and soreness and to help avoid injuries[7].

b) Aerobic Exercises:

These exercises are steady exercise using large muscle groups. Aerobic exercise strengthens your heart and lungs and improves your body's ability to use oxygen. It also reduces fatigue, increases energy levels and helps you sleep better, control your weight, and lift your spirits. It is generally recommended to gradually work up to three or four sessions per week, each lasting 15 to 60 minutes.

Include a 5-minute warm-up (including stretching) before the activity and 5 to 10 minutes of a cool down (stretching and slower activity) afterwards. Walking, stationary bicycling, water exercises and chair exercises are excellent choices. Walking is recommended according to your ability, comfort and safety. Even short, slow walks can provide benefit.

Aquatic exercises and swimming provide optimal exercise conditions. Water eliminates the effects of gravity, allowing weakened limbs to attain a greater range of motion. Water also helps support the body so there is less stress on hips, knees, and spine. Exercises in the water can help increase muscle power and endurance and help mobilize joints and muscles. They also help to relax muscles and improve coordination. Temperature and the level of the water are adjustable. Warm water can be especially good for stiff, sore joints. Exercises can be done in shallow water.

Stationary bicycling is a great way to improve fitness without putting stress on hips, knees, and feet. Chair exercises can provide a great workout and easily incorporate strengthening and stretching exercises[4,8,33].

c) Strengthening Exercises:

These exercises are repeated muscle contractions until the muscle becomes tired. Strengthening exercises help increase muscle tone and improve the quality of muscles. This enhances mobility and provides energy and a positive sense of well-being. Strong hip and leg muscles are needed to lift the legs to walk, and strong arm muscles are needed to carry out daily functions. Strong abdominal and back muscles help maintain correct posture and can counter pain resulting from poor gait, poor posture or the use of mobility aids. Knowing which muscles need to be strengthened and how to perform the exercise without over-stressing the joints is important[12].

Functional Ambulation:

The success of splints or other attempts for functional ambulation depends on whether the injury is complete or incomplete and the injury level. Irrespective to the level of injury, incomplete SCI patients have a potential to walk. T12 is accepted for to start point of functional ambulation level.

Mobilization in parallel bars and stabilization of trunk and pelvis is obligatory. Mobilization in the parallel bars, standing and balance training exercises should be started and the patient could be supported by a posterior shell in the parallel bars during this period (Figure-2).

Figure-2. Standing and balance training exercises with parallel bars

A long and locked knee joint walking device is utilized, ensuring the integrity and stability of the lower extremity joints in patients after the upright standing with a posterior shell. Standing is beneficial in reducing spasticity, depression and risk for deep vein thrombosis, pressure ulcers and improves recovery of bowel and bladder function.

In chronic stage ambulation, walkers, crutches and orthoses are used. Orthosis or crutches make walking possible outside the parallel bars for patients with pelvic control. In patients with normal muscle strength of quadriceps femoris, patient can walk with elbow crutches and orthosis without need for wheelchair.

Parawalker (hip guidance orthosis) is necessary for ambulation in patients with complete C8-T12 injury. Easy mobility in SCI is achieved by decreasing the weight of the walking devices. The cost increases in proportion to the increased technological

features. The shape, type and weight of the material which is used in the device effect the oxygen consumption, energy expenditure and walking speed[12,33].

Robotic training is a newly applied technique which is becoming popular day by day. After training, manual muscle test scores of wrist extensor, finger flexor and finger abductor are significantly increased. Another study demonstrated that the robotic-assisted gait training using the locomat system improved the functional outcome of subacute SCI patients (Figure-3)[19].

Figure-3. Use of the Locomat system for training of walking in patient with paraplegia

Bladder and urethral sphincter retraining exercises:

Bladder and urethral sphincter retraining exercises are used to restore a normal continence/micturition cycle that is compatible with social life and achieve complete bladder emptying with each act of urination.

By intensive bladder training bladder control can be achieved. Due to unawareness of need to urinate, patients with neurogenic bladder require training to initiate urination. Patients with reflex bladder emptying require training techniques that make reflex emptying more effective. Suprapubic pressure helps urine flow when there is no reflex. In case of need intermittent catheterization can be applied by a nurse or patients themselves.

Training must be aimed to avoid over distention and dribbling when the patient has flaccid bladder with paralysis at second, third or fourth sacral segment. Catheters, penile clamps or other collecting devices are required when bladder control is not achieved to a certain degree[2].

Complications of bladder such as urinary tract infections and calculi formation are seen in patients with paralysis. The formation of bladder stones results from incomplete emptying of the bladder, with pooling of urine and inadequate elimination of wastes. Formation of stones can be minimized by drinking 2500- 3000 ml of fluid daily[2].

As in bladder training, the program for bowel training is designed according to the individual needs of the patient and ability to work with those who are developing the program. Abdominal distention and fecal impaction are seen in flaccid bowel. The patient may have fecal incontinence as well as frequent accumulations of flatus and fecal material in the lower intestine. Bowel control methods uses in patients to achieve regular defecation. It is important to make the training according to patient's status in regard to nerve damage and potential for rehabilitation. Fluid and food intake should also be regulated in the training. By using appropriate stimulation techniques normal defecation reflex can be achieved. Manual bowel evacuation techniques are used when reflex is impaired. Intestinal transit is eased by balanced diet which is rich in fibers and large amounts of liquids and regular 15 minutes abdominal massages[13,29].

Prevention of pressure sores:

Pressure sores are commonly seen in patients with paraplegia. For this reason it is important to teach the patient prevention and monitoring techniques. The risk for pressure sores can be reduced by using specialized wheelchairs, seating systems and mattresses. Skin care should be taken meticulously. In case of unexpected leaks it is important to define the underlying etiology for to take appropriate preventive measures and take care with changing clothes and garnitures. Insensible body parts should be kept far from heat sources especially for to protect legs and feet burns. In case of redness in skin, the golden rule is to eliminate all pressure on this area until redness disappears or fades significantly. If pressure sores occur, patients can experience prolonged periods of time where they cannot sit.

Prevention of pressure sores in paraplegic patients can be achieved by lifting buttocks regularly in sitting position, changing positions regularly in lying position, avoiding sitting on hard surfaces by using a cushion, foam or gel, routine inspection of the skin with a mirror or by palpating gently

the areas at risk and keeping skin dry and clean (especially perineal area)[27,31].

Orthostatic hypotension:

Patients with a long period of lying in bed are likely to have orthostatic hypotension. While patients are sitting and being lifted up, syncope can be seen due to low blood pressure. For patients with this condition a tilt table may be useful (starting from 45 degrees for 30 min a day). Patient's complaints or state determines the degree. Blood pressure reflex is stimulated to a sufficient and persistent limit with standing upright. The patients adapt to sit and stand and are prepared to transfer and balance. When the patient comes to the upright position with a tilt table, the patient should be in a sitting position on the edge of the bed 3-4 times a day and balance exercises should be done to maintain this position. In the wheelchair use and enabling wheelchair transfer, it is important to be able to sit independently on the edge of the bed. Stability and strength education for sitting and transportation is the aim of the rehabilitation. Functional goals must prepare the patient for movements such sitting up in bed or a wheelchair, dressing and transfers. ROM and stretching exercises are used for functional activities. Exercises for sitting, balance and strengthening of the upper extremities should be done at the beginning. Patients who can tolerate sitting can begin to push up, with static and dynamic balance training to transfer to the wheelchair[14].

Respiratory problems:

Deep breathing exercises are useful in hypostatic pneumonia and other respiratory problems. Proper postural drainage is ensured by physiotherapist, through focusing on breathing out and forced coughing. The individual who will perform this preventative technique is taught how to perform it regularly, including in cases of bronchopulmonary obstruction[28].

***Occupational therapy**:*

Occupational therapy is especially useful to the paraplegic patient. It helps patients to perform daily activities independently. It includes learning and training in personal hygiene care, dressing up, eating and transportation adaptations, such as wheelchair and adapted car. Occupational therapy will help the individual to find ways to perform some daily activities independently. This help may include using assistive devices or showing the patient a different way to accomplish tasks than is normally employed[22].

Preparation for returning home:

Preparation for returning home is settled immediately after the prognosis is known and was announced to both patients and his/her family. All rooms in the house must be accessible for the patient. If patient cannot achieve full independence assistance for personal care and for daily living tasks is required. For manual wheelchair access door width should be 81.5 cm and 86.5 for battery assisted wheelchairs. The height of electric switches should be 91.5 cm. Insulation and heat must be provided adequately at home. Door handles must be the "leverage shaped" type and the height of the door sills should not impede the passage of a wheelchair for paraplegic patients. Floor should be hard and without carpet in order to ease wheelchairs movement. Bath tubs should be mounted on the wall and must have handles. The kitchen tools height should be accessible for the patient. Ramp at the entrance to the house is obligatory[12].

Transportation:

Rehabilitation team prescribes and adjusts wheelchair for appropriate pressure distribution with safe and easy driving. Height, pelvic width, seat length, backrest, seat and arm support of the wheelchair should be specifically prescribed for each patient. Upper segment injuries require battery assisted wheelchairs and manual wheelchair is preferred at lower segment injuries[18].

The most common mode of transportation is the car, which can be use either by adapting the driving space for paraplegic patients (hand controls), or adapting the car to allow wheelchair access.

COMPLICATIONS:

The results of SCI bring damage to independence, physical function, and cause many complications. Frequent complications after SCI include neurogenic bladder, neurogenic bowel, urinary tract infections, pressure ulcers, orthostatic hypotension, fractures, deep vein thrombosis, spasticity, heterotrophic ossification, contractures, autonomic dysreflexia, pulmonary and cardiovascular problems, and depressive disorders. The patient's life expectancy and quality of life are directly related to these complications. In the very first hours and during the resuscitation phase, especially in cases of multiple traumas, the risk of death is present in traumatic spinal cord injuries with para- and quadriplegia. It is critical to avoid any complications of the spinal cord injuries including during casualty collection and transportation, as well as in positioning of the patient for complementary examinations. Using positioning devices such as eggshell mattresses to immobilize patients is the standard for any transportation until fractures are reduced and fixed (with lateral restraint devices or through osteosynthesis). Prevention of pressure sores should start at the same time in the desensitized areas (special mattresses, frequent position changes every 2 or 3 hours), particularly as blood pressure and thermal disorders may be present. Protecting patients against

bronchial obstruction is often a priority in quadriplegia due to paralyzed abdominal muscles and inability to cough. Subsequent onset of pulmonary atelectases (area of the lung that is no longer ventilated) causing infection is very common. Frequent position changes and sessions of guided breathing exercises and chest percussion therapy can prevent this[6,12].

Afterwards, the complications that may become frequent are urinary tract (pyelonephritis, cystitis) and genito-urinary infections (prostatitis, urethritis), kidney and bladder calculi, as well as thrombophlebitis. Other rare complications include: osteomas (abnormal bony outgrowths) or paraosteoarthropathies in large joints (risk of ankylosis), pathologic fractures occurring at the level of injury and causing minor trauma due to bone demineralization and the postponed diagnosis due to analgesia, as well as bowel obstruction caused by a lack of proper fecal discharge.

Circulatory disorders such as edemas, phlebitis, embolisms are generally avoided by wearing compression stockings, placing the person in a slight sloping position during the night (elevated feet), as well as avoiding clothes that are very tight around the knees and hips. Monitoring by a specialized physician should be made once every year or two, or more if required. As for general follow-up, an attending physician who is aware of the clinical history should be helpful for every intervention at home and in treating intercurrent conditions[12,26].

PROGNOSIS:

The prognosis will depend upon the severity of the injury. At the clinical level, it is more likely that individuals who have sustained an incomplete injury recover immediately compared to those with a complete injury.

An important feature is the speed of recovery. During the first weeks following the injury, the prognosis emerges. The recovery potential decreases very quickly over time after two months without recovery. Conclusions can be drawn formally after a post-traumatic follow-up period of 8 months in the case of spinal cord injuries. This period is 18 months for associated root and peripheral nerve injuries.

Paraplegics with non-progressive conditions who use manual wheelchairs for many years tend to rely exclusively on their arms and shoulders for mobility and transferring. Later in life this will often cause problems. Their shoulders will have problems due to the abnormally heavy use. Use of mechanical assistive devices throughout life helps to preserve their abilities before damage to the shoulders occurs[9,12,33].

REFERENCES:

1. Anderson K, Aito S, Atkins M, Biering-Sørensen F, Charlifue S, Curt A, Ditunno J, Glass C, Marino R, Marshall R, Mulcahey MJ, Post M, Savic G, Scivoletto G, Catz A, Functional Recovery Outcome Measures Work Group. Functional recovery measures for spinal cord injury: an evidence-based review for clinical practice and research. *J Spinal Cord Med* 2008; 31 (2): 133-144.
2. Benevento BT, Sipski ML. Neurogenic bladder, neurogenic bowel, and sexual dysfunction in people with spinal cord injury. *Phys Ther* 2002; 82 (6): 601-612.
3. Chen Y, Devivo MJ, Jackson AB. Pressure ulcer prevalence in people with spinal cord injury: age-period-duration effects. *Arch Phys Med Rehabil* 2005; 86 (6): 1208-1213.
4. Crane DA, Hoffman JM, Reyes MR. Benefits of an exercise wellness program after spinal cord injury. *J Spinal Cord Med* 2015 (In press).
5. Ditunno JF, Little JW, Tessler A, Burns AS. Spinal shock revisited: a four-phase model. *Spinal Cord* 2004; 42 (7): 383-395.
6. Hagen EM. Acute complications of spinal cord injuries. *World J Orthop* 2015; 6 (1): 17-23.
7. Harvey LA, Herbert RD. Muscle stretching for treatment and prevention of contracture in people with spinal cord injury. *Spinal Cord* 2002; 40 (1): 1-9.
8. Jacobs PL, Nash MS. Exercise recommendations for individuals with spinal cord injury. *Sports Med* 2004; 34 (11): 727-751.
9. Kaptanoğlu E, Yılmaz T. Akut travmatik omurilik yaralanması ve yönetimi. In: *Temel Spinal Cerrahi*. Özer AF, Arslantaş A, Dalbayrak S (Eds.). İntertıp Yayınevi, İzmir 2016; pp: 529-539.
10. Kirshblum SC, Biering-Sorensen F, Betz R, Burns S, Donovan W, Graves DE, Johansen M, Jones L, Mulcahey MJ, Rodriguez GM, Schmidt-Read M, Steeves JD, Tansey K, Waring W. International standards for neurological classification of spinal cord injury: cases with classification challenges. *J Spinal Cord Med* 2014; 37 (2): 120-127.
11. Kirshblum SC, Waring W, Biering-Sorensen F, Burns SP, Johansen M, Schmidt-Read M, Donovan W, Graves D, Jha A, Jones L, Mulcahey MJ, Krassioukov A. Reference for the 2011 revision of the international standards for neurological classification of spinal cord injury. *J Spinal Cord Med* 2011; 34 (6): 547-554.
12. Kirshblum SC. Rehabilitation of spinal cord injury. In: *Physical Medicine and Rehabilitation, Principle and Practice*. DeLisa JA, Gans BM, Walsh NE (Eds.). Lippincott Willams&Wilkins, Philadelphia 2005; pp: 1715–1751.

13. Krassioukov A, Eng JJ, Claxton G, Sakakibara BM, Shum S. Neurogenic bowel management after spinal cord injury: a systematic review of the evidence. *Spinal Cord* 2010; 48 (10): 718-733.

14. Krassioukov A, Eng JJ, Warburton DE, Teasell R; Spinal Cord Injury Rehabilitation Evidence Research Team. A systematic review of the management of orthostatic hypotension after spinal cord injury. *Arch Phys Med Rehabil* 2009; 90 (5): 876-885.

15. Krause JS, Carter RE, Pickelsimer EE, Wilson D. A prospective study of health and risk of mortality after spinal cord injury. *Arch Phys Med Rehabil* 2008; 89 (8): 1482-1491.

16. Lala D, Dumont FS, Leblond J, Houghton PE, Noreau L. Impact of pressure ulcers on individuals living with a spinal cord injury. *Arch Phys Med Rehabil* 2014; 95 (12): 2312-2319.

17. Lombardi G, Del Popolo G, Macchiarella A, Mencarini M, Celso M. Sexual rehabilitation in women with spinal cord injury: a critical review of the literature. *Spinal Cord* 2010; 48 (12): 842-849.

18. Minkel JL. Seating and mobility considerations for people with spinal cord injury. *Phys Ther* 2000; 80 (7): 701-709.

19. Morawietz C, Moffat F. Effects of locomotor training after incomplete spinal cord injury: a systematic review. *Arch Phys Med Rehabil* 2013; 94 (11): 2297-2308.

20. New PW, Reeves RK, Smith É, Townson A, Eriks-Hoogland I, Gupta A, Maurizio B, Scivoletto G, Post MW. International retrospective comparison of inpatient rehabilitation for patients with spinal cord dysfunction epidemiology and clinical outcomes. *Arch Phys Med Rehabil* 2015; 96 (6): 1080-1087.

21. Ohana N, Sheinis D, Rath E, Sasson A, Atar D. Is there a need for lumbar orthosis in mild compression fractures of the thoracolumbar spine?: A retrospective study comparing the radiographic results between early ambulation with and without lumbar orthosis. *J Spinal Disord* 2000; 13(4): 305-308.

22. Pillastrini P, Mugnai R, Bonfiglioli R, Curti S, Mattioli S, Maioli MG, Bazzocchi G, Menarini M, Vannini R, Violante FS. Evaluation of an occupational therapy program for patients with spinal cord injury. *Spinal Cord* 2008; 46: 78–81.

23. Ricciardi R, Szabo CM, Poullos AY. Sexuality and spinal cord injury. *Nurs Clin North Am* 2007; 42 (4): 675-684.

24. Saur MA, Abel R. Rehabilitation for paraplegics. *Orthopade* 2015; 44 (6): 477-486.

25. Sekhon LH, Fehlings MG. Epidemiology, demographics, and pathophysiology of acute spinal cord injury. *Spine* 2001; 26 (24 Suppl): S2-12.

26. Sezer N, Akkuş S, Uğurlu FG. Chronic complications of spinal cord injury. *World J Orthop* 2015; 6 (1): 24-33.

27. Sunn G. Spinal cord injury pressure ulcer treatment: an experience-based approach. *Phys Med Rehabil Clin N Am* 2014; 25 (3): 671-680.

28. Tamplin J, Berlowitz DJ. A systematic review and meta-analysis of the effects of respiratory muscle training on pulmonary function in tetraplegia. *Spinal Cord* 2014; 52 (3): 175-180.

29. Vallès M, Mearin F. Pathophysiology of bowel dysfunction in patients with motor incomplete spinal cord injury: comparison with patients with motor complete spinal cord injury. *Dis Colon Rectum* 2009; 52 (9): 1589-1597.

30. van Gorp S, Kessels AG, Joosten EA, van Kleef M, Patijn J. Pain prevalence and its determinants after spinal cord injury: a systematic review. *Eur J Pain* 2015; 19 (1): 5-14.

31. Warren DV. Managing pressure ulcers in patients with a spinal cord injury: a case study. *Br J Nurs* 2010; 19 (6): S9-10, S12.

32. Wirth B, van Hedel HJ, Kometer B, Dietz V, Curt A. Changes in activity after a complete spinal cord injury as measured by the Spinal Cord Independence Measure II (SCIM II). *Neurorehabil Neural Repair* 2008; 22 (2): 145-153.

33. Yağız On A. Omurilik yaralanmalarında rehabilitasyon. In: *Temel Nöroşirürji*. Korfalı E, Zileli M (Eds.). Pelikan Yayınevi, Ankara 2010; pp: 1731-1748.

PROF. ALİ FAHİR ÖZER, M.D.

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SUMMARY:

Ali Fahir Özer was born in 1953 in Gumushane. He gratuated from Erzurum Ataturk University in 1976. He completed his residency at Hacettepe University. In 1989 he became an associate professor and in 1994 he became a full professor. He was the one who performed several spine surgeries for the first time in Turkey. He founded The Peripheric and Spinal Surgery Group in 1995. He served as the president of the spinal group between 1999-2001.

He described numerous surgical techniques in his own name and developed instrumentation systems. He published numerous national and international articles. He used the dynamic system for the first time in Turkey and he is a leader in using dynamic systems. He is one of the leaders in the Turkish Spine Surgery.

Key words: Ali Fahir Özer, spinal surgery, dynamic systems, open window corpectomy

Level of Evidence: Biography, Level V

ÖZET:

Ali Fahir Özer 1953 yıllında Gümüşhane'de doğdu. Erzurum Atatürk Üniversitesi'ni 1976 yılında bitirdi. Beyin cerrahisi ihtisasını Hacettepe Üniversitesi'nden aldı. 1989 yılında doçent 1994 yılında profesörlük ünvanını aldı. Türkiye'de omurga cerrahisinde ilkleri gerçekleştirdi. Türk Nöroşirurji Derneği Spinal Grubu'nu 1995 yıllında kurdu. 1999-2001 yılları arasında Spinal Grup başkanlığı yaptı.

Kendi adına sayısız cerrahi teknik tanımladı ve enstrümantasyon sistemleri geliştirdi. Çok sayıda ulusal ve uluslararası makale yayınladı. Dinamik sistemi Türkiye'de ilk kez kullanan ve dünyada dinamik sistem enstrümantasyonun kullanımında söz sahibi omurga cerrahlarından biridir. Turk omurga cerrahisinde lider kişilerden biridir.

Anahtar Kelimeler: Ali Fahir Özer, omurga cerrahisi, dinamik sistem, açık pencere korpektomi

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INTRODUCTION:

Ali Fahir Özer is the pioneer of the Turkish neurosurgeon spine surgeons. It's an honour for me to have this privilege of writing the biography of my Professor, Ali Fahir Özer, who started the spine surgery and performed complicated spinal surgeries in Turkey. You may criticize him as inaccessible, silent and a professor who may lose temper at any moment if you don't know him well. However, you start learning how kind, approachable and humanistic he is, when you spend time with him.

During my years of residency, when I developed an interest in spine surgery, I started respecting Professor Fahir even more. Because he was trying to spread out his experience, while at the same time supporting and helping everyone who wanted to learn spine surgery.

Fahir Özer is open to all kinds of personal and scientific criticisms. He is interested in innovation and he is still enthusiastic about his profession as if he were still in his first years. When Fahir Özer switched from fusion to dynamic sysytems our colleagues said 'For years, he told us about the fusion, so we started fusion. Now he says dynamic'. He developed dynamic systems, tested them biomechanically and supported their national production. And he showed the courage of performing these systems in a centre like the American Hospital.

All these are the clear indications of his open mind for development and change as a leader. Numerous surgical techniques, tools and instrumentation systems developed by Professor Fahir have had contributions for spine surgery not only in Turkey but also across the world.

The most interesting thing about working with Professor Fahir is learning new things and discovering a new side of him. A lifetime full of spine surgery needs to be to published as a book but here is a brief summary of Professor Ali Fahir Özer's life.

LIFE STORY:

He was born in 1953 in Gümüşhane as the first child of Family Özer. His mother Ayhan was a housewife and his father Mehmet was a civil engineer. He has a brother called Reha and a sister called Züleyha. He spent his childhood years in a large mansion in Gümüşhane playing the cowboy game with his cousins. He started elemantary school in Dumlupınar Primary School in Gümüşhane (Figure-1).

The family moved to Erzurum becasue of the father's job, and therefore, he completed elemantary school at Culture Institution of Erzurum. He graduated from Erzurum 23 July Middle School. He was the president of the middle school library club. In that period he had the chance to read many world classics.

As childhood memories, he remembers the tough winter conditions in Erzurum and also the little coach trips with his family. He also recalls the Varto earthquake. When the earthquake occurred, he was standing in a garden opposite to their house.

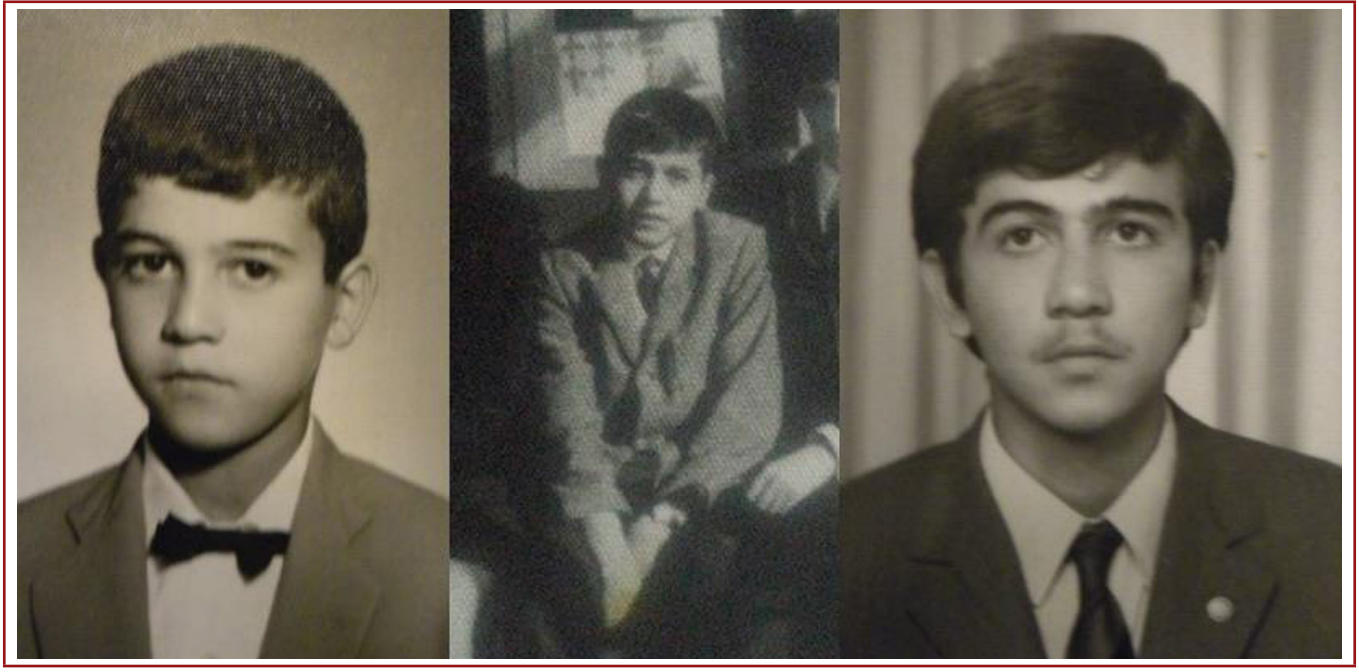

Figure-1. Elementary school, middle school, high school ages of Ali Fahir

He watched his house move from one side to the other side, but it did not collapse. Thus, he got the idea that 'Elastic structures adapt to nature better than static structures'[17].

Later the family moved to Ankara because of the father's job. He was a young man. He started the high school in Ankara Cumhuriyet Lisesi. He had a photographic memory. He answered a question in the history exam about 'Çifte Minare'. His history teacher accused him of cheating because every word he said was exactly as written in the history book. He decided to paraphrase the sentences for next exams. He says his grades were mediocre in mathematics and physics. He dealed with his mathematics teacher and he gave him 5 so that he could pass the class.

At the end of the high school he wanted to enroll in the faculty of medicine, law or Political Sciences. He enrolled in the Faculty of Medicine at Erzurum Ataturk University. Following the first two years in Hacettepe University, he went to Erzurum. His initial years at university were marked with the political turmoil of March 12th. Ali Fahir was impressed by those days when he was a university student. Incidents of the attacks between the right wing and left wing and political instability led to the military coup on March 12th and then came a deep silence in the whole country.

The cadaver course was the first memory he can recall from the faculty of medicine. He would never talk with his friend who prayed with a scalpel before the dissection of the cadaver. In the first faculty years he decided to be an anatomist than a pathologist. In the third semester he wanted to be a hematologist, then he decided to be a surgeon at his fourth year.

In the fifth year, he was affected by two events. When he was a trainee at Pediatrics, there was a child who had tense fontanelle. A neurosurgeon drained the CSF by dipping the needle into child 's head. Ali Fahir was astonished, he could not believe it. He developed a respect for neurosurgeons. Then he met Aykut Erbengi. During the time when Dr. Erbengi was teaching him, Fahir Özer was deeply impressed by the way he acted, his personality and style. Based on this he decided to become a neurosurgeon[17].

He graduated from the faculty of medicine in 1976. He decided to take exams for Hacettepe University Department of Neurosurgery. One of his references was Professor Ayhan Göçmen. While they were sitting in the department Professor Yunus Müftü entered. Dr. Göçmen introduced them to each other. Dr. Yunus Müftü said 'Son, you look like a very good man. What will you do with those monsters?' The monsters he referred to would be Fahir Özer's best friends and professors. Those were Dr. Işık Gürel, Dr. Kemal Benli, Dr. Ümit Acar and Dr. Erdem Çöteli. Also Dr. Yamaç Taşkın, Dr. Tunçalp Özgen, Dr. Metin Güner, Dr. Kemal Gökdemir would be very close to him like brothers[17].

Fahir Özer was very sick on his first day at Hacettepe and he had fever as high as 39 to 40 degrees. He did not want to leave a bad impression in the begining. He did not say he was sick. He thought that he could go to bed very early, take a good sleep and the next morning he would feel better. But, instead he could sleep at 4 a.m. and woke up at 6 a.m. He asked himself 'God, where am I ?' (Figure-2).

Figure-2. Hacettepe University (1977-1982)

He has lots of memories from his residency years. A few of them: Ecevit was the President of the Republic in those years and there was shortage of everythingin the country. Oil was one of the basic necessities that was scarce. They put some oil instead of soap in the toilet. Dr. Cevdet Caner went to the toilet and washed his hands using the oil.

Suddenly he came out looking for Fahir Özer. At that time Fahir Özer was at the department of pediatrics. People warned him saying 'Do not come to the department or he will kill you.' Dr. Hülya Caner was Dr. Cevdet's wife 'and the head of the department of pediatrics'. Fahir Özer called Dr. Hülya and told her that he had not organised that joke and asked for her help. Next morning Dr. Cevdet was still angry at him but could not do anything because of his wife, the head of neursougery. Later they discovered that it was Dr. Mehmet Tandoğan had organized the joke.

Another anecdote: There was a constant friction between the departments of pediatrics and neurosurgery. Dr. Ferhan Hamarat had received one of Picasso's paintings from the pediatrics department and he had put in the head's room in the department of neurosurgery. One morning Dr. Fahir came early. Everyone was asleep. He took the painting and he hid it. He hung a notice which said 'Neurosurgeons! It is our painting. We will not let you have it'. The neurosurgeons who heard about this notice started attacking the department of pediatrics. They piled up Nelson's book, baby food, diapers and many other materials in room 61. At day 4, Dr. Tandoğan said 'Fahir, this is your hand writing but where is the painting?'. And everyone learned the truth.

Fahir Özer learned two important things from his professors during his residency; writing scientific papers and comparing treatments to what is said in the literature. Dr. Fahir Özer was deeply impressed by Dr. Vural Bertan as Dr. Bertan went to Canada and studied with Hardy. He brought the necessary surgical equipments with him and started transsphenoidal surgery. He was inspired because he thought that new things could be learned and performed. This would have a huge effect on the following years (Figure-3)[17].

At the fourth year of his residency he married Dr. Nesrin Özer. Dr. Nesrin was also an academic who worked on biochemistry. They had a child named Can in 1987. And Can would be an economist (Figure-4).

Fahir Özer completed his military service as a reserve officer in Kayseri Military Hospital. He performed lots of surgeries there. He made his compulsory military service in Ankara Numune Hospital. The heads of department were Dr. Yıldız Yalçınlar and Dr. Yamaç Taşkın . He gained a lot of experience (Figure-5).

He went to Glasgow. He learned lots of things about head trauma and its treatment. And he started performing these techniques at Numune Hospital. Invited by Aykut Erbengi, he returned to Hacettepe University. He started his PhD on Neurosurgical Neurological Sciences Microsurgery. However, he then started Marmara University with Dr. Pamir and left Hacettepe University (Figure-6).

Figure-3. Prof. Dr. Aykut Erbengi and Ali Fahir Özer

Figure-4. Fahir Özer's wife Prof. Dr. Nesrin Özer and his son Can Özer

There very really impotartant changes in spine surgery in those years. New surgical techniques were developed. Laminectomy was the most common surgical procedure for lumbar pathologies. Laminectomy and in-situ fusion and braces for 3 months were the limited techniques for spinal trauma. Terms like stability and instability and instrumentation were rarely used. Transpedicular instrumentation, Kaneda systems for anterior surgeries became more common.

Lots of spinal pathologies could be treated with those new techniques. At that time Dr. Fahir Özer chose to perform more spinal surgeries in his daily practice[17].

He became an associate professor in 1989 and a full proffesor in 1994. He worked as the head of the Neurosurgery Department at Kocaeli University. Following the invitation of Professor Ali Çetin Sarıoğlu he started to work with him at the American Hospital. With his team, they worked like a university hospital for 20 years.

Figure-5. Kayseri Military Hospital in 1983

Figure-6. Founders of Depatment of Neurosurgery of Marmara University (Mehmet Ozek on the left side Necmettin Pamir on the right side)

CONTRUBUTIONS TO THE TURKISH SPINAL SURGERY:

He performed lots of surgeries as a pioneer. He worked with more than 50 national and international fellows. He published many 50 national and 150 international papers. Furthermore, he published 9 books as an editor and 43 book chapters.

The American Hospital became a school in the Turkish Spine Surgery. Contrubutions of Prof. Dr. Ali Fahir Özer to the Spine Surgery Ali Fahir Özer established 'Spinal Surgery Group' with Dr. Mehmet Zileli, Dr Murat Hancı and Dr Nusret Demircan in 1995. He was also one of the first members of Turkish Spine Society.

He performed many surgeries for the first time in Turkey. Performing those surgeries in a private hospital rather than a univesity hospital made them more important. He performed the first lateral mass screwing and published it[3]. He performed the first odontoid screwing with Dr. Celal İplikçioğlu and performed the first C1-2 Magerl technique and presented it during the EANS meeting in Spain[4-5]. These two surgical operations were important because they showed the level of spine surgery back in those years. He also used the first cervical disc prosthesis and published it as an article (Figure-7) [6].

In 1999 he described 'Open window corpectomy' technique for cervical spondylopathic myelopathy and published the long-term results in an article[7-8]. He suggested creating new holes to increase the fusion rate for the treatment of old odontoid fractures and described a new technique. 5,9 He modified a new technique for the treatment of C7-T1 and published it[10].

He standardized the technique for protecting the ligamentum flavum for the L4-5 and L5-S1 disc herniations[11]. He described a new operation technique that dynamic screw and dynamic rod could be used in the lateral reccess stenosis cases in which facet joint was removed[12].

He performed a new technique for cervical foramina stenosis cases. This new technique increases the foramina via distracting the lateral mass without fusion[13] He described another new technique for spondylolisthesis. He drilled the pedicule in cases with balanced spondylolisthesis, in which the nerve was compressed in the foramen[14]. His colleague Sasani and he described and published single-stage posterior corpectomy and expandable cage placement for treatment of thoracic or lumbar burst fractures and other pathologies[17].

He also found a cervical disc retractor and named it 'Ozer Cervical Disc Retractor' (Figure-8)[15].

He designed 'Dynamic Safinaz Screw System' and used this system[1-2]. He also designed. 'Alfa-D'cervical disc prosthesis' and used it for the treatment of cervical disc herniation (Figure-9).

Figure-7. A picture during a presentation

Figure-9. Alfa-D cervical disc prosthesis

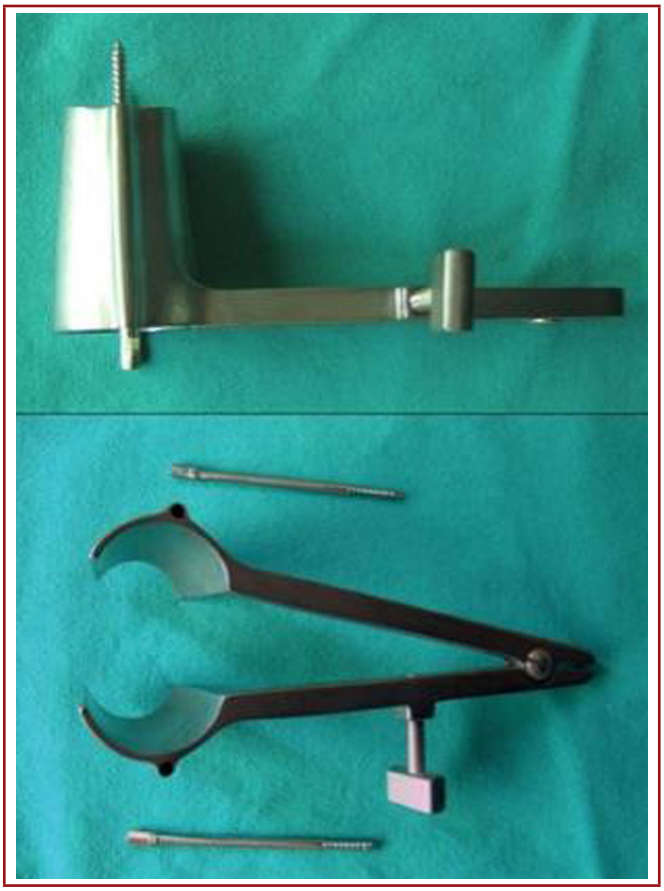

Figure-8. Ozer cervical disc retractor

Dr. Fahir Özer spread out the use of dynamic stabilization. He identified the indications of using dynamic stabilization. He classified the dynamic systems. And he created a suitable algorithm for the treatment of lumbar disc herniation[16].

Dr. Fahir Ozer currently works on a new modular dynamic instrumentation system. He finished the biomechanical studies. He will soon start the patient application. He believes that this project will change many things in dynamic systems. Advantage of the his new dynamic stabilization is it will be used in multilevel instability so that many deformities can be treated without fusion. He also designed another dynamic screw with Dr. Deniz Erbulut. This new screw can be used in fusion to increase the loads on graft and also can be used to increase the movement when applied on S1 segment. And he also designed a third generation Talin Rod System to use with this system. In the future he will use this system also in the cervical spine. (Figure-10).

He also works on a cervical collar that can prevent cervical injury with Prof. Dr. Kemal Türker from Koç

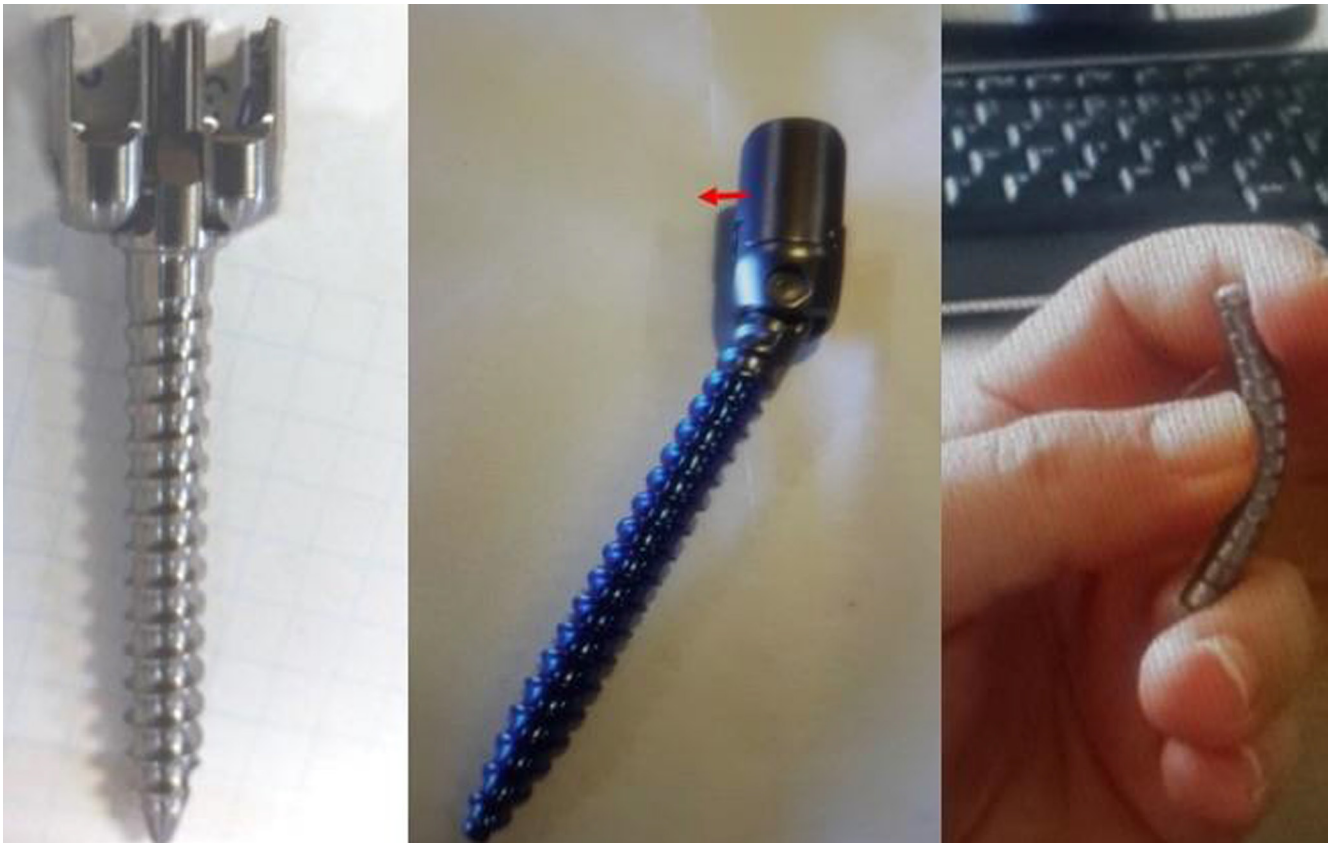

Figure-10. A new dynamic screw with two heads and third generation Talin Rod

REFERENCES:

1. Erbulut DU, Kiapour A, Oktenoglu T, Ozer AF, Goel VK. A computational biomechanical investigation of posterior dynamic instrumentation: combination of dynamic rod and hinged (dynamic) screw. *J Biomech Eng* 2014;136(5): 051007
2. Öktenoglu T, Erbulut DU, Kiapour A, Ozer AF, Lazoglu I, Kaner T, Sasani M, Goel VK. Pedicle screw-based posterior dynamic stabilisation of the lumbar spine: in vitro cadaver investigation and a finite element study. Comput Methods Biomech Biomed Engin 2014 (In press).
3. Özer AF, Öktenoğlu T, Kılıç T, Özgen S, Keles GE, Pamir MN. Servikal travmalarda plak vida sistemi ile posterior internal fiksasyon. *Türk Nöroşirürji Dergisi* 1995; 5: 65-69.
4. Özer AF, İplikçioğlu C, Sarıoğlu AÇ. Tip II odontoid kırığının transodontoid vida ile tespiti. *Türk Nöroşirürji Dergisi* 1997; 7: 31-34.
5. Ozer AF, Iplikcioglu C, Bozkus H, Oktenoglu T, Kalelioglu M, Sarioglu AC. Trasodontoid screw fixation in type II odontoid fracture. (The first reported series in Turkey). *JTSS* 1998; 9 (2): 67-70.
6. Özer AF, Öktenoğlu T, Sasani M, Bozkuş H, Canbulat N, Sarıoğlu AÇ. Servikal Disk Protezi. Türk Nöroşirurji Dergisi 2005; 15: 285-290.
7. Özer AF, Oktenoğlu BT, Sarioğlu AC. A new surgical technique: open-window corpectomy in the treatment of ossification of the posterior longitudinal ligament and advanced cervical spondylosis: technical note. *Neurosurgery* 1999; 45(6): 1481-1485.
8. Özer AF, Oktenoglu T, Cosar M, Sasani M, Sarioglu AC. Long-term follow-up after open window corpectomy in patients with advanced cervical spondylosis and/or ossification of the posterior longitudinal ligament. *J Spinal Disord Tech* 2009; 22(1): 14-20.
9. Özer AF, Cosar M, Oktenoglu TB, Sasani M, Iplikcioglu AC, Bozkus H, Bavbek C, Sarioglu AC. A new transodontoid fixation technique for delayed type II odontoid fracture: technical note. *Surg Neurol* 2009;71(1):121-125.
10. Özer AF, Kaner T, Sasani M, Oktenoglu T, Cosar M. Anterior approach to disc herniation with modified anterior microforaminotomy at C7-T2: technical note. *Spine* 2009; 34(17): 1879-1883.

11. Özer AF, Oktenoglu T, Sasani M, Bozkus H, Canbulat N, Karaarslan E, Sungurlu SF, Sarioglu AC. Preserving the ligamentum flavum in lumbar discectomy: a new technique that prevents scar tissue formation in the first 6 months postsurgery. *Neurosurgery* 2006; 59(Suppl.-1): ONS126-133.

12. Özer AF, Suzer T, Sasani M, Oktenoglu T, Cezayirli P, Marandi HJ, Erbulut DU. Simple facet joint repair with dynamic pedicular system: technical note and case series. *J Craniovertebr Junction Spine* 2015; 6(2): 65-68.

13. Özer AF. et al. A novel foraminal expansion technique. Asian Spine J 2016 (in press).

14. Özer AF, Suzer T, Sasani M, Oktenoglu T, Egemen E. Enlargement of neural foramina and dynamic stabilization in spondylolisthesis without restoring the alignment: technical Note. *Korean J Spine* 2016;13(1): 37-39.

15. Özer AF. A new retractor for the anterior cervical approach. *Brit J Neurosurgery* 1994; 8: 469-470.

16. Özer AF, Suzer T, Cezayirli P, Erbulut D. Evaluating lumbar disc herniation and other motion segment pathologies from the window of dynamic stabilization systems. *J Spine Neurosurg 2014*; S2.

17. Sasani M. Özer AF. Single-stage posterior corpectomy and expandable cage placement for treatment of thoracic or lumbar burst fractures. *Spine* (Phila Pa 1976) 2009 Jan 1;34(1):E33-40. doi: 10.1097/BRS.0b013e318189fcfd.

18. Yaman O. Personal talkings. 2016

1- Which sentence of the below is true according to the study of Mısır et al.

a) In the Scheuermann kyphosis group, T1-12 kyphosis angle was increased postoperatively.
b) Significant decrease in T2-5 kyphosis was seen in the Schuermann kyphosis group postoperatively
c) In the sharp kyphosis group, T1-12 kyphosis angle was increased postoperatively.
d) T2-5 kyphosis angle increased in the sharp kyphosis group, postoperatively.
e) The increase of the T2-5 kyphosis angle was statistically significant.

2- How many patient with the kyphosis had been evaluated in the study of Mısır et al?

a) 10
b) 20
c) 30
d) 40
e) 50

3- Which the coronal angles of two spinal level's tunnels were defined in the study of Karadeniz and Duman?

a) L5-S1
b) S1-2
c) S2-3
d) S3-4
e) S4-5

4- How many patient was evaluated in the study of Karadeniz and Duman?

a) 32
b) 42
c) 52
d) 62
e) 72

5- Which cervical level was most affected with thw disc herniation according to the first study of Aydoğmuş *et al*?

a) C2-3
b) C3-4
c) C4-5
d) C5-6
e) C6-7

6- How many cases instrumented were presented in the second study of Aydoğmuş *et al*?

a) 140
b) 150
c) 160
d) 170
e) 180

7- How many cases opereted were established non-surgical according to the TLICS in the study of Tiryaki *et al*?

a) % 79.4
b) % 66.5
c) % 42.7
d) % 25.3
e) % 15.7

8- Which value accept non-surgical according to the TLICS?

a) 1-3
b) 3-5
c) 5-7
d) 7-9
e) 9-11

9- In which vertebral level, burst fracture had been occured in the lumbar segment fused in the first case of Woo *et al*?

a) L1
b) L2
c) L3
d) L4
e) L5

10- How many years old is the patient with the multiple meningeal cysts presented in the study of Eser *et al* ?

a) 68
b) 70
c) 72
d) 74
e) 78

JTSS 27(1) issue CORRECT ANSWERS OF CME QUESTIONS:

1. **e**
2. **d**
3. **e**
4. **c**
5. **a**
6. **b**
7. **a**
8. **d**
9. **d**
10. **a**


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