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ORJİNAL ÇALIŞMA / *ORIGINAL ARTICLE*

COMPARISON OF THE RESULTS OF COTREL-DUBOUSSET AND SUBLAMINAR WIRE FIXATION METHODS FOR THE TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS: MINIMUM 5 YEARS FOLLOW-UP

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SUMMARY:

Objective: *At least 5 – year follow up results of adolescent idiopathic scoliosis, those were treated using Cotrel- Dubousset instrumentation (CDI) and Luque sublaminar wiring methods were reviewed with retrospective cohort study. Results of these two cohorts were compared.*

Methods: *Twenty nine patients contain two cohorts were included in the study. Fourteen of patients were treated using CDI and fifteen were treated with Luque sublaminar wiring method. Mean age at the time of surgery was 15.3 years in CDI group and 17.7 for sublaminar wire group. Preoperatively primary curves were measured using Cobb method, revealing a mean of 49.9 degrees for CDI group and 56.4 degrees for sublaminar wire group. At the end of follow up period, mean Cobb value was 15.6 for CDI group and 19.7 for sublaminar group.*

Results: *Statistical analysis of the results revealed that there is no statistical difference between these two methods at follow up (p>0.05). During follow up period, for two patients in CDI group pull-out of proximal hook were encountered. In one of these patients revision was performed.*

Discussion: *From aspects of correction of deformity and maintenance of correction, comparison of CDI and sublaminar wiring method showed that there is no difference between these two methods at the end of follow up period.*

Key words: *Idiopathic scoliosis, sublaminar wire, hook system.*

ÖZET:

Amaç: *Minimum 5 yıllık takibe sahip, cerrahi tedavileri için Cotrel – Dubousset enstrümantasyonu ve Luque sublaminar telleme sistemi kullanılan iki grup idiopatik skolyoz hastasının sonuçları retrospektif olarak değerlendirildi ve sonuçları karşılaştırıldı.*

Metot: *Bu çalışma 29 idiopatik skolyoz hastayı içermekte olup, bu hastalardan 14'ü CDI ve 15'i Luque sublaminar telleme ile tedavi edilmişti. CDI ve Luque sublaminar telleme grubunda sırasıyla ortalama yaşları 15.3 ve 17.7, preoperatif Cobb açıları 49.9 ve 56.4 derece idi. Son kontrolde Cobb açılarının sırasıyla 15.6 ve 19.7 dereceye indiği belirlendi.*

Results: *İki grup preoperatif, postoperatif ve son kontroldeki değerler açısından istatistiki olarak farklı olmadığı belirlendi (p > 0.05). Takipte CDI uygulanan 2 hastada proksimal hooklarda çıkma saptandı ve 1 hasta revizyon cerrahi gerektirdi.*

Discussion: *Bu sonuçların ışığında CDI sistemi ile sublaminar tellemenin skolyotik deformitenin düzeltilmesinde ve korreksiyonun korunmasında benzer etkide olduğu saptandı.*

Anahtar Kelimeler : *İdiopatik skolyoz, sublaminar telleme ve hook sistemleri.*

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INTRODUCTION:

Cotrel-Dubousset instrumentation (CDI) corrects the three-dimensional scoliotic deformity by using derotational maneuver[8]. However, some investigations had shown that derotational force of CDI system is transferred to the neutral vertebra resulting imbalance and decompression problems [12,14]. Therefore sublaminar wiring and translation that used by Luque have been repopularized [5].

In this study, we reviewed retrospectively at least 5–year follow up results of adolescent idiopathic scoliosis; those were treated using Cotrel-Dubosset instrumentation and sublaminar wiring with translation method. The results of preoperative and last control frontal Cobb's angles of these two methods were compared.

METHODS:

Total twenty-nine patients contains two different homogenous cohort were included in the study. In first cohort, there were fourteen of patients which treated with CDI system (Texas Scottish Rite Hospital System "TSRH") (Figure 1). In second cohort, there were fifteen patients which treated with Luque sublaminar wiring method (Isola Spinal Instrumantation) (Figure-2).

Mean age at the time of surgery was 15.3 years in CDI group and 17.7 for sublaminar wire group. 12 of the patients in CDI group and 13 of the patients in sublaminar wiring group were female. Preoperatively primary curves were measured using Cobb method on coronal plane, revealing a mean of 49.9 degrees for CDI group and 56.4 degrees for sublaminar wire group. At the end of follow up period, mean coronal plane Cobb value was 15.6 degrees for CD group and 19.7 degrees for sublaminar group (Table-1).

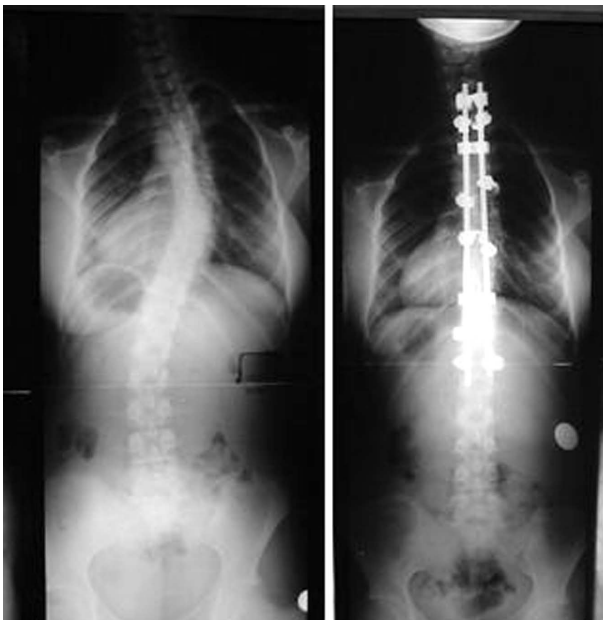

Figure 1: Fourteen year old girl with King Type II curve preoperative (a) and postoperative (b) radiographs were shown. The correction was achieved by derotation maneuver using TSRH system.

The mean of correction between two groups was analyzed by using student's t-test. The statistical analyses were conducted by using SPSS 12.0 software.

Table-1. The mean age, pre and postoperative frontal Cobb angles of the major curve and the mean follow-up period of both CDI and Sublaminar wiring groups.

GROUPS	AGE (YEARS)	PREOP (DEGREES)	POSTOP (DEGREES)	FOLLOW-UP (YEARS)
CDI	15.3	49.9	15.6	9.43
SUBLAMINAR	17.7	56.4	19.7	8.27

Figure 2: Twelve year old female with a thoracic scoliosis King type II preoperative (a) and postoperative (b) radiographs were shown. The correction was achieved by Isola sublaminar wire technique.

RESULTS:

There were no statistical difference between CDI and sublaminar wiring groups for mean age and the degree of deformity at the beginning of the study. Correction of coronal plane major curves for CDI and sublaminar wiring was found to be 68,7 % and 65,1 % respectively. Statistical analysis of the deformity correction degree, revealed that there is no statistical difference between these two methods at the end of the follow up period ($p>0.05$). During follow up period, for two patients in CDI group pull-out of proximal hook were encountered. For one of these patients revision was considered to correct the deformity because fusion was not achieved.

DISCUSSION:

The main difference between CDI and sublaminar wiring is that the correction of the spinal deformity was achieved by derotation of the rod for the CDI system and translation of the spinal column for the sublaminar wiring system [5].

It was proposed that imbalance and decompansation arises because of transmission of derotational effect on healthy vertebral column [5,12]. The decompansation problems of CDI system an old alternative method was repopularized by Asher by translating the spinal column deformity with Isola system using alternatively hooks or sublaminar wires [1,5]. Gondo and Asher reported that the Isola spinal instrumentation system does not cause decompansation problems [9]. In current study we did not observe significant decompansation problem when we compare two groups. We had seen two proximal hook failures which have also been reported by Richards in the literature in CDI group [13]. In these two cases curves were not flexible.

In a recent study compares the instrumentation systems for scoliosis correction, Luk et al, reported that the amount of correction achievable is largely determined by the inherent character of the curve (flexibility) rather than the surgical technique or instrumentation (TSRH, CD-Horizon, Moss-Miami and ISOLA) used. This conclusion is the same with our study [11].

In this study the percentage of correction is comparable with the literature [2-4,6-7]. Benli et al suggested that satisfactory correction rates have been obtained in both sagittal and frontal planes with multifilament, titanium, and double crimp sublaminar wire augmented third generation instrumentation systems [4]. No decompansation and imbalance have been observed and in the last examination a totally balanced or balanced vertebral column has been obtained in all patients. In a recent study, Cheng et al stated that, apical sublaminar wire and pedicle screw instrumentation both offer similar major curve correction with similar fusion lengths without neurological problems in the operative treatment of idiopathic scoliosis [7]. Although more expensive, pedicle screw constructs had significantly less

blood loss and slightly shorter fusion lengths than the sublaminar wire constructs.

There is an important issue for using sublaminar wiring technique. Titanium wire is not available in the Isola System. This restricts the surgeon's demands. Therefore there is no way to use titanium implant for special situations in Isola sublaminar wiring system.

From aspects of correction of deformity and maintenance of correction, comparison of CDI and sublaminar wiring method showed that there is no significant difference between these two methods at the end of follow up period. Authors found that, both instrumentation techniques are efficient but sublaminar wiring is cheaper than multihook or pedicle screw systems.

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ORJİNAL ÇALIŞMA / *ORIGINAL ARTICLE*

OMURGANIN NÜKS HİDATİK KİSTİ: OLGU SUNUMU
RECURRENT SPINAL HYDATID CYST: CASE REPORT

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SUMMARY:

Hydatidosis, caused by Echinococcus granulosus, is an endemic parasitic disease in Mediterranean countries. The most frequent anatomic locations are liver and lung. Hydatidosis is located in the bones in 0.5 to 2% of all cases; approximately 50% of these involve the spine. We present a case diagnosed lumbar vertebral hydatid cyst disease. 48 years old male living in a farm with animals, admitted with back pain symptoms for several months. He underwent in anterior spine surgery 11 years before for hydatid cyst disease. Plain radiographs and magnetic resonans imaging studies performed. Anterior decompression, radical debridment, grafting, posterior instrumentation and fusion performed. Microbiologic and pathologic findings were adressed hydatid cyst of spine. Albendasole medication given for 4 months. The symptoms revealed, and there were no recurrences in radiographic studies at 6 months later follow-up. Differential diagnosis is important between this rare spinal lesion and other spinal infections such as tuberculosis, brucellosis, vertebral osteomyelitis and spinal tumors.

Key words: *Hidatid cyst, anterior radical debridment, posterior instrumentation.*

ÖZET

Etkeni Ekinokokkus granulosus olan hidatidoz Akdeniz ülkelerinde görülen endemik paraziter bir hastalıktır. En sık anatomik lokalizasyonlar karaciğer ve akciğerdir. Hidatidoz tüm olguların %0.5-2'sine kemik dokusunu, bunların yaklaşık %50'sinde de omurgayı tutar. Lomber omurga hidatik kist hastalığı tanısı konan bir olguyu sunuyoruz. Bir çiftlikte çeşitli hayvanlarla birlikte yaşayan 48 yaşında bir erkek birkaç aydır süren bel ağrısı şikayetleri ile başvurdu. Hastaya 11 yıl önce omurga kist hidatik hastalığı nedeniyle anterior omurga cerrahisi yapılmış. Direkt radyografiler ve manyetik rezonans görüntüleme çalışmaları yapıldı. Anterior dekompresyon, radikal debridman, greftleme, posterior enstrümentasyon ve füzyon uygulandı. Mikrobiyolojik ve patolojik bulgular omurganın kist hidatik hastalığını gösterdi. Hastalara 4 ay süreyle albendazol verildi. 6 ay sonraki takiplerinde şikayetlerin tamamen kaybolduğu, görüntüleme çalışmalarında nüks olmadığı görüldü. Nadir görülen bu omurga lezyonunun, omurganın tüberküloz, bruselloz ve osteomyeliti ve omurga tümörleri ile ayırıcı tanısı önemlidir.

Anahtar kelimeler: *Kist Hidatik, anterior radical debridman, posterior enstrümentasyon.*

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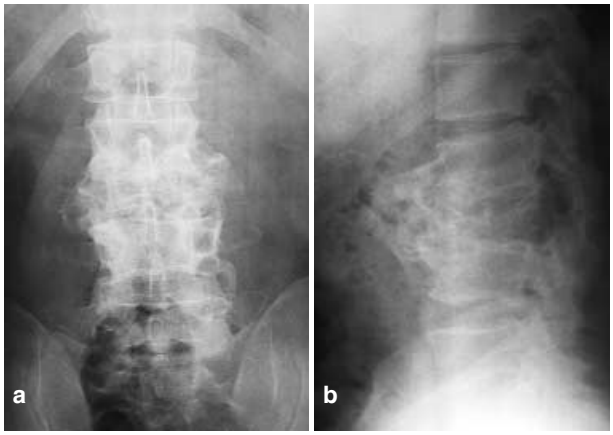
GİRİŞ

Kist hidatik dünyada çeşitli coğrafi bölgelerde önemli morbidite nedeni olabilen bir hastalıktır. Orta Doğu, Akdeniz, Güney Amerika, Hindistan ve Kuzeybatı Çin'de 100,000'de 3-50 hastada görülebilen, endemik bir hastalıktır[16,30,32,36]. Hastalık en sık karaciğere yerleşir. Tüm hastaların % 0.5-2'si kemiktedir[37]. Bunların da yaklaşık yarısı omurgada görülür.

Hidatik kisti en sık echinococcus granulosus paraziti tarafından oluşur. Ayrıca echinococcus alveolaris ve nadiren de echinococcus multiloculoris tarafından meydana getirilebilir. Kesin konakçı köpekler veya diğer etobur hayvanlardır. Köpeklerin dışkısıyla atılan parazit yumurtalarının koyun gibi otçul hayvanlar tarafından yenmesiyle bu hayvanlar enfekte olur, ki bunlara ara konakçı denir. Koyunların enfekte etlerinin köpekler tarafından yenmesiyle skoleksler köpek barsağında erişkin solucanlara dönüşür ve parazitin yaşam döngüsü tamamlanır. İnsanlar köpek dışkısıyla bulaşmış su ve sebzeleri yiyerek enfeksiyonu alırlar.

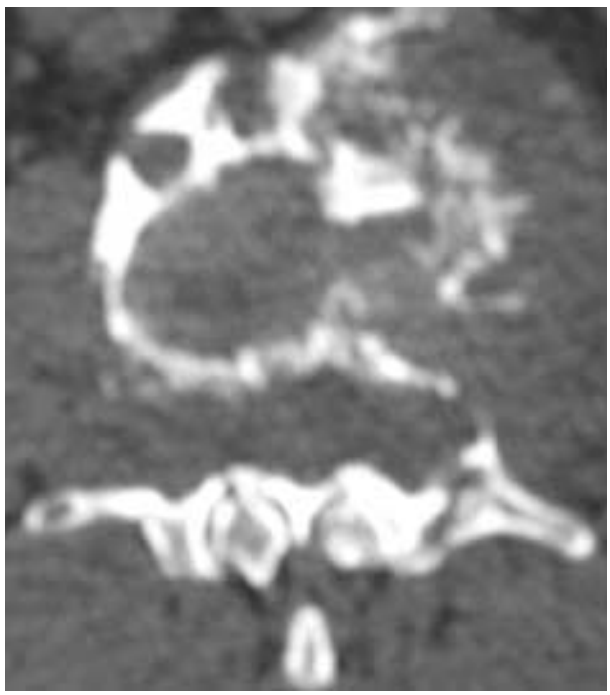
Olgu sunumu

48 yaşında erkek hasta kliniğimize bel ağrısı şikayeti ile başvurdu. Hasta çiftlikte yaşamakta ve çeşitli hayvanlarla uğraşmakta idi. Yaklaşık 11 yıl önce benzer şikayetler nedeniyle omurgada lezyon saptanarak anterior cerrahi yapılmış ve patoloji sonucu hidatik kist olarak bildirilmiş. Uzun yıllar şikayeti olmamasına karşın son 2 aydır şikayetleri tekrarlamış. Yapılan fizik muayenesinde sol anterior Flank insizyon skarı, sol alt ekstremitede yaygın ağrı, düz bacak germe testi pozitifliği saptandı. Direkt grafide L3 korpusunda anteriora uzanım gösteren düzensiz, içerisinde yer yer radyolusen alanların olduğu, çevresi sklerotik lezyon görüldü (Resim-1). Eritrosit sedimentasyon hızı 101 mm/saat, C-reaktif protein



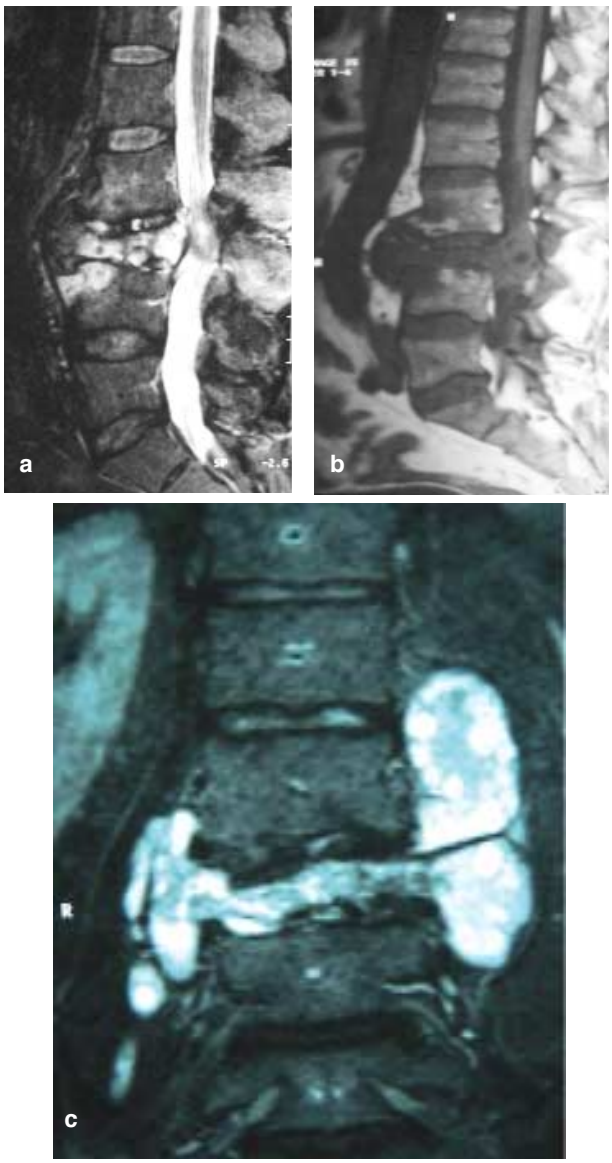
Resim-1a, b: Ameliyat öncesi direkt ön-arka (a) ve yan (b) grafiler. L3 omurgada düzensiz, anteriora ve posteriora uzanım gösteren, sklerotik lezyon.

değeri 76,3 mg/L olarak tespit edildi. Bilgisayarlı tomografide L3 korpusunu destrükte eden anteriora ve posteriorda kanal içine uzanan abse formasyonu görüldü (Resim-2). Manyetik rezonans



Resim-2: Aksiyel kesitte L3 omurga cisminde içi sıvı dolu, omurgayı destrükte etmiş ve korteksin bütünlüğünü bozmuş lezyonun Bilgisayarlı Tomografi görüntüsü.

görüntülemede ise L3 omurgayı tutan, içinde kist sıvısı dolu lobule alanları olan ve kanal içine uzanan kitle izlendi (Resim-3). Karaciğerde de

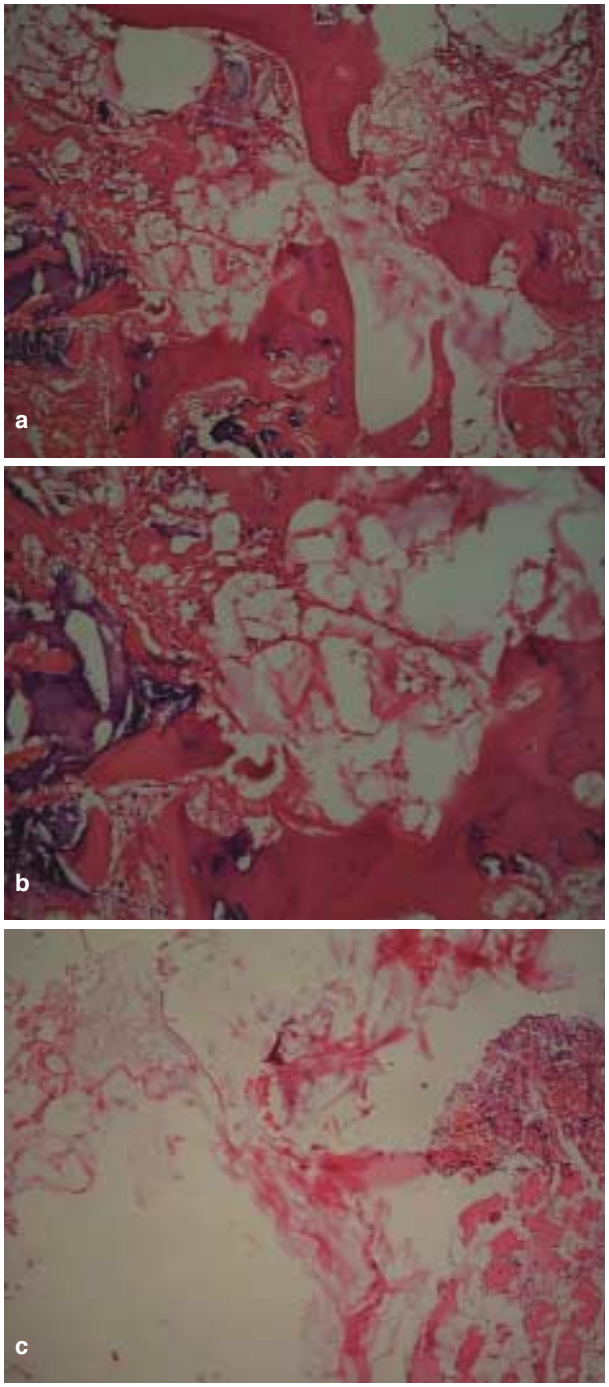


Resim 3a,b,c: T1 ve T2 ağırlıklı Manyetik Rezonans Görüntüleme sekanslarında L3 korpusunu tutan, içi kist sıvısı ile dolu, lobule, omurga cismini destrükte etmiş, anterior longitudinal ligament içinde ilerlemiş ve spinal korda bası yapan kitle.

kist hidatik ile uyumlu solid kitle tespit edildi, ancak klinik semptomu olmaması nedeniyle gastroenteroloji ve genel cerrahi bölümlerince cerrahi tedavi planlanmadı. Hastaya genel anestezi altında önce lateral pozisyonda eski insizyon skarı üzerinden girilerek retroperitoneal olarak L3 düzeyine ulaşıldı. Kist hidatik ile uyumlu, içinde kist sıvısı bulunan kitle saptandı. Eşlik eden granülomatöz görünümlü lezyonlar dikkat çekti. Abse drenajı, radikal debridman, iliak kanattan alınan trikortikal otogreftle artrodez yapıldı. Ardından posterior yaklaşımla L1-L5 arasına posterior enstrümentasyon uygulandı (Resim-4).

Resim 4a,b: Ameliyat sonrası ön-arka (a) ve yan (b) grafiler. Anteriorda trikortikal greft ve posterior enstrumentasyon izleniyor.

Alınan örnekler patolojik ve mikrobiyolojik incelemeye gönderildi. Patoloji ve mikrobiyoloji sonuçları tamamlanana kadar kist hidatik için albendazole (2x400 mg po) ve olası tüberküloz enfeksiyonu için 2'li antitüberküloz tedavisi (rifampisin, izoniazid) başlandı. İncelemelerde tüberküloz enfeksiyonu tespit edilmemesi üzerine antitüberküloz tedaviye son verildi. Patolojide kist hidatik için tipik olan skoleksler ve eozinofilik kütikül materyali saptandı (Resim-5). Hasta ameliyat sonrası 48. saatte drenleri çekilerek mobilize edildi. Yara problemleri olmaması ve genel durumunun iyi olması üzerine 4. gün taburcu edildi. Ameliyat sonrası 1. ayda sedimentasyon ve C-reaktif protein değerleri tamamen normale döndü. 4 ay albendazol tedavisine devam edildi. 6. ay kontrollerinde hastanın herhangi bir şikayeti ve patolojik klinik muayene bulgusu yoktu.



Resim 5: Cerrahi materyalin histolojik preperatları
a; Kemik lamelleri arasında amorf, eozinofilik kütikül materyali izlenmekte (H&E 50x)
b; Kemik lamelleri arasında kütikül materyali. (H&E 100x)
c; Paravertebral çizgili kas lifleri ve kütikül materyali yanında inflamatuar yanıt izlenmekte (H&E 100x).

TARTIŞMA

Ekinokok enfeksiyonunun nadir görülen bir formu olmasına karşın omurga hidatidozu özellikle endemik ülkelerde, ki Türkiye'de % 3.8[3], Tunus'ta % 14'e[8,25] varan oranlarda nörolojik defisite neden olan bir hastalıktır. Ekinokok öncelikle karaciğer ve akciğerleri tutar, ancak değişik organ ve dokularda da kistler meydana gelebilir. Omurga kist hidatiği ilk kez 1807'de Churrier tarafından tarif edilmiştir[30,35]. 1928'de Dew anatomik lokalizasyonuna göre intramedüller, intradural ekstramedüller, ekstradural intraspinal, vertebra cismi ve paravertebral kist hidatik olmak üzere 5 sınıfa ayırmıştır[13]. Braithwaite ve Lees de radyolojik olarak bu sınıflamayı kullanmıştır[7]. Chakir ve ark. 23 intradural hidatik kisti olan bir seri yayınlamışlardır[10]. Omurga hidatidozu % 90 sıklıkta omurga cismini tutar[30]. Daha sonra kolon boyunca veya paraspinal yumuşak dokulara yayılabilir. Primer omurga hidatidozu hematojen yayılımla oluşur. Parazitler portal venöz şantlarla kan dolaşımının yüksek olduğu omurga cisminin merkezine yerleşirler[32]. En sık torakal (% 49,82), ikinci sıklıkta lomber (% 18-39) omurgayı tutar[30,35]. Sekonder hastalık paravertebral veya pulmoner lezyonlardan direkt yayılım ile ortaya çıkar. Spinal hidatidoz daha çok sekonder görülür[20].

E. granulosus'un larvası tutulum göstereceği organa vardığında, kapillerlerde öncelikle mononükleer hücreler ve eozinofillerden oluşan inflamatuar bir reaksiyon oluşturur. Bu sırada pek çok larva harap olurken, bir kısmı kistik yapılar oluşturur. Kistler mikroskobik boyuttan başlayıp zaman içinde büyür ve yaklaşık 5 yıl sonra 10 cm'nin üzerinde bir boyuta ulaşırlar. İç tarafta nükleuslu germinatif tabaka ile dış tarafta opak, nükleus içermeyen laminalardan oluşan dış tabaka vardır. Bu opak tabakanında dışında konağa ait fibroblast tabakası, dev hücreler, mononükleer hücreler ve eozinofillerden oluşan infla-

matuar reaksiyon izlenir. Zaman içinde yoğun fibröz kapsül oluşur. Kistler oluştuktan sonra, 6 ay içinde, germinatif tabakanın etkisiyle yavru kistler gelişir.

Hastalık kemikte divertikül oluşumu ve eksojen vezikülasyon olmak üzere iki şekilde görülür. Sestodlar düzensiz, veziküler divertiküller oluşturur ve başlangıçtaki vezikküllerden ayrılmaya çalışırlar. Sert yapısı nedeniyle eksojen kistler kemik için tipik. Kist duvarları içinde erişkin solucanlar bulunur[15]. Kemik invazyonu üç mekanizmayla gerçekleşir: (1) Dévé'e göre çevre yumuşak ve sert dokuları kuşatan, sıkıştıran, parçalara ayıran bir "su topu"nun mekanik işlevleriyle kemiğin ve vasküler sinir dokularının atrofisine neden olması ve osteit oluşumu[12], (2) besleyici damarların obstruksiyonu ile iskemik sürecin kemik nekrozu ve sekestr oluşturması, (3) kompresyona uğrayan kemik dokusunun etrafında osteoklast oluşumu ve hücresel yanıt. İnflamatuar reaksiyon olmaksızın kemik destrüksiyonu gelişir[37].

İç organlardakinin tersine kemik dokuda kist oluşumu yoktur. Bu yüzden kemik tutulumu ekinokokozis veya kemik hidatidozu olarak adlandırılır[38]. Kemik tutulumu ve patolojik kırığa ikincil olarak kemik çevresindeki dokularda parazit oluşumu ekstraosseoz invazyonla sonuçlanır. Burada seropurulan eksüda içeren hidatik abse oluşabilir. Omurga lokalizasyonunda bu görünüm Pott hastalığına benzerdir[37].

Omurga hidatidozunda primer lezyon genellikle omurga cismine yerleşir. Ancak başlangıçta posterior elemanlara yerleşim de görülebilir. Omurga cisminde, merkez veya lateral yerleşimli, oval, birbirini takip eden, birbirinden bir duvarla ayrılmış, üzüm taneleri şeklinde lakünalar mevcuttur[37]. Daha ileri evrede, lezyon tüm omurga yapılarına ilerleyerek, kanal, kanalı çevreleyen kemikler, kostalar ve çevre yumuşak dokuları tutabilir. Bir veya birden fazla omurgada kompresyon gelişebilir. En son spinal disk etkilenir. Yumuşak dokularda abse meydana gelir. Lezyonun daha da ilerlemesiyle, omurgada tam destrüksiyon ve diskin harabiyeti hidatidozun spondilitle karışmasına neden olabilir.

Eozinofili, kompleman fiksasyon testinde pozitif sonuç, Casoni deri testi ve enzime bağımlı 'immunoassay' ile tanı konabilir. PCR ile de etken patojeni saptamak mümkündür[18]. Ancak, özellikle karaciğer dışı hidatik kist hastalığında bu testlerin duyarlılığı % 25-56'dır[30]. Perkütan aspirasyon, dissemine hastalığa yol açma ve aynı zamanda anaflaktik reaksiyon oluşturma riski nedeniyle kontrendikedir.

Direkt grafilerde karakteristik "güve yeniği" ve etrafında skleroz ve çevre yumuşak dokularda kalsifikasyon görülebilir. Ancak bu bulgular tanı koydurmaz. Myelografi kistin paravertebral dokulara uzanımını göstermde başarısızdır ve kistin yırtılması riski taşır[23,34]. Direkt radyografide şüpheli olan vakalarda MRI ile kist adedi ve detaylı bilgilere ulaşmak mümkündür[31]. İntraosseöz yerleşimli hidatid kist olguları, klasik uniloküler gelişimlerini göstermezler. Genellikle multiloküler düzensiz sınırlı bir lezyon olarak izlenirler ve bu nedenle radyografilerde kolaylıkla tümör ile karıştırılabilirler[9]. Multiloküler gelişim, kemik dokunun gösterdiği direnç nedeniyle larvanın dışa doğru tomurcuklanmasına neden olur ve orijinal implantasyon alanı dışında çok sayıda küçük kistlerin oluşumuna yol açar. Bu kistlerin içinde nadiren skoleks bulunduğundan, kistler genellikle sterildir. Ancak kist, çevredeki yumuşak dokuya doğru gelişim gösterdiğinde, geniş uniloküler lezyonlar izlenebilir[9]. Operasyon sırasında, karakteristik laminer kist membranının görülmesi ile lezyon tanınabilir.

Mikroskobik olarak, tipik bir kist duvarı, genellikle fibröz laminer kitinöz dış membran (kutikula) ve içte germinal tabakadan oluşur. Kist duvarı, granülasyon dokusu veya fibröz bir kapsül ile

çevrilidir. Ancak kemik içine yerleşim gösteren multiloküle görünümlü hidatid kist lezyonlarında, fibröz enkapsülasyon gelişmez[24]. Larvalar büyüdükçe kemiğin spongioz tabakası içine doğru basınç yaparak, çok sayıda mikrokistik divertikül oluşturur. Kemiğin etkilenen kısımlarında atrofi gelişir. Sıklıkla kemik korteksinde erozyonla birlikte spontan kırık gelişimi olur[24]. Mikroveziküllerin içi saydam bir sıvı ile doludur. Bu sıvı içerisinde, yavru kistler ve skoleksleri barındıran kız veziküller yer alır. Skoleksler 20-40 mikron uzunluğunda kanca yapılarına (hooklet) sahiptir.

Epidural osseöz tipte kistlerde, mikroveziküller kemik içine diffüz dağılım göstermektedir. Bunlar, operasyon sırasında rüptüre olurlar. Bu durum, rekürrenslere neden olur. İntradural ekstramedüller formunda ise rekürrens gelişimi çok nadirdir.

Omurga kist hidatiğinin patognomonik klinik bulgusu yoktur. Genellikle kompresyona bağlı semptomlar ve bel ağrısı ile hastaneye başvuru söz konusudur. Özellikle endemik bölgelerde hayvanlarla yakın temas olasılığı olan ve sırt-bel ağrısı şikayetleri ile gelen hastalarda hidatik kist akla getirilmelidir. Kist, kemiği aştığında ve ekstradural boşluğa geçtiğinde, şiddetli bir ağrıyla beraber nörolojik defisit gelişir. Nörolojik defisit gelişimi, olguların % 25-84'ünde bildirilmiştir[18].

Primer intradural ekstramedüller hidatik kist çok nadir ve genellikle soliterdir[34]. Ancak kistin yırtılması ve subaraknoid aralığa skolekslerin geçmesi veya ameliyat ya da lomber ponksiyon sırasında dural yırtık oluşmasıyla intradural mesafede kist oluşabilir[1,30,34]. Literatürde intramedüller hidatik kist bildirilmiştir[26].

Omurga hidatidozu hastalığın serebral formunun aksine, daha çok 20-40 yaş arası erişkin erkeklerde görülür[14]. Hastalar, kistin lokalizasyonuna göre uzun süredir (birkaç ay-yıl) devam eden sırt veya radiküler ağrı yakınmasıyla başvururlar. Alt ekstremitede güçsüzlük, azalmış derin tendon refleksleri, parapleji, duyu kaybı, sfinkter disfonksiyonu ve kauda ekina sendromu gibi nörolojik bulgular görülebilir[25,30]. %20 olgunun travma sonrası saptandığı bildirilmiştir[19]. Bizim olgumuzda birkaç aydır süren sırt ağrısı, hastanın daha önce aynı şikayetler sonucu edindiği tecrübesi nedeniyle kliniğimize çabuk müracaat etmesini sağlamıştır. İlk hastalığında şikayetlerin yaklaşık bir yıl sürdüğünü ve basit ağrı kesicilerle ağrısını baskılamaya çalışarak hekime 1 yıl sonra görünebildiğini ifade etmiştir.

Bilgisayarlı tomografi ve manyetik rezonans görüntüleme yöntemleri tanı için ideal seçeneklerdir. İnce, septasız duvarları olan, multiloküler, düzensiz kemik lezyonları hidatik kisti gösteren bulgulardır[6,16]. Daha ilerlemiş olgularda, omurga cismi, pediküller ve komşu kostalarda fragmentasyon görülebilir[5]. Yumuşak doku ve nöral tutulum olduğunda, yumuşak doku rezolüsyonu ve serebrospinal sıvı ve spinal kordu daha iyi görüntülemesi nedeniyle magnetik rezonans bilgisayarlı tomografiye üstündür. Eşlik eden ekstraspinal enfeksiyon % 46'ya kadar rapor edildiği için, beyin, toraks ve karın içi organların incelenmesi gereklidir[16,19,30]. Olgumuzda da karaciğer sağ lob anteriorunda 4x4 cm boyutlarında hidatik kist tespit edildi.

Omurga hidatidozunda tanıyı güçleştiren ayırıcı tanılardır. Bunların içinde en önemlisi hidatidozu taklit edebilen omurga tüberkülozudur[22,29,35]. Özellikle hem tüberkülozun, hem de kist hidatiğin yaygın olduğu, Türkiye gibi ülkelerde yanlış tanı riski yüksektir. Ekinokok için intervertebral disk tutulumu atipiktir[22,29]. Artmış kemik reaksiyonu, pediküller ve posterior arkın ayrılması, kosta tutulumu Pott hastalığında daha sık görülür[28]. Granülomatöz reaksiyon tüberkülozu işaret eder. Olgumuzda ameliyat sırasındaki granülomatöz görüntü hidatidoza tüberkülozun eşlik ettiğini düşündürdü. Ancak patoloji ve mikrobiyolojik çalışmalar tüberkülozu destek-

lemediğinden antitüberküloz tedaviye son verildi. Ayırıcı tanıda pyojenik enfeksiyonlar, mantar enfeksiyonu, abse, fibröz displazi, hiperparatiroidizm ve araknoidit akla getirilebilecek diğer lezyonlardır[29,30].

Hastalığın kesin tedavisi cerrahi olarak kistin çıkarılmasıdır[32]. Ancak olguların yaklaşık yarısında kesin tanı ancak cerrahiden sonra konulabilmektedir[33]. Belirgin spinal kord, kauda ekina veya sinir kökü basısı olan hastalarda posterior dekompresyon ve laminektomi yapılmalıdır[32]. Ancak, kemik tutulumu olduğunda, etkilenen omurga cisminin ve çevresindeki yumuşak dokuların anterior yaklaşımla çıkarılması en uygun cerrahi işlem olarak görülmektedir[30,33]. Radikal kemik rezeksiyonu yayınlanmış ancak sürviye etkisi kanıtlanmamıştır[22]. Nüksü önlemek için cerrahi alanın hipertonik tuz solüsyonuyla irrige edilmelidir. Formol serebrospinal sıvı etkilendiğinde toksik myelite neden olabileceği için kullanılmamalıdır. Cerrahi veya kemik destrüksiyonu nedeniyle stabilite bozulduğunda omurga stabilizasyonu yapılmalıdır. Bizim olgumuzda da kistin çıkarılması ve debridman yapılması için anterior yaklaşım uygulanmış ve posterior stabilizasyon eklenmiştir.

İlk ameliyattan sonra bir yıl içinde nüks sıklığı literatürde % 30-40 arasında bildirilmiştir[5,25,30,35]. Çok sayıda nüks görülen hastalarda malignan bir gidiş düşünülür ki, ortalama sağkalım süresi 5 yıldır[27,30]. Olgumuzda 11 yıl sonra tespit edilen nüks tipik bir durum değildir. Ancak karaciğerde saptanan kist nedeniyle bu kadar uzun süre sonra nüks olacağını düşünmekteyiz. Belki de karaciğerdeki kistin çıkarılması küratif olabilirdi. Ancak ilk tedavi yeterli yapılmasına karşın hidatidoz nüks yapabilen bir hastalıktır.

Medikal tedavide mebendazol ve daha güncel olan kullanılan albendazol nüks sıklığını azaltmak ve cerrahi tedavi uygulanamayan ve nörolojik elemanlara bası yapan büyük kistleri küçültmek için önerilmektedir[4,17]. Praziquantel de albendazolle birlikte kullanıldığında iyi sonuçlar bildirilmiştir[1,41]. Garcia –Vicuna ve ark. servikal omurgada soliter hidatidozu olan bir olguya cerrahi sonrası aralıklı ve uzun süreli albendazol tedavisi sonrası 9 yıllık nükssüz takip bildirmiştir[17]. Olgumuza da ameliyat sonrası 4 ay albendazol tedavisi verilmiştir. Tekrar nüksü önlemek için yıllık kontrollerle takibi planlanmıştır ve takiplerinde medikal tedavi aralıklı olarak uygulanabilir.

Sonuç olarak, omurganın hidatidozu nörolojik defisite de yol açabilen, endemik bölgelerde özellikle tüberkülozla ayırıcı tanısının iyi yapılması gereken bir hastalıktır. Erken tanı, lezyonun cerrahi olarak çıkarılması ve antihelmintiklerle medikal tedavi ile iyi sonuçlar mümkündür ancak yüksek nüks sıklığı akıldan çıkarılmamalıdır.

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DERLEME / *REVIEW ARTICLE*

POSTERİOR SPİNAL ENSTRÜMANTASYONDA FASET FİKSASYONU

Esat KITER*

ÖZET :

Omurganın metal aparatlar fiksasyonu, spinal füzyon ve korreksiyonun önemli bir bileşenidir. Günümüzde kullandığımız spinal fiksasyon yöntemleri, geçtiğimiz yüzyıla ait onlarca buluşun neticesinde gelişmiş ve son hallerini almışlardır. Aslında omurganın faset vidası ile fiksasyonu, bu tarz uygulamaların en eskilerinden birisidir ve 1940 yılında King tarafından tanımlanmıştır. Omurgada faset fiksasyonunun diğerlerinden ayrıldığı önemli bir konu hala güncelliğini koruması ve popülaritesinin son on yılda artması hatta bazı güncel yayınlarda transpediküler vidaya bir alternatif olarak gösterilmesidir. Bu yazının amacı eski ve yeni literatür bilgileri ışığında faset fiksasyonunun gelişimini ve başlıca avantajlarını aktarmaktır.

Anahtar Kelimeler: *Spinal füzyon, faset fiksasyonu*

SUMMARY :

Facet fixation in posterior spinal instrumentation.

The fixation of spinal segments with hardware is an important part of the spinal fusion and correction. Current spinal fixation systems are legacy of the numerous innovations during the last century. Actually, the facet screw fixation of the spine is one of the oldest hardware applications, described in 1940 by King, and it is almost unique among the historical fixation techniques since it still keeps the popularity and currency. This paper is willing to narrate the developments in the facet fixation and its advantages in the ligth of related literature.

Key Words: *Spinal fusion, facet fixation*

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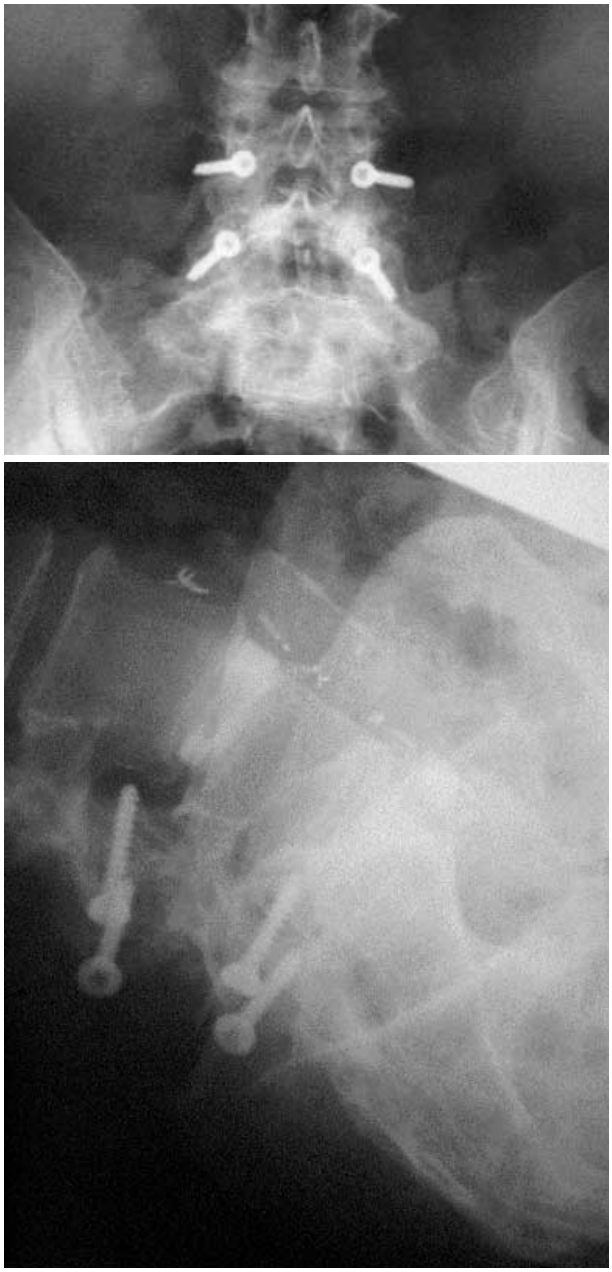
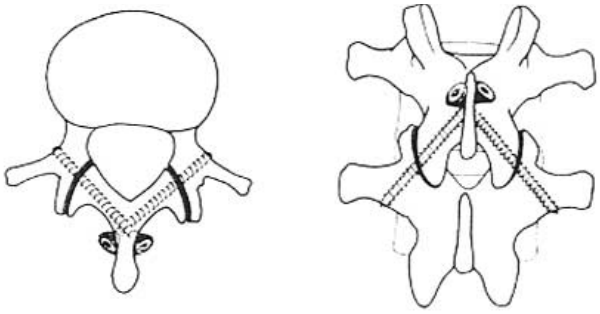
GİRİŞ :

Faset fiksasyonunun tarihçesi pedinkül vidalarına göre oldukça eskidir. Bu fiksasyon yöntemi, ilk kez 1940 yılında King tarafından faset eklemlerin boylu boyunca geçen kısa vidalarla (20-25mm) tespiti olarak tanımlandı[15](Şekil-1). Boucher, fiksasyonun stabilitesini arttırmak amacıyla daha uzun vidalar kullanarak ve vidanın ucunu pedinküle yönlendirerek bu tekniği modifiye etti[3]. Günümüzde sıklıkla tercih edilen Trans-Laminar Faset Fiksasyonu (TLFS) ise 1984 yılında Magerl tarafından tanımlandı[18]. Bu yöntemde, vidanın giriş noktası artrodez uygulanacak fasetin karşı tarafında, spinöz proses ile laminanın birleşme bölgesindedir (Şekil-2-3). Bu noktadan gönderilen vida, lamina içinde seyrederek faset ekleme ulaşır. Teorik olarak Magerl yönteminde vida kemik içinde daha uzun yol aldığı için fiksasyon daha rijittir. Bouchard yöntemi ile fiksasyon, nörolojik yaralanma olasılığını arttırması nedeniyle pek tercih edilmese de, vida ucunun alaya dayandırılması ile L5-S1 faset fiksasyonlarında uygulanabilir. Özellikle tüm bikortikal ya da trikortikal vida uygulamalarına karşın vida rijiditesinin sorun olduğu sakrum bölgesinde TLFS fiksasyonunun daha avantajlı olduğunu bildiren yazarlar vardır[10,11].

Faset fiksasyonunun en önemli avantajı, daha az invaziv ve daha pratik bir yöntem olmasıdır. Öğrenme periyodu kısadır ve uygulanması için transvers proseslerin açılmasını gerektirmez[7,10,11]. Maliyet olarak ucuzdur ve 4.5 luk AO vidaları ile bu tespit yapılabilir. Ancak son zamanlarda TLFS uygulamaları için özel kılavuz aparatları ile titanyum vidalar daha yaygın olarak kullanılmaktadır (Discovery spine system DepuySpine). TLFS uygulamalarında her ne kadar intakt bir lamina gerekse de bu olgularda lamina altı dekompresyon başarı ile uygulanabilmektedir[2]. Ancak yine de majör dekompresyon gerektiren olgularda kullanımı mümkün değildir. Öte yandan, Humpke TLFS uygulamalarında, intakt bir anterior kolonun etkin bir tansiyon band mekanizması için mutlaka gerekli olduğunu ifade etmektedir[9]. Anterior kolonun bütünlüğünün bozulduğu olgularda da bu fiksasyon yöntemi uygun bir seçenek değildir. Bu nedenle anterior desteğin kaybolduğu kırık olgularında tek başına



Şekil 1a ve 1b: Klasik faset vidası uygulamasının AP ve lateral görüntüsü.

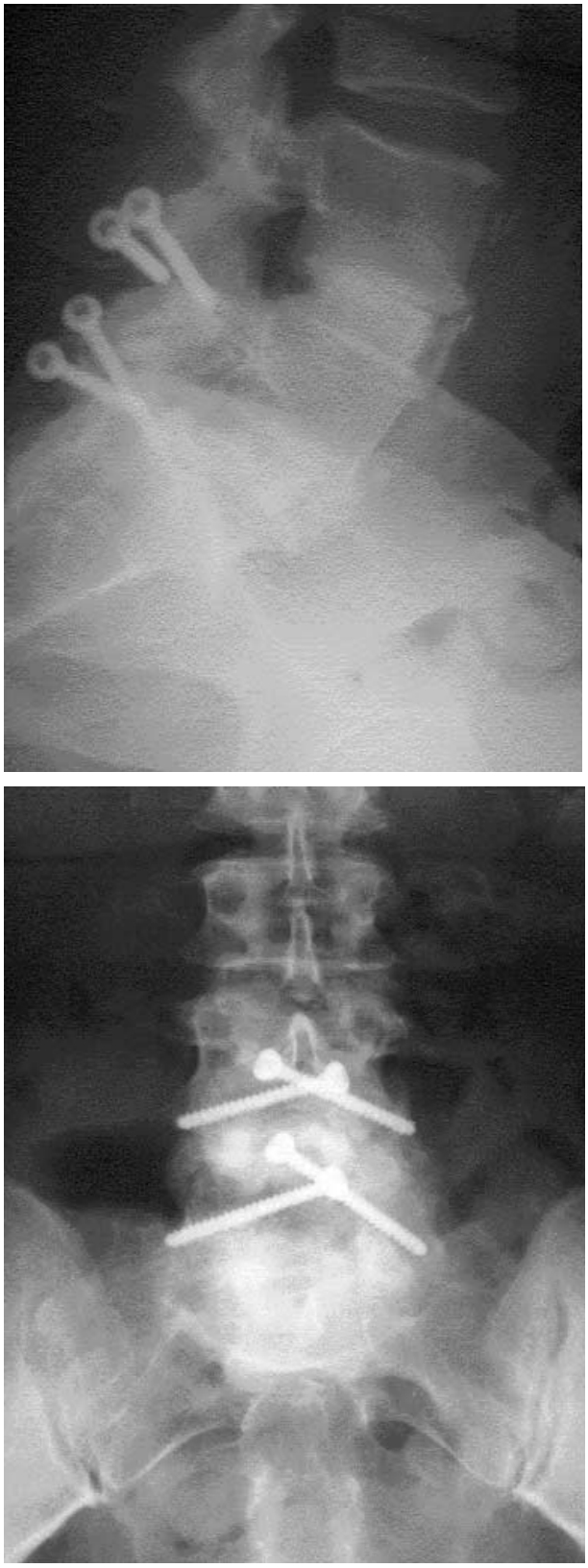


Şekil 2: Translanminar Faset Vidasının (TLFS) uygulanması. Bu teknikte vidanın giriş noktası artrodez edilecek fasetin karşı tarafındaki lamina ile spinöz prosesin birleşme noktasıdır

yeterli sağlamlığı sağlayamadığından kullanımı sınırlıdır.

Literatürde faset fiksasyonu (FF) ile ilgili komplikasyon oranlarının azlığı dikkat çekicidir[2,11,12,18]. Pedinkül vidası (PV) uygulamaları, her ne kadar spinal fiksasyonda yoğun olarak kullanılsa da % 20' lere ulaşan komplikasyon oranlarına sahiptirler[5,13,25]. Yukarıda sayılan özellikleri nedeniyle faset fiksasyonu ilk tanımlandığı andan itibaren güncelliğini yitirmemiş, son zamanlarda sirkümferensiyal (füzyonun giderek artan oranda bel ağrısı tedavisinde yaygınlaşması nedeniyle daha da popüler olmuştur.

Özellikle interbody füzyonun tek başına uygulandığı hastalara ilişkin bildirilen füzyon oranlarının tutarsız olması, özellikle ekstansiyonda bu tespit yönteminin biomekanik olarak instabil olması[17,22,26] cerrahları ek bir posterior stabilizasyona ve sirkümferensiyal (füzyon kavramına doğru yönlendirmiştir. Posteriordan yapılan ek fiksasyonun ekstansiyonu mükemmel bir şekilde kısıtladığı ve daha sağlam bir fiksasyon yarattığı da kadavra deneylerinde gösterilmiştir. Posterior fiksasyon yöntemlerinin karşılaştırıldığı biyomekanik çalışmalarda, özellikle TLFS'nin fiksasyonun rijiditesine oldukça fazla katkısı olduğu, hatta pedinkül vidaları ile benzer biyomekanik bir profil sergilediği ifade edilmiştir [4,6,7,16,21,23,26].



Şekil 3a ve 3b: Translaminar Faset Vidasının AP ve lateral görüntüsü

Faset fiksasyonunun mekanik özelliklerini ortaya koymak için yapılan çalışmaları tarihsel sırası ile irdelersek; İlk yapılan çalışmalar faset fiksasyonunun sadece posterior stabilizasyon için kullanıldığı modelleri içermektedir. Bu çalışmalar, faset ekleme vida tespiti yapılan omurgaların intakt omurgaya göre 9 kat daha sert olduğu bildirilmektedir[7,16]. Faset fiksasyonu ilk olarak Volkman ve arkadaşları tarafından anterior lomber interbody füzyona (ALIF) kombine edilen posterior tespitte çalışılmıştır. Bu çalışma, ALIF'un stabilizasyon konusunda en zayıf olduğu ekstansiyonda, posteriordan yapılan faset fiksasyonunun instabliteyi çok etkin bir biçimde önlediğini göstermektedir [26]. Rathoyi ve arkadaşları benzer bir çalışmada, ALIF için BAK kafesini kullanarak posteriordan uygulanan TLFS fiksasyonunun ekstansiyonda ve aksiyel rotasyonda stabilizasyonu desteklediğini gösterdiler [23]. Bu çalışmalar ve bu çalışmalarla eş zamanlı yayınlanan klinik çalışmaların yüz güldürücü sonuçları, faset fiksasyonu'nun bazı yazarlar tarafından pedinkül fiksasyonuna ciddi bir alternatif olarak kabul edilmesine yol açtı. Böylece biomekanik çalışmalar daha çok FF ve PV karşılaştırılması şeklinde tasarladılar. Deguchi ve arkadaşları FF ve PV'nı karşılaştırdıkları çalışmalarında, biomekanik özellikleri açısından FF'nun performansının PV fiksasyonuna eşdeğer olduğunu bildirdiler [4]. Ferrara ve arkadaşları, Beaubien ve arkadaşları ALIF'a kombine ettikleri posterior fiksasyonda FF ve PV'nı karşılaştırdılar ve Deguchi ve arkadaşları bulgularını destekler sonuçlar elde ettiler [1,6]. Bu konudaki güncel biomekanik çalışmaların bir diğerinde ise Phillips ve arkadaşları, ALIF'a kombine edilen FF'nunun stabilitesini omurgaya binen fizyolojik tekrarlayıcı yükleri simüle ederek çalıştılar ve faset fiksasyonunun fizyolojik şartlar altında sağlamlığı arttırıcı etkisini gösterdiler [22].

Klinik sonuçlar açısından değerlendirildiğinde, faset fiksasyonu ile sadece posterior füzyon uygulanan hastalarda başarılı sonuçlara sıklıkla rastlamak mümkündür. Pseudoartroz oranları % 1.5-9 arasında değişmektedir [2,7,9,10,11,12,20,24]. Bu çalışmalar, sirkümferensiyal (füzyonu ve PV ile FF arasında bir kıyaslamayı konu almamış, sadece posterior uygulamalarda FF'nun füzyon elde etmedeki başarısını dökümante etmişlerdir. Ancak unutulmaması gereken bir nokta, posterolateral füzyon olgularında bu teknik "az invaziv" özelliğinden uzaklaşmaktadır. Daha geniş ve derin bir açılım gerektirmektedir. Bu nedenle az invaziv bir operasyon amaçlandığında orta hat ve faset füzyonunun tercih edilmesi daha uygun olur. Klinik olarak PV ile FF'nunu karşılaştıran klinik çalışmalar oldukça kısıtlıdır. Markwalker ve arkadaşları posterior fiksasyon ve füzyon uyguladıkları dejeneratif spondilolistezisli hastalarda, PV ile FF'nu kıyasladılar. Bu çalışmanın sonuçlarına göre PV uygulanan hastalarda revizyon operasyonu hiçbir vakada gerekmezken, FF uygulanan olguların % 13'ünde revizyon gerekmiştir. Yazarlar bu sonuçlarıyla birlikte FF'nunun yeterli sağlamlığı sağlayamadığını öne sürmektedirler [19]. Holte ve arkadaşları ise ALIF'e ilave olarak posteriordan Steffee plağı ve TLFS ile sirkümferensiyal (füzyon uyguladıkları olguların sonuçlarını yayınladılar. TLFS ve Steffee plağı arasında doğrudan bir karşılaştırma yapmamakla birlikte tüm olgularında füzyon oranını % 97 olarak bildirdiler [8]. Kıter ve arkadaşları dejeneratif disk hastalığı olan ve sirkümferensiyal (füzyon ile tedavi edilen hastalarda ALIF'a ek olarak posterior fiksasyon için uygulanan PV ve TLFS sonuçlarını değerlendikleri prospektif randomize klinik çalışmalarında, faset fiksasyon grubunun füzyon oranlarını düşük buldular [14].

Sonuç olarak faset fiksasyonu, sadece posterior orta hat füzyonu amaçlandığında, anterior kolon defekti ve majör dekompresyon gerektiren spinal darlık da yoksa kullanılabilirliği ve etkinliği ispatlanmış bir tespit yöntemidir. Ayrıca ALIF'a

kombine edilen destekleyici posterior fiksasyonda daha az invaziv olması nedeniyle faset fiksasyonu, gerçekten de akılcı bir alternatif gibi gözükmektedir. Ancak literatürde, biomekanik ve klinik açıdan başarılı posterior füzyon oranlarının yanında, sirkümferensiyal (füzyonda biomekanik sonuçları destekleyecek klinik sonuçlar henüz mevcut değildir ve FF'nun kullanımı açısından cerrahları cesaretlendirecek veriler yoktur [19,14]. Biomekanik modellerin, doğalarında olan en büyük dezavantajlarının, her ne kadar biyolojik şartlar mümkün olduğunca sağlanmaya çalışılsa da "in vivo" ortamı yansıtmalarındaki yetersizlik olduğunu hatırlamamızda fayda vardır. Bu nedenle sirkümferensiyal (füzyonda FF'nun etkinliği, özellikle klinik çalışmalar açısından daha fazla araştırılmaya açık bir konudur.

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SRS REGIONAL COURSE AND EUROPA-MIDDLE EAST MEETING, ISTANBUL, MAY 25-27, 2006*
INSTRUCTIONAL COURSE LECTURE

ADVANCES IN THE TREATMENT OF GROWING SPINE DEFORMITY

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Introduction: Treatment of early onset scoliosis presents a significant challenge. Scoliosis can manifest early in life with many different etiologies. Some curves may show significant deterioration at an early age causing not only trunk shortening, but significant respiratory problems which may be life threatening. Treatment for these children has not been very successful with the methods available. Cast and brace treatment may be ineffective, since the immature rib cage often deforms before significant correction is transmitted to the spine. Skeletal traction may also be used occasionally prior to surgical treatment.

Surgical treatment is indicated for progressive curves not responding to non-operative treatment. Traditional surgery includes posterior spinal arthrodesis, often supplemented by anterior arthrodesis to prevent crankshaft phenomenon. Circumferential arthrodesis will halt curve progression but at the same time it prevents future spinal growth. If this type of fusion is done in a very young age, the pulmonary development can be compromised. Other surgical methods include Hemiepiphysiodesis, Titanium Rib Prosthesis (VEPTR), posterior growing rods procedures and anterior non-fusion procedures such as stapling. The VEPTR procedure has been used successfully in children with severe respiratory compromise and fused ribs where the thoracic cage is stiff due to congenital anomalies. In this lecture, we will focus on the technique and results of posterior growing rod procedures.

Growing Rod instrumentation without arthrodesis is a treatment option aimed at preserving spinal growth, obtaining initial scoliosis correction and allowing control of the ongoing deformity. Several studies regarding growing rod technique have recently been published. The recent studies show that this technique promotes continued spinal growth, maintains deformity correction and has a reasonable rate of complications. Using the basic principles ofisola instrumentation described by Asher and the use of dual rods by McCarthy, Akbarnia and Marks have developed a dual growing rod technique that can be used submuscularly

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or subcutaneously [2-4,6]. This technique is currently being used by the author.

Technique: Subperiosteal dissection is performed only at the upper and lower anchor sites of the implant. At the upper end of the curve, hooks or screws are placed in a claw pattem spanning two to three levels to anow for adequate space between the hooks in a young chiıd. A similar pedicle screw or hook pattem is placed at the lower end of the construct. These upper and lower sites are also called the "foundations" of the construct. A transverse connector is preloaded at the level of each foundation especially when hooks are used. In a recent biomechanic study, Bagheri et al demonstrated that pedicle screws and transverse connectors add significant stability to the construct [7,8]. Fusion is performed at the site of the foundations with the use of local bone or synthetic graft. Each rod is then measured and cut into an upper and lower rod. Contoured rods are placed on each side of the spine and the upper and lower rods are linked by way of a tandem connector placed at the thoracolumbar junction. Bracing is used on all patients until a solid fusion is achieved.

Results: We have reported on 23 children with a minimum of 2 years follow-up who had primary dual rod instrumentation[2]. Sixteen patients were still in active treatment at the time of the report. There were various diagnoses. All had curve progression over 10 degrees following bracing or casting to qualify for inclusion. The mean age at surgery was 5.4± 2.6 years. There were a total of 189 procedures, 151 being lengthenings. The mean follow-up was 4.7±1.8 years. The mean preoperative scoliosis was 82±20 degrees. This improved to 38±15 degrees postoperatively and 36±15 degrees at last follow-up. T1-S1 length increased from 23.01±4.13 to 28.00±3.73 cm after the initial surgery longation and to 32.65±4.92 cm at last follow-up. The overall T1-S1 growth (post-initial to post-final fusion) was 1.21±0.69 cm/year. The complications included 2 deep wound infections, 4 superficial wound problems, 2 rod breakages, 3 anchor displacements, one junctional kyphosis and one crankshaft phenomenon occurring during the treatment period. Eleven of 23 patients experienced complications and all complications were addressed at routine lengthenings or at additional unplanned surgeries.

The results of single and dual rod was compared in an other study by Thompson; Akbarnia et al. This study provided a thorough comparison of dual and single growing rod techniques[9]. Twenty-eight patients were divided into three groups and followed to final fusion: single rod with anterior and posterior apical fusion (5 patients), single rod without apical fusion (16 patients), and dual rod without apical fusion (7 patients). Patient diagnoses included 10 with idiopathic scoliosis, 8 with neuromuscular scoliosis, 8 with an underlying syndrome, and 2 with congenital scoliosis. The mean age at surgery was relatively similar: Group 1,7.0±2.9 yrs (range, 2.9 to 9.3 yrs), Group 2, 8.7±1.9 yrs (range, 5.9 to 11.6 yrs), and Group 3, 7.0±3.9 yrs (range, 2.1 to 12 yrs). The mean number of lengthenings were 3.4±1.8, 2.8±1.3, and 6.1±2.8 per patient groups, respectively.

The mean preoperative scoliosis was 85±23 degrees in Group 1, 61±13 degrees in Group 2, and 92±21 degrees in Group 3. Following definitive spinal fusion the mean postoperative scoliosis was 65±22 degrees, 39±15 degrees, and 26±18 degrees, respectively. When analyzing the final percent deformity correction, it was 23±22 % in Group 1,36±23 % in Group 2, and 71±22 % in Group 3. The

percent of correction in group 3 was significantly higher than that of group 2 (p=0.0031) and group 1 (p=0.0015). When measuring the total mean spinal growth between the postoperative initial to postoperative final radiographs, the increase in T1 and S1 length was improved at 0.3±1.02, 1.04±.09, and 1.7± .58 cm/yr. Thus, the total T1 to S1 spinal growth was 6.4±1.4 cm in Group 1,7.6±4.7 cm in Group 2, and 12.1±1.9 cm in Group 3. This was statistically significant. Four patients (80 %) in Group 1 sustained 8 complications: 3 rod breakages and 5 hook displacements. Three patients (19 %) in Group 2 sustained 5 complications: 3 rod breakages, one each hook displacement and superficial wound infection. Two patients (29 %) in Group 3 sustained two complications: one broken rod and one superficial infection.

While the authors determined that either single or dual rod technique was effective at controlling curve correction and allowing spinal growth, thedual rod system not only improved the curves but maintained initial correction better and facilitated increased spinal growth. In the series, short apical fusion was associated with curve stiffening, crankshaft phenomenon, and a higher incidence of complications. As a result, the authors question the effect of combining apical fusion with the growing rod techniques in treating patients with early onset scoliosis.

At the 2005 Annual Scoliosis Research Society, Akbarnia et all retrospectively examined 15 patients treated primarily with Dual Growing Rod technique and followed to final fusion. The average age at initial surgery was 7.0±2.9 years and the patients were followed for 5.4±2.5 years. There was an average of 5.3±2.5 lengthenings per patient occurring at an interval of 8.9±4.4 months. Pre-operative scoliosis decreased from 81±22 degrees to 39± 17 degrees post-operatively and was 32.5±21 degrees following definitive fusion. T1-S1 length increased from 24.46±3.42 centimeters pre-operatively to 29.22±3.61 post-operatively and vas 34.41±3.97 centimeters following final fusion. The non-congenital group was subdivided into two groups, those lengthened at ≤ 6 month intervals (range, 5.5 to 6.7 months) and those lengthened at > 6 month intervals (range, 9 to 20 months), for comparison. The group lengthened more frequently achieved greater scoliosis correction (78 % versus 48 %) and a greater T1-S1 growth rate (1.8 cm/yr versus 1.0 cm/yr) over the treatment period. The differences in deformity correction and spinal growth between the two groups were significant at p=0.007 and p=0.02, respectively.

In the most recent study by the Growing Spine Study group to be presented at this meeting, Akbarnia et al.[5] reviewed the complications seen thus far with the dual growing rod treatment program. Twenty-nine of 48 patients reviewed developed 55 complications. Twenty-seven implant, 14 wound, 5 general and 9 alignment-related complications occurred. Eighteen complications resulted in 23 unplanned procedures while 37 complications were able to be addressed during planned procedures. Diagnosis was insignificant except for Infantile Idiopathic Scoliosis (IIS), where 8 of 9 total patients had implant-related complications. In general, the implant complication group had 5 of 27 complications requiring unplanned surgeries; most implant problems were addressed during planned surgeries. Six deep infections occurred. Additionally, 2 of 3 wound problems evolved into deep infections and 2 of 4 superfieial infections became deep. At initial surgery, younger patients had higher complication rates and more comp-

lications occurred with longer treatment periods. Patients whose lengthening intervals were ≤7 mos had fewer implant complications but more wound complications. Patients whose intervals were ≥7 mos had more implant complications but fewer wound complications. Wound problems should be addressed aggressively to prevent deep wound infections. The authors felt that this technique has a high but manageable complication rate.

Discussion: Posterior dual growing rod technique has the advantage of correcting scoliosis, maintaining correction and at the same time allowing continued spinal growth. It has the ability to increase the space available for lung in non-congenital scoliosis without the need for a thoracotomy.

Single growing rod technique has been associated with high rate of implant related complications and variable outcomes. Dual growing rods have been shown to be more effective than single rods in achieving and maintaining adequate correction of the scoliosis and allowing continued growth of the spine. There has been less implant failure and crankshaft compare to single rod method but as with many other non fusion techniques, the dua l growing rod is a complex technique ans stili has a high rate of complications. This technique should be performed in appropriately selected patients by those surgeons who have experience with the procedure and the possible complications.

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INSTRUCTIONAL COURSE LECTURE

NOVEL BIOLOGIC TREATMENT OF DEGENERATIVE DISC DISEASE

Jeffrey C. WANG

Disc Degeneration

Pathogenesis

Different stages of disc degeneration

Annular fissures

Loss of proteoglycans and water content of disc

MRI signal changes

Changes in disc biology

Loss of cells

Loss of extracellular matrix

Acidic environment

No blood supply

Immunoprotected area

Although it is a difficult environment, gene therapy may be best option

Intervention

Are we able to intervene biologically when biomechanics are altered

Is biological intervention only appropriate for early stage disease

Do we regenerate the nucleus pulposus, annulus, and/or cartilaginous enplates

Difficult task

Strategies

Growth factors

Cellular therapies

Gene therapy

Scaffolds

Combinations/tissue engineering

Growth factors

Identify growth factors that will stimulate disc cell growth and matrix

Identify the growth factors that are present in disc recovery

Growth factor delivery

Promising factors: bmp-2,bmp-7,bmp-14, TIMP

Animal models of disc regeneration

Human studies of disc regeneration

Cellular therapies

Disc cells

Stem cells

Matrix and environmental changes to support disc cell growth

Stern cells from different areas: bone marrow, adipose tissue

Cell delivery

Gene Therapy

Sustained release of factors via gene therapy

Ability to infect disc cells in vivo

Animal studies of efficacy

Different genes tested

Different models of disc degeneration

Intervening in degenerative cascade with different genes

Efficacy of gene therapy

Scaffolds

Ability to resist biomechanical altered stresses

Matrix for cellular growth

Delivery of scaffolds

Biological scaffolds

Mechanical scaffolds

Combinations

Most likely will need combinations of all factors

Cells

Gene therapy for delivery of appropriate mix of growth factors

Intervening early in cascade of degeneration

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INSTRUCTIONAL COURSE LECTURE

STEM CELLS/DISC REGENERATION TECHNIQUES - OUTLINE

Jeffrey C. WANG

Intervertebral disc environment is stringent area

No blood supply to adult disc

Diffusion for nutrition is required, no direct delivery via blood supply

Immunoprotected area where body may not counteract introduced genes/proteins

Introduction of cells may allow for revival and synthesis of disc matrix

Degeneration of the disc is poorly understood.

Environment is altered from it's normal state

Discuss alterations - the pH changes, mechanical stresses, fissures can appear

Proteoglycan synthesis is altered.

Breakdown of disc elements and stmcture/proteins is increased

Regeneration will require synthesis and maintenance of stmcture components.

Biomechanics - altered, must counteract. Unsure if this can be corrected

May require substrate or scaffold with biomechanical properties of normal disc

Nutrition to the disc must be increased

Scaffold may be mechanical or biological or some combination

Stem cells may allow us to rejuvenate the disc and substrate

Theoretically would require us to regenerate annulus, nucleus, and enplates

Replace cells of the disc to allow for synthesis

Synthesize elements of di sc and maintain this over long period of time

Synthesize growth factors to act on cells

Synthesize different cells - annulus/nucleus/cartilaginous endplates

Cell - biomechanical counteracting forces and poor nutrition addressed

Keep it alive, otherwise, cells will die

Stem cells

Source - many sources of stem cells

Bone marrow, adipose tissue, cell lines, embryonic sources

Direct to certain cell - disc cell

This requires several factors to differentiate into the different cell types

Environment may direct cells to differentiate

Growth factors will also differentiate and stimulate growth

Need to direct cells to specific desired cell types

Cell work

Meisel et al.

Inject cells, cultured -lead to increase T2 signal

Perhaps environment is bad, culture allows to grow

But if environment is bad, will it sustain?

Perhaps need factors to produce

Growth factors to maintain cell growth

Interplay - this is a complex interaction of several factors in the triad of regeneration

Cells - required for sustained growth

Scaffold - required to support cells and to provide biomechanical support

Factors - growth factors or differentiation factors

Unknown components yet to be discovered new triad, quadrad, or pentad may be necessary to fully regenerate disc what we can do direct cells - to different desired types environment-provide appropriate environment for growth growth factors - deliver appropriate growth factors gene therapy - may be only strategy to allow for sustained changes make new components new cells to react to component provide better environment for permanent change.

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INSTRUCTIONAL COURSE LECTURE

ADVANCES IN THE TREATMENT OF THORACOLUMBAR INJURIES

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General characteristics

Thoracolumbar injuries are the most common spinal injuries (90 % of all spinal fractures). The vast majority do not involve any neurologic deficit. There are various opinions regarding the ideal management, especially in patients without an associated neurological deficit. Researchers have advocated both an operative and a nonoperative approach.

Open reduction, arthrodesis, and internal fixation offers immediate stability, correction of deformity and spinal alignment, early walking, reduced reliance on orthotic containment, and the theoretical protection against spinal malalignment or neurological injury. Nonoperative care, in the form of either a body east or a brace, offers avoidance of a surgical intervention with its attendant morbidity.[1,2]

There is a lack of evidence-based guidelines for the treatment of traumatic fractures. Even basic questions, whether to treat acute vertebral fractures surgically at all, have not yet been answered for the total spectrum of traumatic lesions. A large number of publications, and discussions among the authors have not led to a general consensus on the optimal treatment.[3.5]

The treatment starts with classification of the injury. Both the Denis and the AO system for the classification of spine fractures had only moderate reliability and repeatability.[5]

Load sharing classification system is useful particularly for decision making regarding anterior vs. posterior approach. The ASIA motor and sensory examination has been shown to have high interrater reliability when used by trained examiners and should be viewed as the state of the art for the neurological assessment of the patient who has a spinal cord injury.[6]

Nonsurgical treatment option

Nonsurgical treatment is indicated in all compression fractures (A1, A2) and most burst fractures (A3) without neurologic deficit. Closed reduction of burst fractures with intact PLC may be possible under effective anesthesia, but it may not be possible to prevent the loss of correction by the stabilization effect of PLC alone. Other parameters, such as comminution of the endplate and vertebral body, may also be taken into account if the aim is to achieve and maintain satisfactory correction. Patient satisfaction seems to be high despite residual deformity. The patient with complete neurologic injury may be not a good canditate for operative treatment & can be better treated nonoperatively.[7,8]

Patient is mobilized as tolerated (one level injury). Nondisplaced posterior elements fractures and many compression fractures can be

mobilized without an orthosis. Bony chance fractures can be treated with a hyperextension east. Anticoagulation is not used for the first 72 hours after injury to avoid the risk of epidural hematoma.

It is difficult to justify decompression if the patient is neurologically intact. However, increased DEFORMITY on upright position and PAIN or worsened neurologic signs indicate failure of orthotic management and warrant change of treatment plan.[9]

Chow et al[10] showed that nonoperative management of thoracolumbar burst fractures with hyperextension casting for 6-12 weeks followed by an additional 6-12 weeks of bracing was proven to be a safe and effective method of treatment in selected patients. Clinical results were favorable; no neurologic deterioration was observed; hospitalization times were minimized, and patient satisfaction was high. Chow et al[10] do not believe that ligamentous injury of the posterior column is a contraindication to nonoperative management of thoracolumbar burst fractures.

Wood et al[2] in a prospective, randomized study comparing operative vs. nonoperative treatment of a thoracolumbar burst fracture without neurological deficit found that operative treatment of patients with a stable thoracolumbar burst fracture and normal neurologic findings provided no major long-term advantage compared with nonoperative treatment.

Nonsurgical treatment is not appropriate if there is complete dislocation, significant sofi tissue disruption, documented neurologic deterioration, increased pain or deformity and for patients with neurologic lesion and insensitive skin.

Pharmacologic treatment in spinal cord injury.

Methylprednisolone is the only drug in widespread clinical use.

A new drug, HP 184, which blocks both Na+ and K + channels, has been tested and it was found to be safe and well tolerated. Early data have suggested that this drug may improve ASIA motor scores following an injury. These studies have paved the way for wider human clinical trials.[6]

The healing of a spinal cord lesion may be promoted by activated macrophages. One study evaluated human monocytes that were stimulated by co-incubation with skin tissue. These cells were found to secrete proinflammatory cytokines, adhesion molecules, and high levels of CD80 and CD86, all of which are potentially beneficial to the injured spinal cord. When injected at the site of injury in ASIA-A patients within fourteen days after the injury, some patients demonstrated improvement in motor and sensory function.[6]

Surgical Treatment of Traumatic Thoracolumbar Injuries.

Surgeon must decide:

1. Is an operation required?

2. Is a decompression warranted in addition to stabilization?

3. Can the surgical task be optimally accomplished via an anterior, posterior, or combined approach?

4. Controversy exists regarding timing of surgery. Spinal canal decompression that is done immediately afier injury would provide a better neurologic recovery in animals. Surgical intervention should be performed as soon as the patient is ready and able to tolerate the

surgery safely. In humans, immediate surgery is associated with greater hemorrhage! The only proven advantage of surgical intervention is decreased hospital stay.[11]

Urgent spinal stabilization (within 24 hours) is safe and appropriate in polytrauma patients when progressive neurologic deficit, thoracoabdominal trauma, or fracture instability increase the risks of delayed treatment according to McLain R, et al [12] .

To make management decisions on any clinical problem, clinicians rely on evidence-based standards, their personal experience, & the experience of their mentors. Important characteristics of thoracolumbar injuries in surgical decision making are Injury morphology, Neurologic status and the Integrity of the posterior ligaments.[13]

Most of studies on surgical treatments for thoracolumbar injuries fail to adequately discuss or provide evidence attesting to the relative merits of each method. This lack of evidence-based standards has led to varied practice patterns based on individual surgeon preferences.[14]

General Considerations

Surgery should be performed if biomechanical instability and/or a neurologic deficit is imminent or already present.

DRAWBACKS:

• need for multiple segment fixation,

• inability to 3-dimensional deformity correction,

• frequent hook-dislodgement,

• biomechanically disadvantageous posterior fixation points often leading to a recurrent kyphosis.

The practice of ROD LONG, FUSE SHORT to prevent fusion of multiple healthy segments, is not recommended (facet degeneration, second operation).

Injury Morphology

Mechanism of injury (axial compression, translation/rotation, or distraction), seems to be an independent variable in influencing surgical decision making. The translation and distraction morphologies specifically and independently dictate surgical approach.[13]

The distraction morphology is seen in flexion distraction injuries (as in a Chance fracture) or distraction-extension injuries (ankylosing spondylitis). Independently of neurologic status or integrity of the posterior ligaments, distraction and translation injuries are managed optimally with an initial posterior approach for realignment and stabilization, followed, if necessary, by an anterior decompression and/or stabilization.

Integrity of Posterior Ligamentous Complex

Disrupted posterior ligaments can be seen as a facet perch/dislocation, interspinous widening, or MRI evidence of ligament discontinuity. Integrity of the posterior ligamentous complex was universally felt to be of much more clinical significance than, and independent of, the integrity of the posterior bony elements. Hence, posterior bony disruption (such as in abone-only Chance fracture) is considered indirectly with neurologic injury as the priority.[15-18]

Decompression

Injuries involving the thoracic or lumbar spine in patients with an incomplete or indeterminate neurologic status should generally be treated more aggressively with a decompression

procedure to maximize the full potential for recovery. There is though a controversy regarding the relation between the presenting neurological status and the spinal canal narrowing. A recent study by Bridwell K, et al[6] has documented a strong correlation between the severity of a spinal cord injury and the degree of spinal canal compromise and spinal cord compression. Early surgical stabilization of the spine following a spinal cord injury has been shown in this study to reduce medical complications and to enhance early rehabilitation, but the effects on neurologic recovery remain controversial.[6,19,20]

Because the majority of thoracolumbar fractures present with anterior neural compression, decompression is usually best accomplished via an anterior approach. It allows complete decompression under direct vision but it is technically demanding and is associated with higher morbidity. It should be noted that fragment removal via anterior approach, does not seem to produce superior results as compared to indirect surgical reduction alone.

However, in certain circumstances, a posterior approach for decompression may be indicated.

Direct posterior decompression is possible via the transpedicular or the lateral extracavitary approaches. Although these techniques can result in an adequate anterior decompression, they are technically demanding and not considered routine. Some of the indications for direct posterior decompression include comminuted posterior elements with symptomatic posterior neural compression, a posterior epidural hematoma requiring evacuation, the repair of dural tears associated with a burst and lamina fractures, or the presence of a contraindication for an anterior decompression.[21-23]

The anterior spinal canal can also be decompressed posteriorly indirectly via ligamentotaxis with pedicle screw instrumentation. Posterior indirect decompression uses the ligamentotaxis effect by applying tension to the posterior longitudinal ligament to restore vertebral body height and reduce displaced anterior fracture fragments.

Ligamentotaxis is not always successful and produces incomplete decompression of spinal canal, although there is poor relationship between the decompression achieved and the neurologic recovery ensured. It seems that Neurologic damage occurs at the moment of injury and little correlation exists between degree of canal narrowing and the neurologic injury sustained.

Posterior decompression and stabilization is the least expensive procedure when taking into account hospital and physician charges.[14,16,17,24,25]

Debate continues over the indications for decompression in patients with a complete neurologic injury (ASIA-A). Surgical goals in this patient population are somewhat different because meaningful neurologic improvement is generally not expected. Unlike the cervical spine where surgery may facilitate local recovery in the zone of injury, this issue is not relevant to the thoracic spine. However, there is emerging evidence that decompression in complete paraplegic patients may reduce late complications such as posttraumatic syrinx and chronic pain.[26-28]

Anterior Approach:

It allows the surgeon to directly decompress the spinal canal, restore anterior column stability, and reestablish the normal sagittal contour of the injured spine. It is indicated in

complete neurologic injury with intact posterior ligaments and incomplete neurologic injury with intact posterior ligaments.

An anterior approach allows for restoration of spinal alignment via the placement of anterior structural support in form of allo/autograft or prefabricated prosthetic replacements. A stand-alone anterior approach minimizes the number of motion segments requiring fusion to one above and one below the fractured vertebrae. It also avoids further iatrogenic trauma to the posterior paraspinal musculature and is associated with lower rates of wound and instrumentation-related complications.[29-31]

Biomechanical testing has shown that in a burst fracture model with intact posterior ligaments, modern anterior plating with transvertebral screws one level above and one below a corpectomy model can restore significant stability when compared with the uninjured spine.[32]

Gurr et al, in a calf spine model, compared the mechanical stiffness of an anterior Kaneda device spanning three levels with a traditional posterior pedicle screw system covering five levels and found them to be nearly identical.

Haher et al[33] have further shown in a cadaver study that a burst fracture shifts the instantaneous axis of rotation posteriorly from its normal position within the posterior half of the disc space. When using anterior spinal instrumentation, the instantaneous axis of rotation is restored closer to its normal position, nearer to the center of gravity.[33]

Clinical reports regarding anterior approach are relatively few. Ghanayem and Zdeblick[34] reported on a smail series of 12 patients treated with anterior instrumentation for thoracolumbar burst fractures, with 11 of the 12 obtaining a good or excellent functional outcome and a solid arthrodesis. Kirkpatrick[35] reported a series of 20 individuals treated with the Kaneda device, with a solid fusion obtained in 95 % of cases.

Keith H. Bridwell et al.[6] studied patients with thoracolumbar burst fractures without an associated neurological deficit, treated via an anterior vs. posterior approach. Comparison of the outcomes showed that, although both anterior and posterior approaches yielded acceptable rates of patient satisfaction and return to work, anterior surgery alone had a lower rate of complications and trended toward outcomes with less pain.

Asimilar prospective, randomized comparative study of Anterior Versus Posterior Treatment of Stable Thoracolumbar Burst Fractures without Neurologic Deficit showed also that, although patient outcomes are similar, anterior fusion and instrumentation for thoracolumbar burst fractures may present fewer complications or additional surgeries.[31]

Anterior Approach- contraindications

Lower lumbar (L3-L5) spine: the anterior approach is technically more difficult because of the major vessels and instrumentation is not feasible. Therefore, many surgeons approach fractures in this region using a posterolateral decompression and posterior stabilization. Alternatively, decompression is achieved anteriorly followed by posterior instrumentation.

In the lumbar spine, the absence of the spinal cord and the greater cross-sectional area of the spinal canal make a posterior approach more feasible with less danger to the neural elements as comparerly with the thoracic spine or thoracolumbar junction.

Relative contraindications for an anterior approach include severe pulmonary disease, severe chest or abdominal injuries, and morbid obesity or prior abdominal surgery where anterior exposure can be difficult. [36-37]

Posterior Approach

It has the advantage of being familiar to the spine surgeon, avoiding vital visceral/vascular/pulmonary structures, and allowing safe surgical re-exploration.[6]

The indications for a posterior approach are:

a. distraction or translation morphology without neural compression or when neural compression is relieved by reduction,

b. isolated nerve root deficit with intact posterior ligaments, intact neurologic status and disrupted posterior ligaments,

c. complete neurologic injury and intact posterior ligaments, and complete neurologic injury and disrupted posterior ligaments

Posterior Approach-exceptions

Situations when anterior vertebral body support is lost through significant comminution. In this setting, circumferential fusİon may be necessary as a stand-alone posterior approach may result in late kyphosis and failure of instrumentation.

Combined Anterior and Posterior Approach (360°)

The anterior approach by itself, it may not resist further destructive flexion forces when the posterior ligaments have been rendered incompetent and thus an additional posterior approach for the purpose of reconstructing the tension band is important.

Indications for combined approach are incomplete neurologic injury and disrupted posterior ligaments, distraction or translation injuries where a secondary anterior decompression or stabilization is required after primary posterior stabilization, significant osteoporosis requiring internal fixation anteriorly and posteriorly and low lumbar or high thoracic injury where anterior instrumentation is not safe owing to anatomic constraints.[38]

Selection of approach and instrumentation for thoracolumbar spine fractures: Historical evolution of instrumentation

The shift from the Harrington toward the transpedicular screw systems was not only because of complications related to the use of the Harrington system, but also because of articular cartilage degeneration and spontaneous facet joint fusion in the immobilized segment, which occurred even after the Harrington rods were removed.[39]

Short-segment instrumentation and fusion for thoracolumbar spine fractures

The development of pedicle screw-based posterior spinal instrumentation systems and successful anterior spinal implants has brought short-segment instrumentation (attachment of one normal vertebra above an injury to one healthy vertebra below an injury) into successful clinical practice (Early reports). The use of pedicle screws in the lumbar spine to stabilize the lower most end of a long rigid construct applied for A3, B, and C thoracolumbar injuries was advantageous when compared with that using hook claws in the lumbar spine because the constructs with screws restored and maintained the fractured anterior vertebral body height better than the hooks without subsequent loss of correction and safe guarded postoperatively a continuous Spinal Canal Clearance at the injury level.[40]

Failure to support the anterior spinal column after posterior correction and instrumentation with pedicle-screw-based implants has led to the failure of these implants by breakage, bending, or loosening in many patients. The critical period appears to be the 6 months after the procedure. Loss of correction and failure of implants were more common in spine fractures repaired with pedicle screws than in studies that used anterior strut grafting and anterior instrumentation. The mean loss of kyphosis correction ranged from 3° to) 2° in the reported pedicle screw studies, whereas the mean loss of correction in the Kaneda studies was only 1 °. In addition, the failure rate of posterior instrumentation ranged from 9 to 54 % in the pedicle screw studies, whereas it was 6 % in the Kaneda studies.[41,42.]

Several concerns for the short segment transpedicular fixation (SSTF) -concept have been raised mainly because of the high rate of failure and therefore SSTF is currently recommended in thoracolumbar and lumbar injuries when the anterior osseoligamentous complex is intact.[43]

A general assessment of comminution (Load-Sharing Classification) is the most successful way to predict C1 inically successful short-segment thoracolumbar spinal fracture repair.

A) Fractures with mild comminution (score≤S 6) can be successfully repaired from only the posterior approach with pedicle screw-based implants.

B) Severely comminuted fractures (score≥7) must be repaired by an anterior approach with vertebrectomy and strut grafting.

Bracing for 4 to 6 months postoperatively is a necessary part of successful short-segment spine fracture reconstruction.

Fracture-dislocations (injuries with translation) are best initially instrumented short segment from the posterior approach. If the Load-Sharing point total is 7 or higher, then a vertebrectomy and anterior strut graft are applied later. Long-segment fracture repair is used for patients with unpredictable postoperative compliance.

Fracture assessment (radiograph and CT sean) is never used alone to decide on fracture treatment. Patient-specific comorbidities are too important to ignore.[42,44]

From a clinical perspective, initial stiffness is probably the more important consideration in selecting appropriate instrumentation. The postsurgical patient protects his or her spine from extreme loads by voluntary restriction of activity, and at times by use of a brace or orthosis. However, the low loads characteristic of the initial stiffness will stili be applied to the spine, and these will define the mechanical environment of soft tissue and bony healing.

Posterior screw fixation alone may be inadequate for short-segment lumbar instrumentation in unstable thoracolumbar fractures, because pedicle screw bending-fracturing occurs in 29 % of superior and 36 % of inferior screws with progressjve kyphotic deformity. The addition of sublaminar hooks to the Short Segment Posterior Instrumentation significantly increases initial stiffness, and therefore may promote both healing of a fracture or consolidation of a fusion mass to avoid screw complications combine screw and hooks.[37,45]

Posterior Transpedicular cancelous bone grafting of the involved vertebral body has been offered and performed successfully as an alternative method to increase structural and mechanical deficiency of the anterior column. Concern still remains about the potential

complication of further canal narrowing or failure of remodeling with this technique. However, many researchers have reported that grafting could not decrease the loss of correction.[46,47]

Balloon kyphoplasty and vertebroplasty are based on the same principal of reinforcement of the anterior column via a posterior approach. Balloon kyphoplasty reduces significantly posttraumatic kyphosis in Burst Fractures Using Pedicle Screws, and PMMA Cement. In cadavera, Vertebroplasty reduces significantly endplate in Burst Fractures Using Pedicle Screws, and Calcium Phosphate Cement.

Both distraction with the pedicle screw construct and inflation of the bone tamps resulted in a significant reduction of the end plate fractures. This effect was more prominent in the lumbar than the thoracic levels, because the lumbar endplates were more severely deformed after the traumatic impact as can be concluded from the results.[48]

Transpedicular hydroxyapatite grafting, and pedicle screw fixation is a method which provides reliable neurologic improvement in patients with incomplete neurologic deficit, and prevents the development of kyphosis. This technique does not require fusion to a segment, thereby preserves thoracolumbar motion. [47,49]

Unfortunately, posterior, anterior and combined instrumentation and fusion have appeared in clinical practice without proper randomized controlled trials to prove their efficacy, and any comparison has only yielded lively debate by their respectiye advocates.[50]

A recent systematic literature review 14 of 132 papers concluded that most of studies on surgical approaches for thoracolumbar injuries are inadequate. The optimal surgical approach to treat acute thoracolumbar spine injuries is controversial. In particular, five surgical subgroups were recognized in this study:

- posterior short-segment (PSS),
- posterior long-segment (PL),
- both posterior short- and long-segment,
- anterior, and
- anterior combined with posterior techniques.

The surgical observations reflect the generally held opinion that: The posterior short-segment is the shortest surgical procedure with the least blood loss white the anterior and posterlor combined group is the most demanding for the patient in these respects.

Radiologically, none of the 5 techniques maintained the corrected kyphosis angle. Posterior-short showed the highest loss of correction, while the anterior the lowest loss of correction

Patients with a mild neurologic deficit at admission had a greater chance for total recovery, regardless of the surgical technique. Posterior long and anterior instrumentation showed the highest rate of general complications

Denis pain and work scales yielded similar results for the patients from all groups, although it should be noted that the patients from the Posterior-Short and Anterior groups had the highest percentage good to excellent results in both scales.[14]

Clinical cases as an example of decision making regarding treatment of thoracolumbar spine injuries.

Clinical Case-I

Neurology & Posterior Ligaments Intact

Most commonly seen in compression or burst fractures. This patient rarely requires

surgical intervention. Bracing is commonly employed in the treatment of these fractures.

The natural history of these fractures leads to healing with some degree of radiographic progression of kyphosis over the first few weeks following the trauma. The vertebral body settling and increased kyphosis are usually of little or no clinical consequence.[7,51]

If surgery is indicated for quick mobilization, a posterior approach (open or minimally invasive) is preferred vs. an anterior approach to reconstruct the injured anterior column.

Surgical intervention may also be appropriate in a neurologically intact patient without posterior ligamentous disruption (rare scenario) who has a peripheral root deficit. This is most commonly seen in low lumbar fractures (L4, L5). In this situation, if surgery, rather than observation, is undertaken, a posterior approach is preferred to allow direct decompression of the affected nerve and stabilization of the fracture.[52]

Clinical Case-2

Neurology OK, Posterior Ligaments Disrupted

Most thoracolumbar injuries involving disruption of the posterior ligaments include severe compression fractures, burst fractures, distraction injuries, or translational injuries. A posterior approach is prefered.[19,53,54]

A combined anterior/posterior procedure is rarely preferred by a minority of surgeons because of concerns over anterior spinal support. In those uncommon situations where additional anterior column support is required because of a severely comminuted fracture, a combined anterior/posterior approach may be considered [19,53,54]

Note that normal neurologic status does not always exclude dural tear and nerve root entrapment in Lumbar Burst Fractures with Greenstick Lamina Fractures. Disappearance of fat pad signal in CT and/or MRI are signs that suggest possible dural tear. Any reduction maneuver will close the greenstick lamina fracture and crush the entrapped neural elements. If there is any suspicion of such an occurrence, it should be the rule to begin with posterior approach and use the open book technique to expose the dura safely before any reduction maneuver.[55]

Clinical Case-3

Neurologically Incomplete or Cauda Equina Injury/Posterior Ligaments Intact

Severe burst fractures, distraction extension injury or flexion distraction injury through bone only. Such a patient is best served by spinal cord or cauda equina decompression via an anterior approach to allow for maximal neurologic recovery. Reconstruction is performed with the use of a strut graft or cage and a side-mounted plate or rod system.

For injuries with a distraction or translation morphology, regardless of neurologic status or posterior ligamentous status, an initial posterior approach is preferred to provide stabilization prior to the decompression anteriorly.[13,29,39,56]

Clinical Case -4

Neurologically Incomplete or Cauda Equina Injury/Posterior Ligaments Disrupted

It is most commonly seen in severe burst fractures, flexion distraction injuries (through posterior ligaments instead of bone), and translational injuries.

In a burst-type injury accompanied by incomplete spinal cord/cauda equina injury with

documented neural compression, an anterior decompression is warranted. Because of the presence of a compromised posterior ligamentous complex, the anterior vertebral reconstruction may require augmentation via posterior stabilization.

In translational or distraction injuries, an initial posterior reduction for alignment and stability is recommended followed by a posterolateral or anterior decompression in the presence of residual canal compromise. Decompression takes priority over stabilization except in translation and distraction injuries where initial realignment was recommended, which may in and of it self serve to relieve any neurologic compressıon

The need for combined anterior and posterior (360°) approaches was agreed upon by 82 % of participating surgeons in a severe burst injury with incomplete neurologic injury and disruption of the posterior ligaments. Low lumbar (L4, L5) fractures may prevent safe and reliable direct anterior decompression or instrumentation, and thus a posterolateral decompression with posterior instrumentation is a reasonable choice.[13]

Clinical Case - 5

Neurologically Complete/Posterior Ligaments Intact

Most instances of complete spinal cord injury in which the posterior ligaments remain intact are represented by severe burst fractures. A flexion distraction injury entirely through bone or a distraction extension injury with the injury line passing only through the posterior elements can also result in this clinical scenario. Nervous system insult is typically from spinal column elements anterior to the canal or canal compromise due to translation. Decompression to regain neurologic function is generally felt to be of little or no benefit

Surgical treatment limited to a posterior approach aimed at stabilization and realignment may be appropriate, but many surgeons prefer an anterior approach for restoration of CSF flow as their primary objective as an attempt to avoid the incidence of posttraumatic syringomyelia.[26,27]

Clinical Case - 6

Neurologically Complete/Posterior Ligaments Disrupted

Severe compressive burst injuries, translational injuries, and distraction injuries all contribute to this type of clinical presentation. Neurologically complete patients with posterior ligament disruption display the most destructive fracture patterns.

In the absence of salvageable neurologic function, a posterior exposure and tixation procedure is the surgical pathway of choice. Restoration of CerebroSpinalFluid (CSF) flow through an anterior-only approach (augmented by internal fixation) was felt by some surgeons.

Recognizing the extreme biomechanical instabilities in these types of fractures, few surgeons favored a combined anterior and posterior procedure, noting the opportunity provided in such instance to not only restore CSF flow but limit the number of motion segments included in the posterior instrumentation because of the anterior construct.

Conclusion

The morphology of injury, neurologic status, and integrity of the posterior ligaments

can help guide the surgical management of thoracolumbar injuries. In most instances, incomplete neurologic deficits warrant anterior decompression if a posterior alignment is not effective in relieving neurologic compromise.

Disruption of the posterior ligaments requires a posterior approach in the majority of cases. When both of the se circumstances are present at the same time, a combined 360° approach is merited.

Other characteristics of the fracture pattem can intluence the choice of approach but are rare compared with typical presentations.

Spinal Canal Remodeling Regardless of the type of treatment

Spontaneous remodeling of the spinal canal succeeding burst fractures of the spine has been recognized as an entity following the advent of the three-dimensional imaging technologies. Remodeling has been shown to occur regardless of the type of treatment, be it surgical or conservative, but the real clinical importance or the influence on neurological recovery, is not yet clearly understood.[25,37,57]

Neurologic recovery following Surgical Treatment of Traumatic Fractures of the Thoracolumbar Spine

A complete paraplegia does not resolve! From a partial cord lesion, a substantial part of the patients recover completely. Patients with the least deficits at admission clearly had the best prospects of complete recovery regardless of the surgical approach. this finding can be explained with two mechanisms:

1. Mild deficits corresponded to lightly damaged spinal cords, and these patients would have a good chance for healing without sequels.

2. Neurologic deficits can improve even 2 to 3 years after the initial damage, although then the gain is usually small. [14,39]

Conclusions

1) Evidence-based guidelines for the treatment of traumatic fractures of the thoracic and lumbar spine are lacking.

2) The scientific evidence is largely based on retrospective case-series.

3) The surgical approach is possibly determined by the injury severity and institutional preference.

4) No surgical method is able to maintain the corrected kyphosis angle.

5) Partial neurologic deficits have potential for recovery, the amount depending more on the initial deficit and the time elapsed since the initial deficit than the treatment strategy.

6) Although complications after surgery for traumatic spine fractures have been reported frequently, serious complications are rare.

7) The added value of transpedicular spongiosaplasty is questionable.

8) The outcome in terms of pain and employment seems to be better than generally believed.

9) Valid designs, e.g., randomized controlled trials, are needed for comparison of different surgical techniques.

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PANEL DISCUSSION

TREATMENT OF LUMBAR DEGENERATIVE DISC DISEASE: DISC ARTHROPLASTY

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Introduction

Lumbar degenerative disc disease (DDD) is one the major causes of pain and disability in adults in developed countries.

Traditionally in these patients with persistent low back pain (LBP) unresponsive to conservative treatment, spinal fusion is still the standard treatment. This kind of surgery can reduce symptoms, climinating any painful intervertebral motion, either by a posterior (PLIF) or anterior (ALIF) techniques. Despite this, fusion is still discussed among surgeons about long-term consequences/benefits of loss of motion, possible revision and fusion extension due to clinical sequelae of possible increasing stress at the adjacent levels[1]. Moreover, it has been shown that lumbar fusion may alter the sagittal balance of the spine, including a decrease in the sacral tilt and lumbar lordosis: clinically, postfusion pain appears to be significantly related to the se sagittal alterations, independent of other factors such as pseudoarthrosis.

In recent years, with the technical development of total disc prostheses, the possible replacement of the degenerated disc by a motion-preserving implant has become widely discussed and popular as an alternative strategy to fusion in the treatment of patients with discogenic pain[2]. Although still in the early phases of development after some pioneer devices; the non-fusion option in LBP surgery is promising and the motion-preservation techniques will become part of the spine surgeon armamentarium, especially with the introduction of new materials and new implants design.

Aim of total disc arthroplasty (TDA) is at least to get the same benefits as fusion, and its theoretical advantages appear to include the ability to relieve pain by maintaining the motion segment and potentially preventing adjacent-segment degeneration [3]. A recent prospective radiographic study about the influence of single-level TDA on spinal sagittal balance has shown that disc replacement doesn't affect and often restores sacral tilt (ST), pelvic tilt (PT), and lumbar lordosis [4].

Other studies have demonstrated that the degree of pain improvement after TDA was equivalent to that obtained with anterior fusion cages using the mini-invasive technique, without significant differences. However, there is a trend towards faster recovery and improvement in disc arthroplasty patients.

Actually a better knowledge in functional anatomy and biomechanics of the spine has made possible the development of modern lumbar arthroplasty devices (e.g., Charite III, ProDisc, Maverick, FlexiCore) of different construct and materials (metal-on-plastic, metal-on-metal).

Indications and Contraindications.

Indications for lumbar TDA are similar to those for anterior interbody fusion (ALIF), except for most severe DDD. The patient should have failed any pain improvement after an appropriate 10-12 months non-operative treatment, and should have an assessed discogenic pain (ev. by discography) related to a single or double level disc disease at L4-L5 or L5-S1. Patients must have good bone stock (usually aged: s 55), because osteoporosis is a clear contraindication for lumbar TDA , due to the higher potential risk of implant endplate subsidence.

Radiculopathy and sciatica, canal stenosis, spondylolysthesis (any) are other contraindications for lumbar TDA[5][6]. AIso posterior facet joint arthropathy is generally considered a contraindications: but are cent paper has studied the correlation between the clinical functional result of TDA and the arthrosis of the posterior facets or the fatty degeneration of the spinal muscles, that appear to be essential for understanding the long-term outcome of devices in functional terms. The study has shown that a semiconstrained implant with a fixed posterior center of rotation can be implanted with grade 1 and 2 facet arthrosis with a good clinical outcome, while the greater the amount of muscle fatty degeneration, the less satisfactory the clinical result[7] .

Surgical approaches.

The new generation of lumbar implants has been developed to be implanted through a minimally invasive anterior retroperitoneal approaches to the lumbar spine. To expose the anterior lumbar spine, a transperitoneal approach can also be used, either open or laparoscopic. However many comparative papers were published in the last few years, showing a clear superiority of mini-open retroperitoneal anterior approach. It can reduce the risk of damage to the superior hypogastric sympathetic plexus (retrograde ejaculation/climax) by 10 times compared to the transperitoneal one.

The patient is positioned supine with abducted and semi-flexed hips. With the assistance of the C-Arm, an accurate identification of the midline is made. Once the centerline has been found, it is usually helpful to mark it on the skin as well as the lateral projection of the target vertebral bodies by lateral fluoroscopic check.

Anterior minimally invasive retroperitoneal approach to LS-S1:

• 5-6 cm horizontal skin incision,

• Fascia - Rectus abdominis sheath opened.

• Retroperitoneum, approached through Douglas' space.

• Left common iliac/aortic bifurcation mobilized (69 % located at L4-5).

• Middle sacral artery and ve in mobilized and ligated (theyare below the bifurcation).

• Blunt dissection and mobilization to the right of the left common iliac artery, sweeping from left to right also the prevertebral tissue (including the superior hypogastric plexus) off the lumbosacral disc.

• Disc approached in the midline.

Anterior minimally invasive retroperitoneal approach to L4-L5:

• 5-6 cm vertical skin incision, Fascia - Rectus abdominis sheath opened. Retroperitoneum, approached through Douglas' space.

• Left ileo-lumbar ascending vein ligated (at L4-LS), because this vein is a horizontal tet-

her, which crosses the body of LS from right to left and ascends in the left paravertebral space. It acts as a direct tether to prevent retraction of the iliac ve in of the spine, and is very vulnerable to avulsion.

• Left Common Iliac Vein mobilisation from left to right, and self-retractors in place. Disc approached in the midline.

Currently some TDA implants (i.e. O-MAV - Medtronic) could be correctly placed at L4-L5 level by an oblique direction, thus reducing the retraction stress on the vessels because their complete dislocation to the right is no more necessary.

Most of the data available from literature about the complication rate of anterior approaches to the lumbar spine are referred to ALIF techniques, but because this access is the same used for TDA, they can be similarly considered in the anterior lumbar spine non-fusion surgery.

The most common approach-related intraoperative complications are vascular injuries, ureteral tears and peritoneum violation, white the post-operative ones are sympathetic dysfunctions (especially retrograde ejaculation in males), urinary retantion and prolonged ileus.

European clinical trail: Maverick lumbar TDA. Prospective study. Preliminary report of 60 cas es at 3 years follow-up [8].

The Maverick is a chrome cobalt metal-on-metal design prosthesis with two metal parts that rub together according to the principle of a balı and socket. One part is therefore fixed inside the other. The device rotates in on a posterior center, limiting stress to the posterior facet during flexion, extension and lateral inclination.

The center of the ball is situated below the vertebral endplate, allowing controlled automatic translation during flexi on and extension. The Maverick is anchored to the bone by a hydroxyapatite coating and a connector press-fitted into the vertebral body.

Objective: The goal of this study was to prospectively analyze the results of the Maverick Lumbar Disc Prosthesis (Medtronic USA) at 3 years follow-up.

Methods: We conducted a prospective analysis of the Maverick lumbar TDA implanted in the first 60 consecutive patients for the treatment of single-level DDD of the lumbar spine resistant to conservative treatment for more than 1 year. The outcome data collected included the Oswestry Questionnaire (ODI 2.0) and Visual Analog Scale (VAS) preoperatively and at routine follow-up. Radiographic analysis included sagittal balance parameters on standing lateral radiographs of the spine and range of motion on flexion/extension dynamic radiographs. 3 european centers were included in the study.

Results: There were 32 females and 28 males with an average age of 43,4 years and average follow-up of 2,8 years (24 to 40 months). The Maverick prosthesis was implanted at L4-5 level in 28 patient and at L5-S1 levels in 32 patients. Clinical success, defined by the FDA as improvement as at least 15 points on the ODI 2.0, was 76 % and 79 %, at 6 months and 1 year follow-up respectively. The VAS show an improvement in back pain from 7.1 (+/- 2) pre-operatively to 3.0 (+/- 1.8) postoperatively.

At 1 year, there was no measurable subsidence of the device and no evidence of device migration.

The measured R.O.M. in flexion-extension ranged from 3 to 16 degrees. L4-5 level is one mobile: average 7.4 degrees. With regards to sagittal balance, there was no significant change in any of the variable studied including sacral tilt, pelvic tilt or overall lordosis after placement of TDA. One complication, a ureter injury occurred during the approach in one procedure. One left İliac vein injury occured intraoperatively and treated with vascular clip. One patient with persistent low back pain was reoperated for posterior fusion with significant improvement of pain at two years. This patient had been operated 3 times before disc herniation and recurrence of HD.

Conclusion

This results of TDA compare favourably with the short-term clinical outcomes associated with ALIF reported in literature. Unlike fusion however, it is evident that disc arthroplasty has less perioperative morbidity and allows enough freedom of motion to maintain the natural sagittal and spinopelvic balance, while restoring dise height, unloading facet joints and opening neural foramen. All these factors may be then critical in obtaining greater pain relief and protecting the adjacent levels, if compared with fusion.

Consequently, modern clinical research and development in disc arthroplasty strongly supports its emergence as a real alternative to spinal fusion for patient with lumbar DDD, although these favourable clinical results must still be assessed after long term follow-up studies.

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PANEL DISCUSSION

THE PLACE FOR DYNAMIC INSTRUMENTATION (TOPSTM-LUMBAR FACET JOINT REPLACEMENT SYSTEM) IN THE MANAGEMENT OF LUMBAR DEGENERATIVE DISC DISEASE

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Degenerative lumbar disc disease is a multifaceted pathological process. The concept of the degenerative cascade was formulated by Kirkaldy- Willis, who delineated its various stages. The final common pathway of the cascade is the degenerated motion segment affecting both the intervertebral disc and the posterior elements with end-stage spinal stenosis. A single standard surgical strategy is not applicable since the degenerative process has many different facets. This feature makes it imperative to match the treatment to the specific pathological anatomy of these different stages.

Until recently, spinal fusion was the universally accepted approach in far advanced spinal degeneration despite the fact that it is a "non-physiological" surgical solution. Considering the well-documented successes of joint replacement, disc replacement is certainly an interesting and promising altemative surgical option. Indeed, the recent popularity of disc replacement surgery has gained close attention from both the public and from spine practitioners. Removal of the "pain generator" and the possibility of restoration of the normal motion characteristics are understandably appealing. The recent resurgence of the issue of disc degeneration in the level adjacent to a surgicaııy fused segment has alsa disfavored spinal arthrodesis and led to further utilization of disc replacement technology. Unfortunately, disc replacement is suitable for only a small percentage of patients with degenerative lumbar disc disease. For example, Huang et al.[1] from the Hospital for Special Surgery in NY, found that only about 5 % of patients undergoing surgery for degenerative disc disease of the lumbar spine were found suitable for lumbar disc replacement. The posterior pathological anatomy is the main symptom generator in most of these patients, and current disc replacement techniques cannot address spinal stenosis or facet arthritis. Therefore, most patients with degenerative lumbar disc disease will still need same kind of posterior surgery. These patients are usually elderly and have significant stenosis and facet arthritis; some have degenerative spondylolisthesis and some degree of osteoporosis as well. In essence, these characteristics comprise a list of contraindications, both relative and absolute, for disc replacement. The spine clinician is, therefore, left with the traditional surgical solution of lumbar decompression accompanied by fusion, especially in cases of degenerative spondylolisthesis. In addition to the loss of motion following fusion, the spondylodesis increases motion and stress in the adjacent segments by means of load transfer. This biomechanical phenomenon has the potential of accelerating adjacent disc degeneration with the possible need of revision surgery. The alternative to this "poor solution" is clearly a procedure that will address nerve root and cauda equ-

ina compressian, abolish pain generators from facet osteoarthritis and restore rather than restrict physiologic lumbar spine motion.

Posterior motion preservation, including facet arthroplasty, is a new concept in spinal surgery. By restoration of the anatomical structures and function of the posterior elements, it is possible to decompress the thecal sac and nerve roots without the need for fusion. Such an approach has numerous potential benefits and the TOPSTM- total posterior spine system incorporates the features afthis concept in the clinical setting [(2)]. It has the potential to replace the posterior elements, integrate current decompression techniques and rely on standard pedicle screw instrumentation. Unlike the currently available alternatives to fusion, the TOPSTM device is designed for both stabilization and motion preservation and not for restraining posterior motion. The TOPSTM system offers a novel approach to facet replacement and allows a dynamic, multiaxial^3 - column stabilization via a standard traditional posterior approach following proper decompression. The central core of the implant is composed of two titanium endplates connected by a closed "box" containing an elastomer that provides 3-axial motion. An internal mechanism in the "box" controls the range of motion. The elastomer is capable of transmitting tensile compressiye and shear forces. The central "box" is connected by two crossbars in the transverse plane to standard polyaxial pedicle screws.

Biomechanical evaiuation

Prof. H. J. Wilke from the University of Ulm in Germany evaluated the implant in vitro. Six human cadaver specimens (L2-S1, mean age 58 years) were used for the in vitro experiment[(3)]. The specimens were loaded with pure moments of flexion/extension, lateral bending and axial rotation in a universal spine tester[(4)]. Each specimen was tested in the intact state af ter bilateral laminectomy and facetectomy and after implantation of the TOPSTM device. The range of motion, neutral zone and intradiscal pressure were determined from the third cycle run on each specimen. Facetectomy significantly increased the flexion/extension, lateral bending and axial rotation. After fixation of the implant, the range of motion was normalized (5.9 degrees, 1O degrees and 5 degrees). The characteristic intradiscal pressure versus load with the TOPSTM was similar to that of the intact spine. In a further experiment with a mounted slightly modified TOPSTM, the extent of flexion/extension was recovered to almost 80 % of the intact spine. The characteristic range of motion with the TOPSTM device was compared to specimens mounted with the Dynesis implant. It was found that the TOPSTM device allowed greater motion than the Dynesis system.

T. Wright from the Hospital of Special Surgery in New York conducted additional in vitro dynamic cadaveric assessment with the TOPSTM device. The compressiye loads on each pedicle screw were tested and compared to the loads when the specimens were mounted with the Dynesis system. The mean purpose of that experiment was to determine if the TOPSTM design lends it self to load sharing among all four pedicle screws. it emergecl that the load on the screws was significantly lower and niore evenly distributed with the TOPSTM system compared to the Dynesis device. This may be explained by the fact that the system is connected to the spine in the transverse plane as opposed to its vertical connection in the Dynesis system and in fusion surgery with pedicle screws, and also because it is a dynamic

mobile implant. In vitro experiments on static load to failure, fatigue and wear simulation after 10 000 000 cycles were also conducted. In summary these in vitro experiments showed that the TOPSTM device almost ideally restored the range of motion in flexion/extension, lateral bending and axial rotation. it provided sufficient stability to the "decompressed spine" and yet was significantly more dynamic in comparison to other currently available "dynamic" systems.

Clinical trial

The initial clinical trial was carried out in Brazil[5]. Ten patients aged 50-70 years enrolled in a nonrandomized pilot study after it was approved by the local institutional review board. The primary indication was neurological claudication due to spinal stenosis with or without degenerative spondylolisthesis at L4-L5. Patients with greater than 50 % loss of disc height had been excluded. The study candidates were evaluated with the DEXA sean and those with a -1.5 SD were excluded.

Prior to instrumentation, bilateral laminectomy and facetectomy were accomplished with decompression of the dural sac and nerve roots through a standard midline posterior approach. Appropriately sized pedicle screws were inserted and an appropriately sized TOPSTM device was connected and secured to the 4 pedicle screws.

There were no intraoperative complications. Blood loss was minimal and did not exceed 200-300 cc. All patients were mobilized 1-2 days after surgery. They have been evaluated with pre- and postoperative X-rays, visual analog scale (VAS) for pain, the Oswestry pain questionnaire, the Zurich Claudication Score (ZCQ) and the SF-36 health survey at 1,3, and 6 months and at 1 year.

Nine patients completed follow-up visits at 6 months and five have reached their 1-year follow-up visit. Thus far, the VAS for pain was reduced by 69 % at 6 months and by 84 % at one year (median follow-up from 8.56 months to 1.33 years). The total Oswestry score was reduced by 63 % at 6 months and 76 % at one year. Independent analysis of follow-up radiographic images have concluded that there has been no evidence of spontaneous fusion or of screw loosening or breakage, and flexion/extension views showed the TOPSTM implant to be mobile. Clinically, all patients exhibited well-preserved lumbar motion. To date, 24 patients have been operated with implantation of the TOPSTM device (ten additional patients in Brazil and four in Turkey by Prof. Azmi Hamzaoglu). There have been no device-related adverse events, and all of the patients in the Brazil II study and Turkey are faring very well.

Discussion

The TOPSTM system is intended for use in skeletally mature patients with degenerative lumbar disc disease. Currently, the implant is suitable to manage only one lumbar level between L3-S1. The system is an alternative to spinal fusion that is designed to stabilize and preserve physiological-like motion of the affected vertebral level and to alleviate pain stemming from facet arthritis, degenerative spondylolisthesis and spinal stenosis. The primary indication is neurological claudication due to spinal stenosis with or without degenerative spondylolisthesis at the L3-4 or L4-L5 levels.

The clinical results in the first 24 patients are highly encouraging. Not only are all patients faring very well, there are no device-related problems, such as screw loosening or screw breakage, the latter being a significant problem with the Dynesis system. Nevertheless, there is room for concem about the concept of continuous motion through a degenerated disc in terms of the possibility of eventual failure of an affected disc. In our experience thus far, no disc has "broken down" and complaints of back pain were minor and did not diminish patient satisfaction.

Future developments are expected to make it possible to incorporate disc replacement via a posterior approach with the TOPSTM system. It will also be possible to manage polysegmental pathology with either motion preservation of multisegments or with a hybrid construct consisting of a component of motion preservation and a component for fixation and fusion.

Careful clinical progress with strict patient selection, close and meticulous follow-up and introduction of minor modifications to the implant will ensure this new promising avenue in spinal patient care. Although the future lies in motion preservation, however, some patients will still need "good old" posterior spine fusion.

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PANEL DISCUSSION

CHANGING CONCEPTS IN THE TREATMENT OF SPINAL INFECTIONS: POSTOPERATIVE INFECTIONS

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Introduction:

Postoperative spine infections following spine surgery can be life-threatening and costly. Given the increasing use of spinal instrumentation over the last 20 years, the treatment of this complication has become increasingly important. Proper management of post-operative wound infections of the spine is paramount to obtaining a spinal fusion, avoiding other possible complications, and ultimately achieving a successful outcome for the patient.

Overview:

Postoperative spinal infections are detrimental because of:

☐ Morbidity and longer hospital stay

☐ Cost - Increases total cost of care for lower back fusion more than 4 times (Calderone 1996)

☐ Poor patient outcomes

☐ Potential for other complications (ex. pseudarthroses, neurologic sequelae)

Postoperative Spine Wound Infections:

☐ Early (0-12 weeks)

☐ Delayed (> 6 months)

Incidence:

By Diagnosis-

☐ Neuromuseular	5 to 15 %
☐ Adult Idiopathie scoliosis	1 %

By Procedure-

☐ Anterior fusion	0.6 %
☐ Diskeetomy	1 %
☐ Low baek fusion	3-5 %
- Fusion w/o instrumentation	1-5 %
- Fusion w/ instrumentation	6 % or greater
☐ Revision surgery	8 %

General Risk Factors:

Patient-related:

☐ Malnourishment

☐ Neuromuscular diagnosis (i.e. cerebral palsy, myelomeningocele, spinal cord injury)

☐ Multi-trauma

☐ Malignancies

☐ Immunocompromised (HIV, Sickle cell, TB, Diabetes mellitus, RA, Drug abuse, Steroid use)

☐ Concurrent Infection

☐ Smoking

☐ Obesity

Intra- and Postoperative Risks:

☐ Increased Op Time

☐ Excessive Blood Loss

☐ Traffic

☐ Exposure

☐ Dead space

☐ Halo traction

☐ Revision Surgery

☐ Greater number of levels

☐ Instrumented fusion

☐ Allograft use

☐ Long stay in the hospital

Organisms:

☐ Staph Aureus

☐ Gram-negative organisms

☐ Propionibacterium acnes

☐ S. epidermdis

☐ Strep group B

☐ Enterobacter cloacae

☐ E. coli

☐ Proteus

☐ Mixed

Signs and Symptoms:

☐ Fever

☐ Malaise

☐ Increase back pain

☐ Drainage

Laboratory Tests:

☐ Leukocytosis

☐ Elevated ESR and CRP

☐ Positive cultures (*Culture for 7 days)

☐ VItrasound and Gad enhanced MRI

Laboratory Tests for Nutrition:

☐ Serum albumin < 3.5 g/dL

☐ Totallymphocyte count <1500- 2000 cells/mm

☐ Zinc levels < 670-1240mg/L

C-reactive protein (CRP) vs ESR:

☐ CRP is more useful than ESR

☐ CRP is minimally elevated 2-3 days post-op and should normalize 5-14 days post-op

☐ ESR peaks 4 days post-op and normalizes 2 weeks post-op

☐ ESR may take 3-6 weeks to normalize

Teatment of Infections:

☐ Prophylactic treatment

- Pre-operative and intra-operative antibiotics

- Intra-operative irrigation

- Dilute betadine solution irrigation (Chen 2005)

☐ Operative Treatment

- Antibiotics ater deep cultures have been taken

- Debridement & Irrigation

- Open or closed treatment

☐ Open vs Closed?

- Open treatment of the wound (packing, vac)

- Closed (drain vs closed irrigation)

☐ Removal vs leaving in instrumentation?

☐ Long term antibioties

Continuous Suction-Irrigation Technique (Akbarnia)

☐ Early intervention

☐ Assumption of deep wound infection

☐ Complete debridement

☐ Pulse lavage

☐ Leaving the implants

☐ Deep inflow catheter

☐ Deep outflows

☐ Tight Closure

☐ Continuous saline irrigation 100 cc/hour

☐ Detail recording

☐ Gradual removal of the drains

☐ Second visit if necessary

☐ Systemic antibiotic therapy

Results;

	Acute	Late
☐ Patients	22	6
☐ Re-infected pts	7	0
☐ Hosp. Stay	15 days (6-63)	8.5 days (4-14)

Implant Removal:

	Number of Pts	Removal
☐ Early	22	0
☐ Delayed	6	4

☐ Closed suction irrigation is an effective method of treatment of post-operative wound infections

☐ Adherence to the detail of technique is essential

☐ Early diagnosis and treatment results in better outcome

☐ Antibiotics not necessary in irrigation

☐ If intervention is done within one week the second procedure will not be necessary

☐ In acute cases the removal of the implants is not usually necessary or advised but in late infections removal of implants is feasible

Delaved Deep Wound Infeetions:

☐ Usually 6 months to 2-3 years following index surgery

☐ Poorly localİzed baek pain

☐ Fluctuance

☐ Spontaneous drainage

☐ High sed. rate

☐ Implant removal usually possible

How to Avoid PostOp Wound Infections:

☐ Identify high risk patients

☐ Nutritional supplements

☐ Treat UTI

☐ Prophylactic antibiotic treatment

☐ Use of the drains??

☐ Topical irrigation??

Summary:

☐ Postoperative spinal infections are relatively rare but serious if not properly treated

☐ Diagnosis should be early

☐ Treatment should be aggressive

☐ Appropriate antibiotic therapy

☐ Treatment recommendations are somewhat anecdotal

☐ Use common sense

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PANEL DISCUSSION

SPONDYLODISCITIS NON TB

Carlos VILLANUEVA

Spondylodiscitis is a non common entity with an annual incidence of 2 per 100.000 habitants per year in an urban area of a developed country [14]. Most common clinical features are aged patient, complaining from back pain (91 %), fever (68 %) with a marked elevation of the erythrocyte sedimentation rate (91 %). Most of the aged patients are in poor general condition due to previous invasive procedures (41 %), underlying cancer (25 %) and diabetes (18 %). Neurological impairment varies in the different series from 28 % to 45 %[14, 21].

The site of infection is generally lumbar with minor incidence in upper areas[18, 20, 27].

Diagnosis

Magnetic resonance imaging has been advocated as the imaging method of choice in suspected spinal infections[3, 5]. MRI allowed the correct diagnosis to be made in all cases, demonstrating the pathological involvement of the paravertebral structures and into the spinal canal earlier and more accurately than CT. However, it is comparable or even worse to CT in the chronic stage of the disease: follow-up magnetic resonance images often gaye impressions of progressive disease, where the clinical picture appeared to improve.

Proper identification of the causative agent is mandatory, the most common methods are blood culture and/or guided biopsy. Guided biopsy allows better accuracy in the identification of the causative organism and allows also the possibility of supplementary histo-pathological analysis [4]. The efficacy of the percutaneous biopsy seems to be highly dependent on the management before the biopsy. Rankine[24] reported a diagnostic efficacy of the percutaneous biopsy of 50 % in patients without previous treatment but only 25 % in patients previously treated. The result of the biopsy led to a change in management in 35 % of the previously treated patients. It seems evident that treating empirically spondylodiscitis with antibiotics before the biopsy can no longer be supported. Most common germens are Staphylococcus aureus and Gram mainly Escherichia coll.

Clinical features varies with the age, children have two forms: pure discitis and spondylitis (vertebral osteomyelitis) Discitis have erlier presentation (2.7y.o. vs 7.5 y.o.) with fever as a less common symptom (28% vs 75 %). In spite that the clinical features distinguish most patients with discitis from those with vertebral osteomyelitis[11]. Although radiographs of the spine usually are sufficient to establish the diagnosis of discitis, again MRI is the diagnostic study of choice for paediatric patients with suspected vertebral osteomyelitis [25]. Antibiotics IV and oral is the treatment of choice with complete resolution in all the cases.

Children may suffer from a infectious arthritis of a lumbar facet, this is a rare case. Clinical features include back pain, contracture

and moderate fever [28]. Lesions of the facet joint are detectable as soon as the first week on MRI, and after 15 days of clinical course on CT sean [8]. Epidural abscess, when present, is best shown by MRI as early as the first week. CT sean can guide percutaneous needle biopsies of the paravertebral abscesses or of the concerned facet joint.

Spondylodiscitis in adults is related with poor inmunitary response[23,29,31] and/or invasive procedures like cardiac surgery [1]. Patients with VIH syndrome have a risk of spondylodiscitis 33 times higher than the normal population. The type of infection seems to be related with CD4T-Cell count: Discitis and/or osteomyelitis occurs in HIV-positive patients with a mild-to-moderate decrease (>/=200 cells/mm) in the CD4 T-cell count, and the infection responds to appropriate antibiotics. Patients with a more severely decrcased CD4 count (50 to 200 cells/mm) may have spinal tuberculosis develop, and patients with the lowest CD4 counts are more likely to have epidural abscesses develop[30]. The prognostic is also related with the inmunitary status, all the patients with non specific infections had clinical resolution after six to twelve weeks of appropriate antibiotics. Fatalities in this study occurred in the two groups of patients with worse inmunitary status. Although the CD4 count can be used as a predictor of the clinical course, identification of the organism remains paramount in the treatment of this complex patient population.

More than a half (55 %) of the patients affected of non specific spondylodiscitis are older than 65 y.o. This is a complex group of population with associated pathologies in many cases. Again patients with poor general status have higher risk of vertebral infection specially those with diabetes, corticosteroids, chemotherapy for cancer, rheumatic or inmunological disease, renal or hepatic failure, malnutrition or myelodysplasia.[2, 18] The urinary tract was the most frequent source of infection. Most frequent infecting organism is Staphylococcus aureus followed by Gram- bacilli and organisms such as Staphylococcus epidermidis, Propionibacterium acnes, and diphtheroid species, that are traditionally considered to be of low virulance.

Some times spondilodiscitis is associated to other infectious process like endocarditis. The incidence varies in the different series Le Moal [16] reported 92 cases of definite infectious endocarditis, among these cases Spondylodiscitis was present in 14 (15 %) cases. Spondylodiscitis was diagnosed before endocarditis in all the cases. We reviewed our series [22] of 666 patients with a confirmed diagnosis of infectious endocarditis but only 28(4.6 %) had associated spondylodiscitis. When we look to our series of piogenic spondylitis the incidence of associated endocarditis is much higher (30.8 %). Other series reported a slighty lower incidence related to the organism responsible [19] In our series, Staphylococus aureus was by far the most common in cases of endocarditis but if we analyze the cases of piogenic spondilodiscitis then the gram - bacillus is more relevant. This a severe association with an overall in-hospital mortality of 11 % (7 % infectious endocarditis). LV should be included in the differential diagnosis in patients with infectious spondylodiscitis and risk factors for endocarditis. In such patients, echocardiography should be performed routinely.

Minor forms of vertebral infection like septic facet arthritis can be also founded in adults. In some cases concomitant epidural abscess is present. The initial clinical features were consistent with a spondylodiscitis. Imaging led to the correct diagnosis in all cases being CT

and specially MRI the method of choice. Lesions of the facet joint as well as epidural abscesses are detectable as soon as the first week on MRI. Appropriate treatment after identification of the causative organism is extremely effective in all the cases.

Epidural abscess complicating spondylodiscitis occurred most often in the cervical spine, followed by thoracic and lumbar areas[12]. The rate of paraplegia or paraparesis also was highest in cervical and thoracic regions. Quadriplegia is uncommon.

Vascular complications like great vessels aneurysms are rare. Some reports have been published in non specific spondylodiscitis[7] but also in patients with active TB.

Treatment

Antibiotics with previous identification of the causative organism is the method of choice. Duration of treatment varies depending the efficacy of the treatment. In patients in good general status, intravenous antibiotics for three weeks followed by six to eight weeks or oral antibiotics can be sufficient.

Surgery should be considered in

• absence of clinical improvement after 2-3 weeks of IV antibiotics,

• systemic effects of chronic infection

• progression neurological deficit in elderly or in cervical infection.

• instability and/or progressive deformity.

Principles of surgical treatment are classical.

Debridement

Fusion if needed

Percutaneous suction and temporary stabilization with a external fixator is the less aggressive option[15]. It can be considered in pyogenic and tuberculous osteomyelitis of the spine localized between T3 and S1. The procedure is an alternative to conservative or more invasive operative treatment modalities in painful lesions of the spine with minimal bone loss, not amenable to efficient orthotic stabilization (thoracic spine from T3 to T9, lumbosacral junction, elderly patients, or presence of deleterious general conditions).

Another MIS option can be transpedicular drainage with[13] This technique can be impressively effective and the results sustained when applied in the early stages of uncomplicated spondylodiscitis and contraindicated in the presence of instability, kyphosis from bone destruction, and neurological deficit. The special point of this procedure is a minimally invasive technique with high diagnostic and therapeutic effectiveness. Nowadays, in cases of moderate instability percutaneous instrumentations can be used safely.

The use of spinal instrumentation has been controversial because the theoretically increased risk of infection. Today, there is enough evidence supporting the use of instrumentationand cages[9]. Spinal instrumentation should be indicated when after radical debridement of infected vertebrae and disc material and bone grafting the stability of the spine is stili compromised. According to the location of the infection and the availability of suitable implants, anterior or posterior instrumentation may be necessary. With appropriate antimicrobial agents, the outcome has been satisfactory in all the reported patients even in case of staphylococcus aureus MRSA + cases with extensive destruction must be treated with spinal reconstruction and again there is not cont-

raindication to the use of cages[10]. Titanium mesh can be used with consistently good results for large anterior column defect reconstructions even in the face of active pyogenic infection. The use of titanium mesh cages has not been associated with early recurrence of infection.

Regarding the approach there are minor advantages with anterior instrumentation in comparison to posterior stabilization in patients with spondylodiscitis[17]. Advantages of ventral stabilization cause early mobilization postoperatively without any increase in complication rates. Except for operation time and intraoperative blood loss, no statistical difference was seen. Important is the individual indication for each method depending on anatomical and clinical signs. Ventral instrumentation should be restricted to cases with sufficient bone stock.

In cases with severe destruction, double approach seems to be the method of choice. Regarding the timing, same day front and back surgery seems advisable[26] Patients severely ill at presentation and requiring urgent treatment can be treated in a sequential manner[6]: Anterior debridement and fusion for restoration of anterior column support and control of the infection followed by two weeks of intravenous antibiotics before posterior instrumentation and fusion. Patients should follow 6 weeks of intravenous antibiotics after surgery.

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PANEL DISCUSSION

TREATMENT OF POTT' S DISEASE

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According to the World Health Organization, tuberculosis has become the world's most deadly infectious disease, killing nearly 3 million people per year. Each year there are 8 million new cases of tuberculosis, and 50 % of them are infectious.

Spinal tuberculosis is the most common form of musculoskeletal tuberculosis. In HIV-negative patients, between 3 % and 5 % oftuberculosis cases are skeletal, compared with 60 % of cases in HIV -positive patients.

The incidence and the site of involvement

Spinal tuberculosis is the most dangerous form of skeletal tuberculosis because of its ability to cause bone destruction, deformity, and paraplegia. Paraplegia is more common in tuberculosis than in pyogenic spondylitis because the neural arch is involved more often with the former. The spine is involved in 50 % of cases of musculoskeletal tuberculosis: 4.2 % in the cervical spine, 55.8 % in the thoracic spine, 16.9 % in the thoracolumbar spine, and 22.8 % in the lumbar and lumbosacral spine. Three forms of vertebral involvement have been described; peridiscal, central, and anterior. Two-thirds of the classifiable cases present with peridiscal involvement, while in more than 50 % of the cases the primary focus can not be determined because of the extension of the disease. Progression of the vertebral disease is usually by direct subperiosteal or subligamentous spread.

Diagnosis

Tuberculosis constitutes a diagnostic challenge. Diagnosis is usually a long and tedious process. Usually the clinical manifestation favors the diagnosis however, diagnosis should be confirmed by evaluating the radiographic changes, computed tomography (CT) and magnetic resonance image (MRI) findings, cultures of blood, and/or percutaneous vertebral aspirates, then bone biopsy, either by an open or percutaneous procedure. PPD is predictive in 86 % ofthe cases. Tc 99 MDP scintigraphy may be negative in 35 % and furthermore Gallium seans could be negative in nearly 70 %. No single imaging finding is pathognomonic of Pott's disease. Slow growth rate of mycobacteria on solid media is a problem due to the nature of the mycobacteria and direct microscopy is insensitive, because samples may contain only a few organisms. And yet, low number of mycobacteria are detected at spine. Diagnostic procedures such as culture, antigen demonstration, serology tests, and polymerase chain reaction are of high priority. The polymerase chain reaction has facilitated

the diagnosis and management of tuberculosis.

Treatment

There have been discussions on whether the treatment of choice should be conservative chemotherapy for 12 months or chemotherapy and surgery combined. Management should be based on the goals of treatment for each individual case.

Effective chemotherapy for spinal tuberculosis is the gold standard and mainstay of the treatment and all other methods of treatment are regarded as supplementary.

Drug Treatment Regimens

The standard triple chemotherapy (isoniazid, rifampin, and pyrazinamide), should be given for at least 12 months, rather than the 6- to 9-month short-term chemotherapy that has been proposed by so me authors. Upadhyay et al reported that 6 months of three-drug chemotherapy in conjunction with radical surgery was adequate for the management of tuberculosis of the spine because it produced results comparable with 9-month and 18-month chemotherapeutic regimens, however this should be taken cautiously. Good general supportive care and an effective chemotherapy started at the early stages of the disease are the keys to early and effective eradication and minimizing complications.

MRC Working Party showed that the combined standard 18-month chemotherapy with isoniazid and PAS produced a cure rate of 90% in children, which was identical to the results obtained with an additional initial 3-month streptomycin treatment. Ambulant chemotherapy alone provided treatment oftuberculosis with a minimum increase of kyphosis. The results of ambulant chemotherapy, however, were not always satisfactory .

Surgery

Although chemotherapy is the mainstay in the management of tuberculosis spondylitis, surgical procedures stili play an important role. Problems arising from bone destruction, paraplegia, and pulmonary insuffıciency due to spinal deformity can not be solved with chemotherapy alone. Indications for surgical treatment include 1) neurological involvement, 2) deformity and/or impending increase in deformity, and 3) the presence of large tuberculosis abscess and/or abundant necrotic tissue.

Abscess, tuberculosis lesion, paraplegia, and kyphosis, have been managed surgically by various procedures:

Cold Abscess.

Aspiration or surgical drainage was carried out for some patients with a large cold abscess because it was thought that evaluation of the abscess improved the patient's general condition, and rapid progression of the abscess along the spine was prevented.

Tuberculous destructive lesion.

Two surgical methods-focal debridement and anterior radical surgery are available to eradicate the lesion.

1. Focal debridement. Focal debridement can effectively remove the diseased tissue and sequestra and also can evacuate the abscess; however, it does not prevent the progression of kyphosis due to the lack of anterior

support. Focal debridement and simple abscess evacuation provide no long-term advantage over ambulant chemotherapy alone and therefore are no longer accepted as a preferred method of treatment.

2. Anterior radical surgery. Anterior radical debridement and arthrodesis with a strut graft and chemotherapy has been the treatment of choice. There is evidence that better results regarding deformity, recurrence, development of paralysis, and resolution are obtained when radical surgery is performed combined with chemotherapy.

Paraplegia.

During the early phases of the disease with active infection, possible reasons include direct compression of the neural structures by the abscess and/or sequestrated bone fragments, direct dural invasion, vascular compromise due to compression or thrombosis, acute instability, or severe deformity. Direct compressian by abscess or necrotic tissue is the most frequent cause of early onset paralysis and generally has a good prognosis and a relatively high probability to resolve with effective treatment. Paraplegia due to vertebral tuberculous lesion is caused by direct impingement of the abscess, ischemia due to altered blood supply, intra dural abscess and kyphosis. it is generally known that the recovery rate from paraplegia is influenced by many factors: the patient's general state, age, and spinal cord condition; the level and the number of involved vertebrae; the severity of spinal deformity; the duration and severity of paraplegia; the time to initiation of treatment; the type of treatment; and drug sensitivity. Paralysis occurring in children generally have a better prognosis compared to adults

Paralysis lasting longer than 6 months is most unlikely to improve, and late paralysis with inactive disease and significant kyphosis is much less responsiye to treatment. Paralysis due to vascular insufficiency has a worse prognosis. Several methods have been used for the treatment of patients with paraplegia:

1) chemotherapy alone,

2) laminectomy,

3) costotransversectomy, and

4) radical surgery.

In the early stages of the disease, paraplegia caused by abscess can be resolved by effective chemotherapy alone as by decompressive surgery, however, chemotherapy al one is inappropriate management of paraplegia in the patient with advanced tuberculosis and deformity. It is unfair to allow a patient to lie paralyzed for some weeks to months awaiting a cure through conservative care. Decompressive laminectomy will destabilize already instable spine therefore should not be done. When patients with Pott's paraplegia and severe spinal deformity do not respond to chemotherapy and have worsening neurology, decompressive surgery is indicated to arrest the progress of paralysis and hopefully to restore normal neurology.

Kyphosis/Deformity

Tuberculosis kyphosis is an unstable lesion that tends to progress until there is so und bony fusion anteriorly. Kyphosis has been managed by several surgical procedures:

- posterior fusion,

- anterior radical surgery, and

- various combined operations such as a one-stage, two-stage, or three-stage procedures.

Each patient should be cautioned about the high neurologic risk with corrective surgery of the rigid deformed spine.

Until now, the following surgical procedures have been practiced by various surgeons:

1. Flexible Kyphosis:

Skeletal traction

Posterior fusion

Anterior radical surgery

Two-stage operation:

Posterior instrumentation followed by anterior radical surgery

Anterior release and grafit, followed by posterior instrumentation

Three-stage operation (anterior release followed by posterior instrumentation and delayed anterior radical surgery).

2. Fixed Kyphosis.

One-stage operation

Two-stage operation (anterior release, deformity correction and anterior grafit, followed by posterİor instrumentation)

Multi-stage operation (osteotomy, halopelvic device, posterior instrumentation and fusion). Skeletal traction for cervical kyphosis.

Posterior fusion for kyphosis. Disproportionate posterior spinal growth has been suspected as a contributing factor in the progression of kyphotic deformity after management of spinal tuberculosis by posterior fusion only.

Especially, in children frequently there will be a loss of the initial gain of correction and progression of kyphosis after noninstrumented posterior spinal fusion if anterior fusion is not achieved. Additional instrumentation seems to prevent the progression of kyphosis.

Anterior radical surgery for kyphosis. Radical surgery (Hong Kong Operation) was found to give better results than focal debridement for the correction and prevention of kyphosis. Progression of kyphosis is more observed in multilevel lesions

Posterior closing wedge osteotomy for kyphosis (Galveston one-stage operation). This technique is a very effective one-stage operation. It involves a modified bilateral costotransversectomy approach to the spine, followed by removal of structures in a wedge shape, including the vertebral arch, the disc, and aportion of the centrum. The wedge is closed by posterior compression instrumentation, enabling an angular correction of 30° to 50°.

Decancellation or corporal eggshell procedure. This posterior close wedge proeedure involves transpedicular curettage or evacuation of the cancellous bone of the vertebral body, excision of the posterior elements and posterior wall of the body, and correction of kyphosis by closing the wedge. This is a highly demanding procedure with additional surgical risks.

Two-stage operations.

1. Anterior radical surgery, followed by posterior reseetion and instrumentation. Yau et al used Luque instrumentation in a two-stage procedure to correct the deformity.

2. Combined posterior instrumentation plus anterior radical surgery for flexible kyphosis (two-stage operation). This procedure may be most appropriate for active cases of progressive kyphosis where the curve is stili flexible.

Prevention and correction of kyphosis and kyphoscoliosis by posterior instrumentation has three advantages. Posterior stabilization of the spine arrests the disease early, enco-

urages early fusion, and enables correction of the deformity. The procedure is indicated only in those patients who are likely to develop or who have a pre-existing deformity. it is suggested that a formula be used to predict the kyphosis that will remain at the end of chemotherapy to determine if prophylactic or corrective spinal instrumentation surgery is indicated. (Rajasekaran formula: Y=a+bX (Y= deformity, X=pretreatment loss in VB, a= constant value of 5.5, b= constant value of 30.5))

A two-stage operation, combining posterior instrumentation and anterior interbody fusion, can be an option for multisegmental tuberculosis of more than two segments. Instrumentation at a distance from the infective process restores spinal stability and prevents graft fracture, slipping, sagging, and resorption. Because of the anterior column deficiency due to the anterior column destruction posterior instrumented correction of kyphosis produces an anterior bone gap that should be reconstructed by anterior strut graft; otherwise, recollapse, instrumentation failure, and recurrent kyphosis will be inevitable.

After it has been shown that anterior instruments can be used safely at the infected site in tuberculosis patients there have been reports showing the advantages of anterior radical debridement strut grafting and anterior instrumentation.

Of course anti tuberculosis drug treatment should never be replaced by any kind of surgery alone.

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Anti-TB drugs

First line drugs

İsoniazid	bactericidal	5mg/kg
Rifampicin	bactericidal	10mg/kg
Streptomycin	bactericidal	15mg/kg
Pyrazinamide	bactericidal	35mg/kg
Etambutol	bactericidal	30mg/kg
Thiacetazone	bactericidal	350mg/d

Principles

• A combination of at least 3 bactericidal antibiotic should be used initially

• Isoniasid and Rifampicin are the most effective and basic combination

• In poor patient compliance

• Supervised regimen 2 or 3 times/week

• NEVER less than 6 months

• Initially 3-4 drugs for 2 months, then 2 drugs

Mechanism of action

Against large population of tb actively multiplying in the walls of the cavity

Isoniasid (bactericidal)

Rifampicin (bactericidal)

Streptomycin (bactericidal)

Etambutol (bacteriostatic)

Pyrazinamide (ineffective)

Against small population of tb slowly multiplying inside macrophage and low pH Pyrazinamide (most effective)

Isoniasid (ineffective)

Rifampicin (ineffective)

Streptomycin (ineffective)

Intermittently multiplying bacilli in solid caseous material

Only rifampin is active