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The Turkish Journal of Spinal Surgery is the official publication of the Turkish Spinal Surgery Society. The Turkish Spinal Surgery Society was established in 1989 in Izmir (Turkey) by the pioneering efforts of Prof. Dr. Emin Alıcı and other a few members. The objectives of the society were to: - establish a platform for exchange of information/ experience between Orthopedics and Traumatology Specialists and Neurosurgeons who deal with spinal surgery - increase the number of physicians involved in spinal surgery and to establish spinal surgery as a sophisticated medical discipline in Turkey - follow the advances in the field of spinal surgery and to communicate this information to members - organise international and national congresses, symposia and workshops to improve education in the field - establish standardization in training on spinal surgery - encourage scientific research on spinal surgery and publish journals and books on this field - improve the standards of spinal surgery nationally, and therefore make contributions to spinal surgery internationally. The Turkish Journal of Spinal Surgery is the official publication of the Turkish Spinal Surgery Society. The main objective of the Journal is to improve the level of knowledge and experience among Turkish medical society in general and among those involved with spinal surgery in particular. Also, the Journal aims at communicating the advances in the field, scientific congresses and meetings, new journals and books to its subscribers. The Turkish Journal of Spinal Surgery is as old as the Turkish Spinal Surgery Society. The first congress organized by the Society took place in Çeşme, Izmir, coincident with the publication of the first four issues. Authors were encouraged by the Society to prepare original articles from the studies presented in international congresses organized by the Society every two years, and these articles were published in the Journal. The Journal publishes clinical or basic research, invited reviews, and case presentations after approval by the Editorial Board. Articles are published after they are reviewed by at least two reviewers. Editorial Board has the right to accept, to ask for revision, or to refuse manuscripts. The Journal is issued every three months, and one volume is completed with every four issue. Responsibility for the problems associated with research ethics or medico-legal issues regarding the content, information and conclusions of the articles lies with the authors, and the editor or the editorial board bears no responsibility. In line with the increasing expectations of scientific communities and the society, improved awareness about research ethics and medico-legal responsibilities forms the basis of our publication policy. Citations must always be referenced in articles published in our journal. Our journal fully respects to the patient rights, and therefore care is exercised in completion of patient consent forms; no information about the identity of the patient is disclosed; and photographs are published with eye-bands. Ethics committee approval is a prerequisite. Any financial support must clearly be disclosed. Also, our Journal requests from the authors that sponsors do not interfere in the evaluation, selection, or editing of individual articles, and that part or whole of the article cannot be published elsewhere without written permission.

The Turkish Journal of Spinal Surgery is available to the members of the society and subscribers free of charge. The publication and distribution costs are met by membership fees, congresses, and the advertisements appearing in the journal. The advertisement fees are based on actual pricing. The Editorial Board has the right for signing contracts with one or more financial organizations for sponsorship. However, sponsors cannot interfere in the scientific content and design of the journal, and in selection, publication order, or editing of individual articles. The Turkish Journal of Spinal Surgery agrees to comply with the "Global Compact" initiative of the UN, and this has been notified to the UN. Therefore, VI our journal has a full respect to human rights in general, and patient rights in particular, in addition to animal rights in experiments; and these principles are an integral part of our publication policy

Recent advances in clinical research necessitate more sophisticated statistical methods, welldesigned research plans, and more refined reporting. Scientific articles, as in other types of articles, represent not only an accomplishment, but also a creative process. The quality of a report depends on the quality of the design and management of the research. Well-designed questions or hypotheses are associated with the design. Well-designed hypotheses reflect the design, and the design reflects the hypothesis. Two factors that determine the efficiency of a report are focus and shortness. Drawing the attention to limited number of subjects allows the author to focus on critical issues. Avoidance from repetitions (apart from a few exceptions), a simple language, and correct grammar are a key to preparing a concise text. Only few articles need to exceed 3000 words, and longer articles may be accepted when new methods are being reported or literature is being reviewed. Although authors should avoid complexity, the critical information for effective communication usually means the repetition of questions (or hypotheses or key subjects). Questions must be stated in Summary, Introduction and Discussion sections, and the answers should be mentioned in Summary, Results, and Discussion sections. Although many journals issue written instructions for the formatting of articles, the style of the authors shows some variance, mainly due to their writing habits. The Turkish Journal of Spinal Surgery adopts the AMA style as a general instruction for formatting. However, not many authors have adequate time for learning this style. Thus, our journal is tolerant to personal style within the limitations of correct grammar and plain and efficient communication.

Responsibility for the problems associated with research ethics or medico-legal issues regarding the content, information and conclusions of the articles lies with the authors, and the editor or the editorial board bears no responsibility. In line with the increasing expectations of scientific communities and the society, improved awareness about research ethics and medico-legal responsibilities forms the basis of our publication policy. Citations must always be referenced in articles published in our journal. Our journal fully respects to the patient rights, and therefore care is exercised in completion of patient consent forms; no information about the identity of the patient is disclosed; and photographs are published with eye-bands. Ethics committee approval is a prerequisite. Any financial support must clearly be disclosed. Also, our Journal requests from the authors that sponsors do not interfere in the evaluation, selection, or editing of individual articles, and that part or whole of the article cannot be published elsewhere without written permission.

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The Journal of Turkish Spinal Surgery (www.jtss.org), is the official publication of the Turkish Spinal Surgery Society. It is a peer-reviewed multidisiplinary journal for the physicians who deal with spinal diseases and publishes original studies which offer significant contributions to the development of the spinal knowledge. The journal publishes original scientific research articles, invited reviews and case reports that are accepted by the Editorial Board, in English. The articles can only be published after being reviewed by at least two referees and Editorial Board has the right to accept, revise or reject a manuscript. The journal is published once in every three months and a volume consists of four issues.

- The Journal of Turkish Spinal Surgery is published four times a year: on January, April, July, and October.

- Following types of manuscripts related to the field of "Spinal Surgery" with English Summary and Keywords are accepted for publication:

I- Original clinical and experimental research studies;
II- Case presentations; and
III- Reviews
The manuscript submitted to the journal should not be previously published (except as an abstract or a preliminary report) or should not be under consideration for publication elsewhere. Every person listed as an author is expected to have been participated in the study to a significant extent. All authors should confirm that they have read the study and agreed to the submission to the Journal of Turkish Spinal Surgery for publication. This should be notified with a separate document as shown in the "Cover Letter" in the appendix. Although the editors and referees make every effort to ensure the validity of published manuscripts, the final responsibility rests with the authors, not with the Journal, its editors, or the publisher. The source of any financial support for the study should be clearly indicated in the Cover Letter.

lt is the author's responsibility to ensure that a patient's anonymity be carefully protected and to verify that any experimental investigation with human subjects reported in the manuscript was performed upon the informed consent of the patients and in accordance with all guidelines for experimental investigation on human subjects applicable at the institution(s) of all authors. Authors should mask patients' eyes and remove patients' names from figures unless they obtain written consent to do so from the patients; and this consent should be submitted along with the manuscript. Clinically relevant scientific advances during recent years include use of contemporary outcome measures, more sophisticated statistical approaches, and increasing use and reporting of well-formulated research plans (particularly in clinical research). Scientific writing, no less than any other form of writing, reflects a demanding creative process, not merely an act: the process of writing changes thought. The quality of a report depends on the quality of thought in the design and the rigor of conduct of the research. Well-posed questions or hypotheses interrelate with the design. Well-posed hypotheses imply design and design implies the hypotheses. The effectiveness of a report relates to brevity and focus. Drawing the attention to a few points will allow authors to focus on critical issues. Brevity is achieved in part by avoiding repetition (with a few exceptions to be noted), clear style, and proper grammar. Few original scientific articles need to be longer than 3000 words. Longer articles may be accepted if substantially novel methods are reported, or if the article reflects a comprehensive review of the literature. Although authors should avoid redundancy, effectively communicating critical information often requires repetition of the questions (or hypotheses/key issues) and answers. The questions should appear in the Abstract, Introduction, and Discussion, and the answers should appear in the Abstract, Results, and Discussion sections. Although most journals publish guidelines for formatting a manuscript and many have more or less established writing styles (e.g., the American Medical Association Manual of Style), styles of writing are as numerous as authors. The Journal of Turkish Spinal Surgery traditionally has used the AMA style as a general guideline. However, few scientific and medical authors have the time to learn these styles. Therefore, within the limits of proper grammar and clear, effective communication, we will allow individual styles.

- **Permissions:** As shown in the example in the appendix (Letter of Copyright Transfer) the authors should declare in a separate statement that the study has not been previously published and is not under consideration for publication elsewhere. Also, the authors should state in the same statement that they transfer copyrights of their manuscript to our Journal. Quoted material and borrowed illustrations: if the authors have used any material INSTRUCTIONS TO AUTHORS XVI that had appeared in a copyrighted publication, they are expected to obtain written permission letter and it should be submitted along with the manuscript.

Review articles: The format for reviews substantially differs from those reporting original data. However, many of the principles noted above apply. A review still requires an Abstract, an Introduction, and a Discussion. The Introduction still requires focused issues and a rationale for the study. Authors should convey to readers the unique aspects of their reviews which distinguish them from other available material (e.g., monographs, book chapters). The main subject should be emphasized

in the final paragraph of the Introduction. As for an original research article, the Introduction section of a review typically need not to be longer than four paragraphs. Longer Introductions tend to lose focus, so that the reader may not be sure what novel information will be presented. The sections after the Introduction are almost always unique to the particular review, but need to be organized in a coherent fashion. Headings (and subheadings when appropriate) should follow parallel construction and reflect analogous topics (e.g., diagnostic categories, alternative methods, alternative surgical interventions). If the reader considers only the headings, the logic of the review (as reflected in the Introduction) should be clear. Discussion synthesizes the reviewed literature as a whole coherently and within the context of the novel issues stated in the Introduction. The limitations should reflect those of the literature, however, rather than a given study. Those limitations will relate to gaps in the literature which preclude more or less definitive assessment of diagnosis or selection of treatment, for example. Controversies in the literature should be briefly explored. Only by exploring limitations will the reader appropriately place the literature in perspective. Authors should end the Discussion by summary statements similar to those which will appear at the end of the Abstract in abbreviated form. In general, a review requires a more extensive literature review than an original research article, although this will depend on the topic. Some topics (e.g., osteoporosis) could not be comprehensively referenced, even in an entire monograph. However, authors need to ensure that a review is representative of the entire body of literature, and when that body is large, many references are required. -

-Original articles; should contain the following sections: "Title Page", "Summary", "Keywords", "Introduction", "Materials and Methods", "Results", "Discussion", "Conclusions", and "References". "Keywords" sections should also be added if the original article is in English.

Title (80 characters, including spaces): Just as the Abstract is important in capturing a reader's attention, so is the title. Titles rising or answering questions in a few brief words will far more likely do this than titles merely pointing to the topic. Furthermore, such titles as "Bisphosphonates reduce bone loss" effectively convey the main message and readers will more likely remember them. Manuscripts that do not follow the protocol described here will be returned to the corresponding author for technical revision before undergoing peer review. All manuscripts should be typed double- spaced on one side of a standard typewriter paper, leaving at least 2.5 cm. margin on all sides. All pages should be numbered beginning from the title page.

- Title page should include; a) informative title of the paper, b) complete names of each author with their institutional affiliations, c) name, address, fax and telephone number, e-mail of the corresponding author, d) address for the reprints if different from that of the corresponding author. It should also be stated in the title page that informed consent was obtained from patients and that the study was approved by the ethics committee. The "Level of Evidence" should certainly be indicated in the title page (see Table 1 in the appendix). Also, the field of study should be pointed out as outlined in Table 2 (maximum three fields).

- Summary: A150 to 250 word summary should be included at the second page. The summary should be in English for articles . The main topics to be included in Summary section are as follows: Background Data, Purpose, Materials- Methods, Results and Conclusion. The English versions of the Summary should be identical in meaning. Generally, an Abstract should be written after the entire manuscript is completed. The reason relates to how the process of writing changes thought and perhaps even purpose. Only after careful consideration of the data and a synthesis of the literature can author(s) write an effective abstract. Many readers now access medical and scientific information via Web-based databases rather than browsing hard copy material. Since the reader's introduction occurs through titles and abstracts, substantive titles and abstracts more effectively capture a reader's attention regardless of the method of access. Whether reader will examine an entire article often will depend on an abstract with compelling information. A compelling Abstract contains the questions or purposes, the methods, the results (most often quantitative data), and the conclusions. Each of these may be conveyed in one or two statements. Comments such as "this report describes..." convey little useful information.

- Key Words: Standard wording used in scientific indexes and search engines should be preferred. The minimum number for keywords is three and the maximum is five.

- Introduction (250 – 750 word): It should contain information on historical literature data on the relevant issue; the problem should be defined; and the objective of the study along with the problem solving methods should be mentioned. The Introduction, although typically is the shortest of sections, perhaps the most critical. The Introduction must effectively state the issues and formulate the rationale for those issues or questions. Its organization might differ somewhat for a clinical report, a study of new scientific data, or a description of a new method. Most studies, however, are published to: (1) report entirely novel findings (frequently case reports,

but sometimes substantive basic or clinical studies); (2) confirm previously reported work (eg, case reports, small preliminary series) when such confirmation remains questionable; and (3) introduce or address controversies in the literature when data and/or conclusions conflict. Apart from reviews and other special articles, one of these three purposes generally should be apparent (and often explicit) in the Introduction. The first paragraph should introduce the general topic or problem and emphasizet its importance, a second and perhaps a third paragraph should provide the rationale of the study, and a final paragraph should state the questions, hypotheses, or purposes. One may think of formulating rationale and hypotheses as Aristotelian logic (a modal syllogism) taking the form: If A, B, and C, then D, E, or F. The premises A, B, and C, reflect accepted facts whereas D, E, or F reflect logical outcomes or predictions. The premises best come from published data, but when data are not available, published observations (typically qualitative), logical arguments or consensus of opinion can be used. The strength of these premises is roughly in descending order from data to observations or argument to opinion. D, E, or F reflects logical consequences. For any set of observations, any number of explanations (D, E, or F) logically follows. Therefore, when formulating hypotheses (explanations), researchers designing experiments and reporting results should not rely on a single explanation. With the rare exception of truly novel material, when establishing rationale authors should generously reference representative (although not necessarily exhaustive) literature. This rationale establishes novelty and validity of the questions and places it within the body of literature. Writers should merely state the premises with relevant citations (superscripted) and avoid describing cited works and authors' names. The exceptions to this approach include a description of past methods when essential to developing rationale for a new method, or a mention of authors' names when important to establish historic precedent. Amplification of the citations may follow in the Discussion when appropriate. In establishing a rationale, new interventions of any sort are intended to solve certain problems. For example, new implants (unless conceptually novel) typically will be designed according to certain criteria to eliminate problems with previous implants. If the purpose is to report a new treatment, the premises of the study should include those explicitly stated problems (with quantitative frequencies when possible) and they should be referenced generously. The final paragraph logically flows from the earlier ones, and should explicitly state the questions or hypotheses to be addressed in terms of the study (independent, dependent) variables. Any issue not posed in terms of study variables cannot be addressed meaningfully. Focus of the report relates to focus of these questions, and the report should avoid questions for which answers are well described in the literature (e.g., dislocation rates for an implant designed to minimize stress shielding). Only if there are new and unexpected information should data be reported apart from that essential to answer the stated questions.

- Materials - Methods (1000-1500 words): Epidemiological/ demographic data regarding the study subjects; clinical and radiological investigations; surgical technique applied; evaluation methods; and statistical analyses should be described in detail. In principle, the Materials and Methods should contain adequate detail for another investigator to replicate the study. In practice, such detail is neither practical nor desirable because many methods will have been published previously (and in greater detail), and because long descriptions make reading difficult. Nonetheless, the Materials and Methods section typically will be the longest section. When reporting clinical studies authors must state approval of the institutional review board or ethics committees according to the laws and regulations of their countries. Informed consent must be stated where appropriate. Such approval should be stated in the first paragraph of Materials and Methods. At the outset the reader should grasp the basic study design. Authors should only briefly describe and reference previously reported methods. When authors modify those methods, the modifications require additional description. In clinical studies, the patient population and demographics should be outlined at the outset. Clinical reports must state inclusion and exclusion criteria and whether XVIII the series is consecutive or selected; if selected, criteria for selection should be stated. The reader should understand from this description all potential sources of bias such as referral, diagnosis, exclusion, recall, or treatment bias. Given the expense and effort for substantial prospective studies, it is not surprising that most published clinical studies are retrospective. Such studies often are criticized unfairly for being retrospective, but that does not negate the validity or value of a study. Carefully designed retrospective studies provide most of the information available to clinicians. However, authors should describe potential problems such as loss to follow-up, difficulty in matching, missing data, and the various forms of bias more common with retrospective studies. If authors use statistical analysis, a paragraph should appear at the end of Materials and Methods stating all statistical tests used. When multiple tests are used, authors should state which tests are used for which sets of data. All statistical tests are associated with assumptions, and when it is not obvious the data would meet those assumptions, the authors either should provide the supporting data (e.g., data are normally distributed, variances in groups are similar) or use alternative tests. Choice of level of significance should be justified. Although it is common

to choose a level of alpha of 0.05 and a beta of 0.80, these levels are somewhat arbitrary and not always appropriate. In the case where the implications of an error are very serious (e.g., missing the diagnosis of a cancer), different alpha and beta levels might be chosen in the study design to assess clinical or biological significance.

- Results (250-750 words): "Results" section should be written in an explicit manner, and the details should be described in the tables. The results section can be divided into sub-sections for a more clear understanding. If the questions or issues are adequately focused in the Introduction section, the Results section needs not to be long. Generally, one may need a paragraph or two to persuade the reader of the validity of the methods, one paragraph addressing each explicitly raised question or hypothesis, and finally, any paragraphs to report new and unexpected findings. The first (topic) sentence of each paragraph should state the point or answer the question. When the reader considers only the first sentence in each paragraph in Results, the logic of the authors'interpretations should be clear. Parenthetic reference to all figures and tables forces the author to textually state the interpretation of the data; the important material is the authors' interpretation of the data, not the data. Statistical reporting of data deserves special consideration. Stating some outcome is increased or decreased (or greater or lesser) and parenthetically stating the p (or other statistical) value immediately after the comparative terms more effectively conveys information than stating something is or is not statistically significantly different from something else (different in what way? the reader may ask). Additionally, avoiding the terms 'statistically different' or 'significantly different' lets the reader determine whether they will consider the statistical value biologically or clinically significant, regardless of statistical significance. Although a matter of philosophy and style, actual p values convey more information than stating a value less than some preset level. Furthermore, as Motulsky notes, "When you read that a result is not significant, don't stop thinking... First, look at the confidence interval... Second, ask about the power of the study to find a significant difference if it were there." This approach will give the reader a much greater sense of biological or clinical significance.

- Discussion (750 - 1250 words): The Discussion section should contain specific elements: a restatement of the problem or question, an exploration of limitations and assumptions, a comparison and/or contrast with information (data, opinion) in the literature, and a synthesis of the comparison and the author's new data to arrive at conclusions. The restatement of the problem or questions should only be a brief emphasis. Exploration of assumptions and limitations are preferred to be next rather than at the end of the manuscript, because interpretation of what will follow depends on these limitations. Failure to explore limitations suggests the author(s) either do not know or choose to ignore them, potentially misleading the reader. Exploration of these limitations should be brief, but all critical issues must be discussed, and the reader should be persuaded they do not jeopardize the conclusions. Next the authors should compare and/or contrast their data with data reported in the literature. Generally, many of these reports will include those cited as rationale in the Introduction. Because of the peculiarities of a given study the data or observations might not be strictly comparable to that in the literature, it is unusual that the literature (including that cited in the Introduction as rationale) would not contain at least trends. Quantitative comparisons most effectively persuade the reader that the data in the study are "in the ballpark," and tables or figures efficiently convey that information. Discrepancies should be stated and explained when possible; when an explanation of a discrepancy is not clear that also should be stated. Conclusions based solely on data in the paper seldom are warranted because the literature almost always contains previous information. The quality of any reXIX port will depend on the substantive nature of these comparisons. Finally, the author(s) should interpret their data in the light of the literature. No critical data should be overlooked, because contrary data might effectively refute an argument. That is, the final conclusions must be consistent not only with the new data presented, but also that in the literature.

- Conclusion: The conclusions and recommendations by the authors should be described briefly. Sentences containing personal opinions or hypotheses that are not based on the scientific data obtained from the study should be avoided.

- References: Care must be exercised to include references that are available in indexes. Data based on personal communication should not be included in the reference list. References should be arranged in alphabetical order and be cited within the text; references that are not cited should not be included in the reference list. The summary of the presentations made at Symposia or Congresses should be submitted together with the manuscript. The following listing method should be used. References should derive primarily from peer-reviewed journals, standard textbooks or monographs, or well-accepted and stable electronic sources. For citations dependent on interpretation of data, authors generally should use only high quality peer-reviewed sources. Abstracts and submitted articles should not be used because many in both categories ultimately do not pass peer review. They should be listed at the end of the paper

in alphabetical order under the first author's last name and numbered accordingly. If needed, the authors may be asked to provide and send full text of any reference. If the authors refer to an unpublished data, they should state the name and institution of the study, Unpublished papers and personal communications must be cited in the text. For the abbreviations of the journal names, the authors can apply to "list of Journals" in Index Medicus or to the address "http://www.nlm.nih.gov/tsd/serials/lji.html".

Journal article:
Berk H, Akçalı Ö, Kıter E, Alıcı E. Does anterior spinal instrument rotation cause rethrolisthesis of the lower instrumented vertebra? *J Turk Spin Surg* 1997; 8 (1): 5-9.

Book chapter: Wedge JH, Kirkaldy-Willis WH, Kinnard P. Lumbar spinal stenosis. Chapter-5. In: Helfet AJ, Grubel DM (Eds.). *Disorders of the Lumbar Spine*. JB Lippincott, Philadelphia 1978; pp: 61-68.

Entire book:
Paul LW, Juhl JH (Eds.). *The Essentials of Roentgen Interpretation*. Second Edition. Harper and Row, New York 1965; pp: 294-311.

Book with volume number:
Stauffer ES, Kaufer H, Kling THF. Fractures and dislocations of the spine. In: Rockwood CA, Green DP (Eds.). *Fractures in Adults*. Vol. 2, JB Lippincott, Philadelphia 1984; pp: 987-1092.

Journal article in press:
Arslantaş A, Durmaz R, Coşan E, Tel E. Aneurysmal bone cysts of the cervical spine. *J Turk Spin Surg* (In press).

Book in press:
Condon RH. Modalities in the treatment of acute and chronic low back pain. In: Finnison BE (Ed.). *Low Back Pain*. JB Lippincott, Philadelphia (In press).

Symposium:
7. Raycroft IF, Curtis BH. Spinal curvature in myelomeningocele: natural historyand etiology.*Proceedings of the American Academy of Orthopaedic Surgeons Symposium on Myelomeningocele* . Hartford, Connecticut, 5th November 1970. CV Mosby, St. Louis 1972; pp: 186-201.

Papers presented at the meeting:
8. Rhoton AL. Microsurgery of the Arnold-Chiari malformation with and without hydromyelia in adults. Presented at the *Annual Meeting of the American Association of Neurological Surgeons*, Miami, Florida, April 7, 1975. 1975

- Tables: They should be numbered consecutively in the text with Arabic numbers. Each table with its number and title should be typed on a separate sheet of paper. Each table must be able to stand alone; all necessary information must be contained in the caption and the table itself so that it can be understood independent from the text. Information should be presented explicitly in "Tables" so that the reader can obtain a clear idea about its content. Information presented in "Tables" should not be repeated within the text. If possible, information in "Tables" should contain statistical means, standard deviations, and t and p values for possibility. Abbreviations used in the table should be explained as a footnote. Tables should complement not duplicate material in the text. They compactly present information, which would be difficult to describe in text form. (Material which may be succinctly described in text should rarely be placed in tables or figures.) Clinical studies for example, of ten contain complementary tables of demographic data, which although important for interpreting the results, are not critical for the questions raised in the paper. Well focused papers contain only one or two tables or figures for every question or hypothesis explicitly posed in the Introduction section. Additional material may be used for unexpected results. Well constructed tables are self-explanatory and require only a title. Every column contains a header with units when appropriate.

- Figures: All figures should be numbered consecutively throughout the text. Each figure should have a label pasted on its back indicating the number of the figure, an arrow to show the top edge of the figure and the name of the first author. Black-and-white illustrations should be in the form of glossy prints (9x13 cm). The letter size on the figure should be large enough to be readable after the figure is reduced to its actual printing size. Unprofessional typewritten characters are not accepted. Legends to figures should be written on a separate sheet of paper after the references. The journal accepts color figures for publication if they enhance the article. Authors who submit color figures will receive an estimate of the cost for color reproduction. If they decide not to pay for color reproduction, they can request that the figures be converted to black and white at no charge. For studies submitted by electronic means, the figures should be in jpeg and tiff formats with a resolution greater than 300 dpi. Figures should be numbered and must be cited in the text

- Style: For manuscript style, American Medical Association Manual of Style (9th edition). Stedman's Medical Dictionary (27th edition) and Merriam Webster's Collegiate Dictionary (10th edition) should be used as standard references. The drugs and therapeutic agents must be referred by their accepted generic or chemical names,

without abbreviations. Code numbers must be used only when a generic name is not yet available. In that case, the chemical name and a figure giving the chemical structure of the drug should be given. The trade names of drugs should be capitalized and placed in parentheses after the generic names. To comply with trademark law, the name and location (city and state/country) of the manufacturer of any drug, supply, or equipment mentioned in the manuscript should be included. The metric system must be used to express the units of measure and degrees Celsius to express temperatures, and SI units rather than conventional units should be preferred. The abbreviations should be defined when they first appear in the text and in each table and figure. If a brand name is cited, the manufacturer's name and address (city and state/country) must be supplied. The address, "Council of Biology Editors Style Guide" (Council of Science Editors, 9650 Rockville Pike, Bethesda, MD 20814) can be consulted for the standard list of abbreviations.

Dear Colleagues,

We sincerely wish the happy and healthy New Year to all my colleagues and their families. We are happy to accomplish the first issue of 2018.

There are 7 clinical research articles in this issue. The first article are about the relation between lumbar degenerative disc disease and human 8-hydroxydeoxyguanosine (8-ohdg) serum level. In the second article, the effect of apical rotation to the trunk balance and shoulder asymmetry is reported. Third is also about the results of global derotation maneuver in the surgical treatment of adolescent scoliosis. In the fourth article, the results of the root retraction or sacrification of the nerve root of the patients with thoracolumbar burst fracture is presented. In the fifth study, 2-year results of Nubac™ disc arthroplasty system are discussed. Sixth study is about the infections after algological posterior paravertebral injections. In the last study, analyze the surgeries for cervical degenerative disc disease with anterior approach in a year was reported.

In this issue, five case reports are presented. In the first and second case, reports are about hematoma of ligamentum flavum with tumor like lesion during anticoagulant therapy and epidural area with neurologic deficit. Third is about perioperative cardiac arrest of a young male during Scheuermann's kyphosis operation In the fourth case report, lumbar spinal aspergillus abscess in an immunocompetent patient is reported. Last one is surgical treatment of mesenchymal chondrosarcoma originated thoracolumbar spine.

Unfortunately, in this issue, there is no section of the "Frontiers of the Spinal Surgery" but we will continue this section in the next issue.

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

Prof. Dr. İ. Teoman BENLİ
JTSS Editor

EDITORIAL

ORIGINAL ARTICLE

BASIC SCIENCE

IDIOPATHIC SCOLIOSIS

SPINAL TRAUMA

DISC ARTHROPLASTY

SPINAL INFECTION

CERVICAL DEGENERATIVE DISC DISEASE

CASE REPORTS

Volume: 29, Issue: 1, January 2018 pp: 1-3 ORIGINAL ARTICLE

RELATION BETWEEN LUMBAR DEGENERATIVE DISC DISEASE AND HUMAN 8-HYDROXYDEOXYGUANOSINE (8-OHDG) SERUM LEVEL

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***There is no conflict of interest between authors.**

ABSTRACT

Aim: Lumbar degenerative disc disease (LDDD) identified as multifactorial, irreversible and degenerative discopathy. The 8-hydroxy-2 deoxyguanosine (8-OHdG) is a nucleoside oxidation of DNA marker of oxidative stress. Present study aim to investigate 8-OHdG levels in patient with LDDD as a marker of oxidative stress.

Material and Methods: The study group included 45 patients with LDDD and 49 healthy individuals for control group. Patients with LDDD were examined with lumbar Magnetic Resonance Imaging (MRI), Oswestry Disability Index (ODI) scores, Visual Analoge Scale (VAS) scores and neurogical examination. Serum 8-OHdG levels determined with The Enzyme-Linked Immunosorbent Assay (ELISA) method.

Results: Patients with LDDD had significantly increased levels of 8-OHdG than healthy control group ($p<0.0001$). Also there was positive correlation between Oswestry and VAS parameters and 8-OHdG serum levels ($p<0.0001$).

Conclusion: In this study evaluated the 8-OHdG serum levels in the risk of LDDD. Increased 8-OHdG serum levels were having negative impact on severity of LDDD.

Keywords: 8-OHdG, Lumbar degenerative disc disease, oxidative damage

Level of Evidence: Prospective case-control study, Level II

INTRODUCTION

Lumbar degenerative disc disease (LDDD) being significantly associated with non-specific low back pain (LBP) and generally lead to reduced physical activity and decreased quality of life. LDDD is a mechanical and irreversible dysfunction and also identified as degenerative process with multifactorial factors [(2)].

The numerous evidences have been displayed that oxidative stress induced damage play important role in pathogenesis of degenerative disorders [(4)]. Reactive oxygen species (ROS) cause severe damage to cellular macromolecules such as DNA. DNA damage is detected by sensor proteins and in irreparable circumstances it give rise to cell cycle arrest or the activation of apoptotic pathways. The 8-hydroxy-2 deoxyguanosine (8-OHdG) and 8-hydroxyguanosine (8-OHG) are the most important products of nucleotide oxidation [(5)].

Therefore, in this study, we aimed to investigate the association between 8-OHdG serum levels and development or prognosis of LDDD.

MATERIAL AND METHODS

Study population

Our study was a prospective case-control study included 45 patients with lumbar degenerative disc disease and 49 healthy individuals for control group. The clinical data of the patients were recorded and followed-up prospectively. All partipiciants were recruited from Neurosurgery Department. Clinical investigations of LDDD patients were determined according to neurological examination, lumbar magnetic resonance imaging (MRI) studies, visual analog scale (VAS) scores to define pain level and Oswestry disability index (ODI) scores. Demographic characteristics of patients and controls were collected from hospital records. Inclusion criteria were leg pain

and low back pain as a result of lumbar radiculopathy and lumbar intervertebral disc protrusion diagnosed on MRI. Exclusion criteria were traumatic patients, oncological pathologies, osteoporosis, spinal stenosis, spondylolisthesis, vertebral fractures and deformities of spine.

All patients were questioned for the level of pain and scored with VAS and questioned with ODI for quality of life analyze. Subject cob stent was obtained in agreement with the Declaration of Helsinki and the local ethic committee and informed consent forms from all patients was provided.

Biochemical assays

Serum samples were extracted and frozen at -20 °C. In the serum samples 8-OHdG levels were determined by enzyme-linked immunosorbent (ELISA) assay.

Statistical analysis

Statistical analysis were performed using SPSS Ver. 23 software (SPSS Inc, Chicago, IL, USA). The significant difference between groups were examined by Student's t-test and demographic information were compared by Chi square and Fisher's exact tests, $p<0.05$ denoted as statistically significant.

RESULTS

The analysis included 45 LDDD patients and 49 controls. Demographic characteristics of the two groups and mean values of VAS and ODI scores are displayed in Table-1 and Figure-1.

The mean age of the patients with LDDD and healthy control group were 37.29 ± 8.30 and 34.98 ± 4.47 years, respectively. There were no significant differences between LDDD and control groups in terms of median age ($p=0.074$). The frequency of gender was 46.7 % male and 53.3 % female for patients; 38.8 % male and 61.2 % female for controls. There were no significant difference with genders ($p=0.044$).

The serum levels of 8-OHdG determined in this study, 8-OHdG levels of patient group was 10.30±4.37 ng/ml and control group was 5.24±4.52 ng/dl. The patient group had significantly higher 8-OHdG levels compared to the control group ($p<0.0001$).

Another important outcome of present study was we determined that there was positive correlation between Oswestry and 8-OHdG serum levels ($p<0.001$) (Figure 2).

Increase in 8-OHdG serum levels were significantly parallel with Oswestry. Moreover there were positive correlation between VAS and 8-OHdG serum levels ($p<0.001$) (Figure-3).

Table-1. Demographic Characteristics of Patient and Control Groups

Parameter	Control (n=49)	LDDD (n=45)	p-Value
Age (Mean±SD)	34.98±4.47	37.29±8.30	0.074
Gender (Male/Female)	19/30	21/24	0.44
VAS (Mean±SD)	-	48.92±19.79	-
Owestry (Mean±SD)	-	64.90±23.01	-

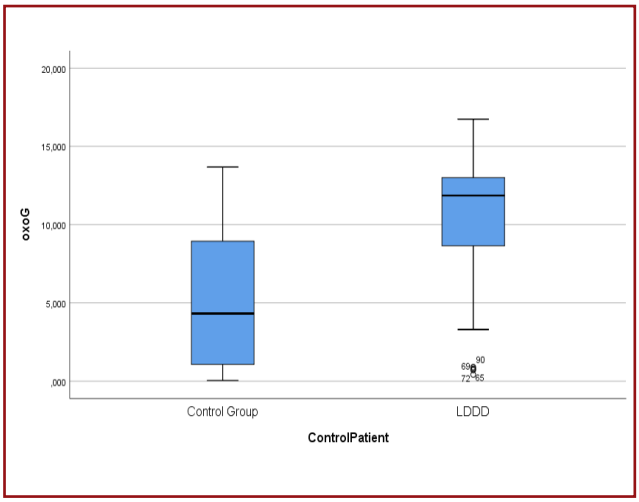

Figure-1. 8-OHdG Serum Levels

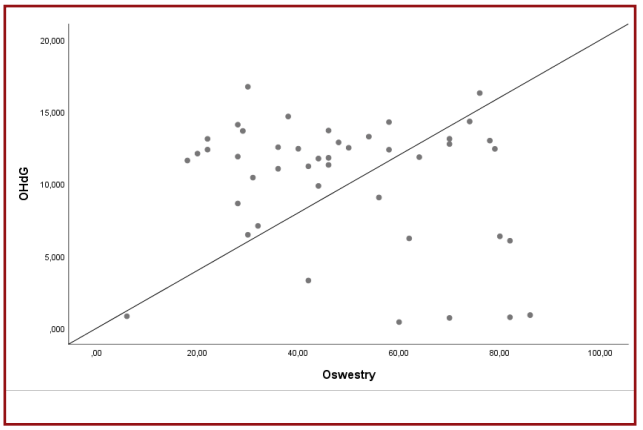

Figure-2. Correlation graphic of 8-OHdG serum levels and Oswestry

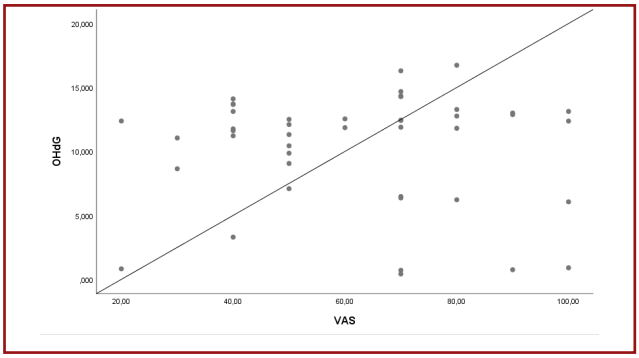

Figure-3. Correlation graphic of 8-OHdG serum levels and VAS

DISCUSSION

LDDD is the most common cause of low back pain (LBP) and sciatica costing millions to the economy each year [1]. The degenerative process is identified as multifactorial, irreversible and associated with a mechanical dysfunction. LDDD is a condition which has prevalence of which may be as much as 80% with rate of an annual prevalence of 25–60 % [6].

The oxidative stress, as the cellular redox status, is established by the balance between the rates of production and breakdown of reactive oxygen species (ROS) [7]. Recent studies have also reported that the oxidative stress was associated with disc degeneration. Over production of ROS could directly damage the intervertebral disc cells and irritate the disc matrix homeostasis, including reduced proteoglycan synthesis and increased matrix metalloproteinase levels [3]. Evidence of oxidative stress exists in disc degeneration, but it is unclear how it affects disc metabolism. Another study revealed that oxidative stress, resulting from overproduction of ROS, was implicated in Intervertebral disc degeneration (IDD) by inducing premature senescence, promoting catabolic metabolism, and causing the apoptosis of intervertebral disc cells [9].

The relationship between oxidative stress and disc degeneration is complicated. Han et al (2017) determined oxidative stress pathways in apoptosis. It has been demonstrated that oxidative stress has a crucial role in programmed cell death and oxidative stress could induce apoptosis in cartilaginous endplate cells. They found that oxidative stress induced by molecules increased the apoptosis and subsequently the calcification in the cartilage cells. While decreased oxidative stress species were advantageous for the survival of cells and also it could delay the physiopathology of disc degeneration [8].

The biomarkers of oxidative damage reflecting the disease risk or severity could be detectable in body fluids such as serum. In present study we evaluated 8-OHdG serum levels as a marker of oxidative stress in LDDD. Another study conducted by Gmitterova et al (2009). They analyzed 8-OHdG levels in neurodegenerative disorders as degeneration marker. They suggested that 8-OHdG levels in cerebrospinal fluid could be use for diagnostic biomarker [10].

CONCLUSION

To the best of our knowledge, this is the first study to evaluate the 8-OHdG serum levels in LDDD. We observed that patients with LDDD had significantly increased 8-OHdG serum levels than healthy controls. Furthermore positive correlations between 8-OHdG serum levels and clinical parameters showed that enhanced 8-OHdG serum levels were having negative impact on severity of LDDD.

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Volume: 29, Issue: 1, January 2018 pp: 5-11 ORIGINAL ARTICLE

THE EFFECT OF PRE-AND POSTOP APICAL VERTEBRA ROTATION ON THE SHOULDER BALANCE AND SRS22-R SCORES IN ADOLESCENT IDIOPATHIC SCOLIOSIS

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ABSTRACT

Objective: To investigate the association between shoulder imbalance and AVR (apical vertebrae rotation) with AVR related ratios and how these radiological parameters effects patients postoperative functional and cosmetic outcomes by using SRS-22r scoring system.

Methods: Adolescent Idiopathic scoliosis patients (n: 48) treated with posterior spinal surgery and followed up for more than 1 years were evaluated retrospectively. The rotation angle of the apical vertebra was measured using Drerup's AVR measuring method in coronal plane radiograph. AVR improvement rate were calculated. Preoperative and postoperative follow-up shoulder balances were assessed by measuring CTAD (clavicular tilt angle difference) in the standing graphs.

Results: According to the Pearson Correlation test there was a statistically mild negative correlation between postoperative shoulder balance and age of operation. There was an inverse moderate correlation between early postoperative apical vertebral rotation and postoperative shoulder balance. According to other tests (Benferroni ve Pillai's Trace), AVR of patients with shoulder imbalance seems to have not improved in the postoperative period. Shoulder imbalance was found to be statistically significant in patients with poorly corrected postoperative AVR. Patients with good shoulder balance appeared to be composed of patients who showed better AVR recovery significantly in the early postoperative period.

Conclusion: Using early postoperative AVR recovery in evaluating the surgical outcomes of patients with adolescent idiopathic scoliosis and the evaluation of follow-up progression may provide important contributions to orthopedic surgery. Nevertheless, there is a need for large populations and long follow-up studies to support this thinking.

Key words: SRS-22r, Adolescent Idiopathic Scoliosis, shoulder balance, pain score, Lenke, Apical Vertebrae Rotation

Level of Evidence: Retrospective clinic study, Level III

INTRODUCTION

The main purpose of surgical treatment for idiopathic scoliosis patients is to establish natural cosmesis and improve self-image. The success of surgical treatment is assessed with radiographic parameters and functional outcomes. Generally, patients are satisfied with a balanced spine, well-corrected rib hump, and balanced shoulders after the surgery.

Although it is very important to provide subjective shoulder balance, it is difficult to evaluate and perform it by using conventional surgical methods. For this reason, radiographic shoulder balance is often used instead of subjective shoulder balance and is also considered as a critical parameter when judging the success of corrective surgery. Although there are many studies investigated several factors related to postoperative shoulder imbalance, no definite conclusions have been made. Also a few studies have investigated relationship between AVR and AVR related ratios with shoulder imbalance in the literature. In these studies no definite conclusions have been made too [1,6]. Therefore, we aimed to investigate the association between shoulder imbalance and AVR with AVR related ratios.

During this investigation we used SRS-22r scoring system as a patient related

evaluating system to investigate how these radiological parameters effects patients postoperative functional outcomes, cosmetic outcomes and their opinion.

PATIENTS AND METHODS

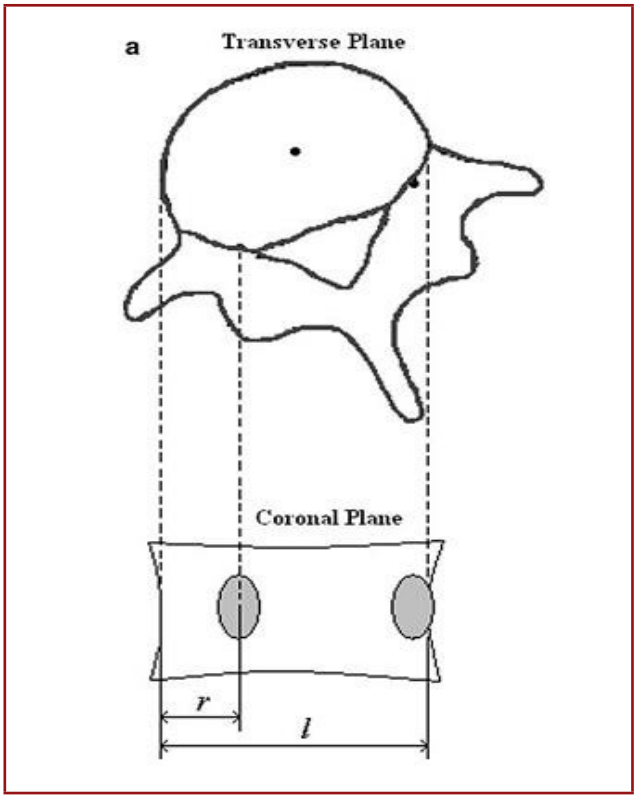
Adolescent Idiopathic scoliosis (AIS) patients (n: 48) who were treated with posterior spinal surgery and followed up for more than 1 years (13-55 months) and completed the SRS-22r outcomes questionnaire were evaluated retrospectively. There were 11 males and 37 females, ranging in age from 11 to 20 years with a mean age of 14.8 years at the time of surgery. We classified the patients' scoliotic curvatures by using Lenke classification system. The distribution of patients according to Lenke Classification system is shown in **Table-1**.

Posterior reduction and fusion was applied all of the patients by three different surgeons. In 36 patients polyaxial screw-rod system, in 8 patients polyaxial pedicle screw-rod system and polyester sub laminar clamp combination and in 4 patients polyaxial pedicle screw-rod system and pedicle or sub laminar hook combination was used. Selective posterior fusion was applied 46 of the 48 patients. Implantation was not extended to a level higher than T3 at any of the patients.

The rotation angle of the apical vertebra was measured by using Drerup's apical vertebra rotation measuring method in coronal plane radiographs **(Figure-1)**. In this formula 'r' indicates the distance between lateral border of the vertebra and the center of the pedicle which exists at convex side of the scoliotic curvature. The symbol 'l' indicates the length of horizontal border of the vertebral corpus (18). For the patients whose apex come across to a disc space, we separately calculated the AVR values of the vertebrae above and below the apical disc space. After these calculations the largest value was used for statistical examination. AVR recovery rate was calculated according to the following formula using pre- op and follow-up AVR values.

Preoperative and postoperative follow-up shoulder balances were assessed by measuring CTAD (clavicular tilt angle difference) in the standing graphs **(Figure-2)**. The reason of choosing this measurement method was that it is the most accurate method of measuring shoulder balance in standing ortho-radiographs in which both shoulders were not visible like our retrospectively evaluated patients. Patients with a clavicular tilt angle difference greater than 4.5 degrees were considered to have an unstable shoulder balance. The clavicular tilt angle is the angle between the horizontal plane and the line drawn along the proximal contour of the clavicle. Shoulder balance is negative for the patients whose right shoulder is high and it is positive for the patients whose left shoulder is high [1].

All patients were investigated by using SRS-22r scoliosis patient evaluation questionnaire for clinical evaluation [2]. According to the answers given to this questionnaire, scoring was done on subjects such as function, pain, external appearance, mental health and satisfaction after surgical treatment. These scores were noted for each patient. The average score, which evaluates patient's clinical scores, totally was also calculated and used in the study.



AVR= ((r/l) x 100) – 10
AVR improvement rate (%) = [(Pre-op AVR – follow-up AVR value) / Pre-op AVR)] X 100

Figure-1. Drerup's apical vertebra rotation measuring method [9,30].

Table-1. Distribution of patients according to Lenke Classification system

	A			B			C		
	(+)	(-)	N	(+)	(-)	N	(+)	(-)	N
I	1		12	3	2	7			6
II	1	2		1	1				
III	1			1					
IV									1
V									5
VI							1		3

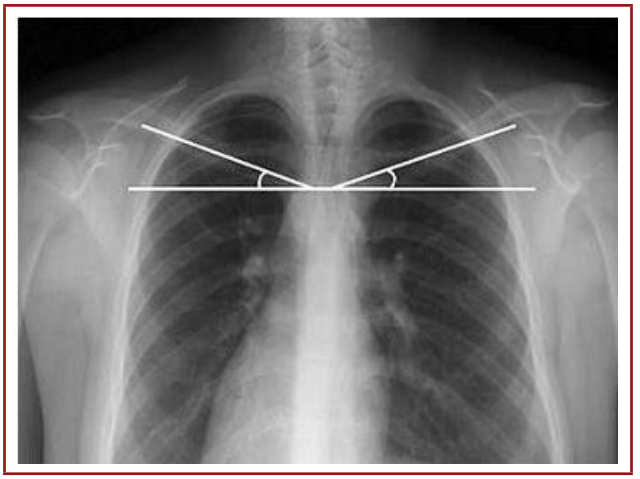


Figure-2. Clavicular tilt angle measuring [1]

RESULTS

None of the patients had pseudarthrosis and paralysis. None of the patients experienced complication due to primary instrumentation. The average time from surgery to last follow-up was 34.6 months (range, 13–55 months).

When the patients were evaluated according to their CTAD values, 18 (37.5 %) had normal shoulder balance and 30 (62.5 %) had shoulder imbalance before the surgical treatment. At the last follow-up, 33 (68.75 %) of the 48 patients had good shoulder balance and 15 patients (21.25 %) had shoulder imbalance.

Seven of 18 patients (38.9 %) who had normal shoulder balance before surgery had shoulder imbalance at the last follow-up. Twenty-one (70 %) of 30 patients with preoperative shoulder imbalance had normal shoulder balance at the last follow-up.

The mean preoperative AVR (apical vertebral rotation) of the patients was 18.64 (0-45) degrees. Mean postoperative AVR value was 17.05 (2-40) and mean last follow-up AVR value was 14.51 (0-31).

The mean last follow-up AVR recovery rate of patients was 21.9% (0-75). Nineteen of the patients (39.6 %) were found to have no improvement in apical vertebral rotation at the last follow-up.

Clinical outcomes of the patients were assessed by Scoliosis Research Society (SRS-22r) questionnaire. Patients were evaluated as having the highest score 5 and the lowest score 1 for each subject and for total score on this questionnaire. Patients descriptive data analysis according to the response to SRS scoliosis patient questionnaire is shown in **Table-2**.

Pearson correlation test was used to statistically analyze the relationship between clinical and radiological outcomes with preoperative, early postoperative, and last follow-up radiological results. SRS questionnaire total score and other domains presents in the SRS questionnaire like activity-function, pain, external appearance, psychological status and treatment satisfaction were not statistically correlated with parameters such as age of operation, preoperative AVR and AVR recovery rate.

Preoperative AVR and AVR recovery rate parameters did not show a significant correlation with SRS- 22r scores according to Pearson Correlation Test.

According to the Pearson Correlation Test, there was a statistically mild negative correlation between postoperative shoulder balance and age of operation (r: -0,302) (better shoulder balance in younger patients).

There was an inverse moderate correlation between early postoperative apical vertebral rotation and postoperative shoulder balance (r: -0.426). There was a slight correlation between postop AVR improvement rate and postop shoulder balance in the same direction (r: 0.289). There was a negative correlation between the amount of last follow-up AVR and the SRS satisfaction score at the end of follow-up (r: -0, 290).

We performed repeated measured analysis by using general linear samples in order statistically to evaluate treatment outcome by using repeated measured radiological parameters analysis including subjective factors. We performed Pillai's Trace test by including subjective factors to these measures. Benferroni Test was performed in binary comparisons. According to these tests, AVR of patients with shoulder imbalance seems to have not improved in the postoperative period. Shoulder imbalance was statistically significant in patients with poorly corrected postoperative AVR. Patients who showed better AVR recovery significantly in the early postoperative period were also patients with good shoulder balance (statistically significant).

Table-2. Descriptive data analysis table arranged according to the patients' response to SRS scoliosis patient questionnaire

	N	Minimum	Maximum	Mean	Std. Deviation
FUNCTION	48	2.6	5.0	5.0	3.747
PAIN	48	2.2	5.0	5.0	4.141
APPEARANCE	48	1.2	4.8	4.8	3.583
MENTAL HEALTH	48	2.2	5.0	5.0	3.494
SATISFACTION	48	2	5	5	4.29
TOTAL	48	2.52	4.73	4.73	3.7979
Valid N (listwise)	48				

DISCUSSION

Adolescent idiopathic scoliosis is accepted as the most common spinal deformity. Efforts for better understanding and analyzing this structure have accelerated with the beginning of the understanding of the three-dimensional structure of the scoliosis. A number of new and effective radiological measurement methods and parameters have been widely used day by day for evaluating AIS with these improvements.

The most important factors determining success in scoliosis surgery are providing patient satisfaction, correcting rib hump and maintaining postoperative shoulder balance. Edgar and Mehta reported that among scoliosis patients who were depressed or insecure, rib prominence and asymmetry were reported as the most concerning deformity related factors [11]. Therefore, a number of studies have been carried out to determine the radiological parameters that will lead to the postoperative stabilization of the shoulder balance. The variability of findings in previous research attests to the challenges of defining, measuring, and correcting shoulder imbalance [10].

In this study, we aimed to determine whether parameters such as apical vertebra rotation and AVR recovery rate measured in the preoperative and postop period affect the shoulder balance and SRS-22r clinical scoring system in the postoperative period.

When we evaluate the studies done, we can see that the shoulder balance is handled in two group as clinical and radiological shoulder balance. Actually when we look at the anatomy of the shoulder, there is no direct contact between the spine and the shoulder [10]. This makes it difficult to understand the relationship between scoliosis and deterioration of the shoulder balance. This also prevents the development of radiologic parameters that will facilitate the work of surgeons to establish shoulder balance after scoliosis treatment, or to evaluate treatment efficacy. In addition the definition of PSI (postoperative shoulder imbalance) has not been clearly established before [18]. Additionally Akel et al. [1] showed that shoulder imbalance is also common in the normal population without scoliosis.

Subjective shoulder balance is most important, but it is hard to evaluate and achieve using conventional surgeries. In addition clinical shoulder imbalance does not correlate with radiographic shoulder imbalance [18]. Thus, radiographic shoulder balance is frequently evaluated instead of subjective shoulder balance and is considered a critical consideration when judging the success of corrective surgery [18]. It is not clear how shoulder imbalance can be measured accurately, but several studies have reported the effectiveness of various methods [12,20,29]. These reasons prevent to develop effective parameters for establishing postoperative shoulder balance.

Kuklo and colleagues reported that there is no objective measurement tool for clinical evaluation of the shoulder balance [14]. They also showed that clavicle angle was the most reliable parameter indicating shoulder balance and they mentioned upright proximal thoracic, or side-bending proximal thoracic Cobb, provided the best preoperative radiographic prediction of postoperative shoulder balance [14,15].

In another study, the best radiographic predictor of postoperative shoulder balance following posterior or anterior spinal fusion has not yet been determined [24]. Again, at the same study they found that the clavicle angle was the best predictor, reaching statistical significance and they mentioned the next best predictor was coracoid height [24]. Kwan et al reported that shoulder imbalance correlated with coracoid height difference (CHD), clavicle\rib intersection distance (CRID), clavicle angle (CA), radiographic shoulder height (RSH), T1 tilt and cervical axis [16].

In another study shoulder imbalance is found associated with T1 tilt, pre-operative shoulder height, first rib inclination, coracoid height difference, clavicle angle, radiological shoulder height, clavicle\rib intersection distance and pre-operative proximal thoracic (PT) curve [4,12]. There are, however, many studies suggesting that T1 tilt is not effective in determining shoulder balance.

In recent years, Ono et al. reported the concept of medial and lateral shoulder imbalance. Medial shoulder imbalance is produced by trapezius bulkiness. The lateral shoulder measurements were defined by the clavicle angle (CA). The position of the proximal spine as measured by T1 tilt, first rib angle, and proximal thoracic Cobb does not correlate well with lateral shoulder balance [20]. These measures correlate better with the medial trapezoidal prominence.

The fact that shoulder imbalance is also present in patients without scoliosis. Identification and measurement of shoulder imbalance has its own difficulties and lack of certain parameters that confirm this antiquity have created many difficulties to us about choosing parameters to use in our work. For these reasons, it become harder for us and for other authors to choose which parameters to use in their studies and for our study. Including all these facts, we used the CTAD, which is the most compatible with the clavicle angle that is the most correlated parameter with shoulder balance in the literature and provide the most accurate measurement of the shoulder balance in standing ortho-radiographs [1].

Rotation of apical vertebrae is primarily responsible for the thoracic cage deformity (rib hump) that represents one of the main cosmetic problems for scoliotic patients [21]. In our study, we evaluated the effects of this parameter on shoulder balance but many aspects are still open to debate. For instance, accuracy of radiographic measurements of vertebral rotation varies different studies [23]. Computed tomography gives the most exact information [17,28] but it is difficult to perform computed tomography for all patients. And it has high radiation exposure. For this reason, it is preferable to make measurements on plain radiographs in the routine.

There are also disadvantages of radiography measurement. Patient positioning during the X-ray may influence apical vertebral rotation measurement. This measurement is graded on an ordinal scale and may not be sensitive in detecting

smaller differences; although, this may not be clinically significant [8].

It can be difficult to evaluate and measure AVR after spinal instrumentation that covers osseous landmarks on standard X-rays [22-23]. The impact of AVR correction on the overall surgical outcome, that is, patients' satisfaction in the short term, was not proven [13].

Chang et al reported that AVR, AVT, and Cobb magnitude, as well as their respective ratios, did not, in fact, predict which patients would require surgery or have marginally acceptable outcomes [6].

In a study for the clinical evaluation of scoliosis patients Bengtsson et al [5] found that patients with severe scoliosis were characterized by insecurity and hypersensitivity, and that their psychosocial adjustment was negatively correlated with the severity of their deformity. In time, SRS scoring system was improve and started to be used in evaluating patient's preoperative perceptions about themselves and their postoperative outcomes. The SRS instrument is the only standard, well validated, disease-specific questionnaire for idiopathic scoliosis, and many authors think that the instrument is very useful despite culture-related differences in perception of the patient [3,25].

There are different SRS scoring instruments like SRS-24, SRS-30 and SRS-22r. The choice of SRS scoring system differs from country to country in routine use but main titles like function, pain, external appearance, mental health, and satisfaction with treatment doesn't differs.

In a study, D'Andrea *et al* examined 78 patients treated with anterior or posterior instrumentation with a minimum 2-year follow-up using the SRS-24 questionnaire, and reported little correlation between the radiographic assessment and the SRS-24 questionnaire scores [7]. In many studies self-image and patient satisfaction have been found to be associated with clinical deformity [5,10,19].

Wilson *et al* examined 265 patients in a multicenter study at 7 scoliosis centers and reported that coronal measures of thoracic and lumbar curve were correlated with the pain, self-image, and total SRS-24 scores (P 0.0001) [26].

Watanabe et al reported that of the scores of the individual SRS-24 domains and radiographic measurements, the scores of the general function, activity, and postoperative function domains did not reveal any correlations with radiographic parameters of spinal deformity. The pain domain score was positively correlated with the magnitude of correction angle of postoperative thoracic rotation angle.

The results of the study indicate that the patients with a greater Cobb angle or rotation angle in the thoracic curve had a negative self-image regarding back appearance at the final follow-up. In addition, satisfaction after surgery was correlated with improvement of patients' self- image based on the result of stepwise regression analysis [25].

In our study there was a slight correlation between postop AVR improvement rates, a rarely used parameter in previous studies that we thought is related to external appearance especially the improvement in the rib hump and postop shoulder balance, and SRS satisfaction scores in the same direction. Although these results are compatible with the study of Watanabe et al, there was mild correlation in our study and there was strong correlation in their study. We concluded that by using these data, the effect of AVR on SRS scores should be evaluated on larger patient populations preferably with the same or longer post-operative follow-up period, would give results that are more accurate.

An interesting result that has not been determined before in the literature was that there was a statistically mild negative correlation between postoperative shoulder balance and age of operation according to Pearson Correlation Test.

Another finding that did not present in the literature review was that an inverse moderate correlation was found between early postoperative apical vertebra rotation and postop shoulder balance. (Watanabe et al. concluded that there was strong inverse correlation between thoracal AVR and general self-image and pain scores at last follow-up).

In addition, a mildly similar correlation was found between postop AVR recovery rate and postop shoulder balance. We performed repeated measured analysis by using general linear samples in order to evaluate treatment outcome by using repeated measured radiological parameters analysis including subjective factors. We performed 'Pillai's Trace' test by including 'subjective factors' to these measures. 'Benferroni Test' was performed in binary comparisons. According to these tests, there was a significant correlation between AVR recovery rate and shoulder balance and patients with good shoulder balance showed better AVR recovery significantly in the early postoperative period. (Statistically significant). Therefore, we think that using early postoperative AVR recovery in evaluating the surgical outcomes of patients with adolescent idiopathic scoliosis and the evaluation of follow-up progression of this parameter may provide important contributions to orthopedic surgery. Therefore, there is a need for long follow-up and high patient population studies.

Yagi et al reported that apical rotation of the main curve is a significant predictor of postoperative shoulder imbalance [27]. This finding is similar with our and Watanabe and his collegues' findings. If any other studies made to support the same information, we could see that apical vertebra rotation, which is very important in determining the rib hump, became a widely used parameter to determine the postoperative shoulder balance.

The presence of different types of curvature in some of the patients and the short follow-up period are the limiting factors of this study. Shoulder imbalance is also seen in patients without scoliosis. Findings from previous studies on the definition and measurement of shoulder balance contradict each other. Additionally different opinions have been put forward in different studies on the reliability of

AVR measurement. In addition, implants used in surgery make it difficult to determine the landmarks that is used for AVR measurement on plain radiographs in the postoperative period. These reasons are restrictive factors for our study and for all studies done about this subject.

We are thinking that we should focus on studies to find a reliable and infallible method that can detect and use intraoperatively in order to ensure shoulder balance after scoliosis operations.

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Volume: 29, Issue: 1, January 2018 pp: 13-18 ORIGINAL ARTICLE

TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS WITH GLOBAL (ROD) DEROTATION MANEUVER USING PEDICLE SCREWS

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ABSTRACT

Introduction: Adolescent idiopathic scoliosis is a three dimensional deformity. For the treatment of deformity, nature of deformity should be well understood and treatment strategy has to be directed to the coronal, sagittal and axial components of deformity. Global Derotation (GD) maneuver is based on simple rod derotation from concave side aiming to correct the deformity on coronal, sagittal and axial profile. In this report we reviewed AIS surgery results treated by global derotation maneuver with all pedicle screw instrumentation.

Material& Methods: Between 2003 and 2011, 253 patients had been operated using GD technique.80 of 253 patients was included to our study. The patients routinely evaluated with preoperative-postoperative and last follow up standing ortho-x-rays. Coronal and sagittal profile parameters measured on x-rays with digital software using Cobb method. Rotational component of the deformity was measured according to Nash-Moe method at the apical vertebra.

Results: 80 patients (71 female ; 9 male)had been followed up average 19,8 (7-37) months. Patients age average were 15,1(12-21) at operation date. Coronal cobb angle measure in thoracic curves preoperative were 48,9° decreased to mean 3,2° postoperatively. The mean coronal thoracolumbar curve were 45,8° preoperatively and decreased to mean 2°. Apical vertebra rotation measure regressed to mean 0,68 (0-1). Thoracic kyphosis showed downward tendency from mean 37,8° to mean 27,8°.

Conclusion: Rod derotation technique enable to correct coronal and axial profile. Coronal Cobb angle improvement seen obviously with correction of axial profile rotation. Sagittal hypokyphotic effect of GD should be kept in mind.

Key words: adolescent idiopathic scoliosis, derotation, pedicle screw

Level of Evidence: Retrospective clinical study, Level III

INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a three-dimensional spinal deformity, composed of coronal, sagittal and axial plane abnormalities. Surgical treatment of AIS evolved historically from compression-distraction rod applications to posterior pedicle screw instrumentation. Evolution to more powerful instrumentation, lead to better correction results with different correction maneuvers.

Harrington instrumentation system utilized distraction and compression forces correcting coronal correction but it was insufficient to correct sagittal and axial deformity as coronal deformity [(8)]. Thereafter Cotrel–Dubousset (CD) instrumentation and pedicle screw instrumentation was introduced which provided correction in all three-dimensions with concave simple rod derotation (SRD) [(4)].

Lee et al. introduced concept of direct vertebral body derotation (DVBD) [(12)] and suggested the idea of better axial correction with DVBD compared with SRD or global derotation. These powerful corrective techniques have helped further reduce asymmetric rib prominences and address scoliotic curves in all three dimensions and studies about correction maneuvers exploring correction ability of coronal, sagittal and axial plane deformity favored vertebral body derotation technique [(16)].

Recently long term results of posterior instrumentation with pedicle screw

pointed hypokyphotic effect on sagittal profile. In fact, the sagittal plane alignment seems to be closely tied to overall health related quality of life in patients with scoliosis [10]. The relative hypokyphosis of the thoracic spine can be addressed during surgery, and surgeons often attempt to reproduce the natural thoracic kyphosis intraoperatively with anterior approaches.

The aim of our study is to report the correction of AIS with simple concave rod rotation, in patients treated by posterior fusion for thoracic AIS using pedicle screws in a single institution.

PATIENTS AND METHODS

A retrospective review, based on a database search, was performed to identify all AIS patients who had undergone posterior spinal fusion with pedicle screw-only instrumentation using rod derotation (RD) between January 2003 and June 2011 at the institution. The inclusion criteria were: (1) diagnosis of adolescent idiopathic scoliosis; (2) preoperative, early postoperative and last follow up standing long cassette x rays (3) posterior fusion using pedicle screw-only construct; (4) a minimum clinical and radiographic follow-up of 6 months.

Radiologic Evaluation

Radiographic evaluation included standing posterior-anterior and lateral films on long-cassettes (90x30 cm), before and after surgery and at the latest follow-up. The Lenke et al. [13]. surgical classification of AIS was used to describe curve patterns. Cobb measurements [3] of the major curves were obtained, and the lateral films were evaluated for thoracic kyphosis (T2–T12), lumbar lordosis (superior endplate of L1 to inferior endplate of L5) in digital software (Surgimap software (New York, New York, USA)). The vertebral rotation was measured from the preoperative, early postop and last follow-up x-rays according to Nash-Moe method [17].

Surgical Procedures

Surgeries was performed one senior surgeon. The patients was prepared and draped prone position on radiolucent operating table. Midline incision and thoracolumbar fascia exposure was performed over spinous procesusus (SP). Paraspinal muscles were detached from SP subperiosteally. Pedicle screw instrumentation were performed from distal levels to proximal levels of the spine. Distal and proximal instrumentation levels were determined according to preoperative bending x rays and traction x-rays. Pedicle screw placement were checked by fluoroscopy anteroposterior and pedicle direction oriented views.

A rod is prepared according to sagittal profile and placed to concave side pedicle screws parallel to ground. Pedicle tap screws closed but not tightened. Proximal and distal vertebral levels attached to rod derotator firmly and rod derotation is performed from convex to concave side between 90 to 180. After derotation maneuver apical vertebra tap screw is tightened. Convex side rod is applied and tap screws are tightened. Prevention of remaining deformity is checked with fluoroscopy and in situ benders are used for compression distraction maneuvers. Shoulder asymmetry and pelvic tilt are checked according to intraoperative images (Figure-1.a,b,c).

Neurophysiologic Evaluation

Intraoperative neurophysiologic evaluation was performed with Stagnara wake up test before 2007 June, later than neuromonitorization has been used in all spine surgery cases in the department.

Statistical analysis

Statistical analysis performed with SPSS software (version 16.0, SPSS Inc., Chicago, IL, USA). After calculating standard deviation, repeating measurements of subgroup analysis were performed with Friedman Test. Recovery rate differences between groups explored with Kruskal Wallis test. ManWhitney U test was used as posthoc test in comparison of statistically significant parameters. $p<0,05$ accepted as statistically significant.

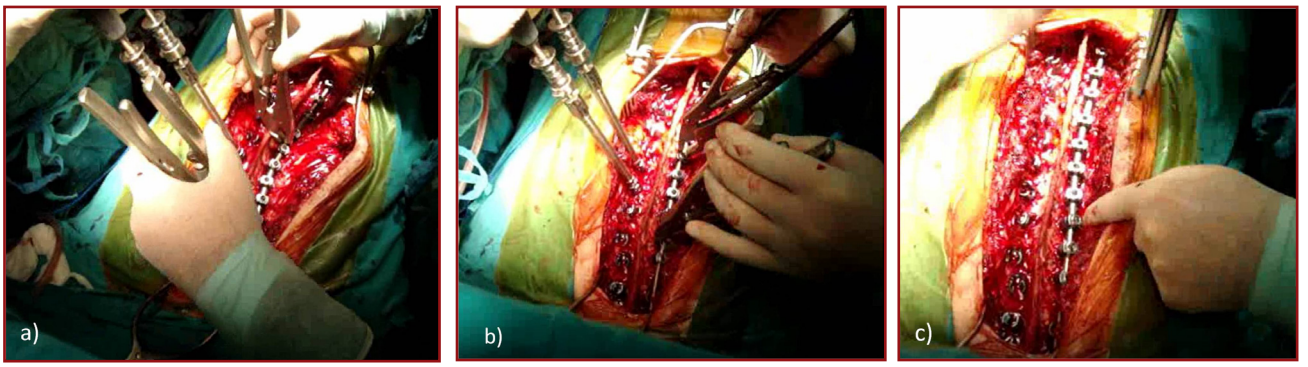

Figure-1. Intraoperative application of derotatuars and maneuver from convex side to concave side of the rod (global derotation) **a)**Proksimal and distal attachment of derotatuars. **b)** Derotation maneuver from convex to concave side **c)**after the main maneuver remaining curve is corrected with distraction compression maneuvers.

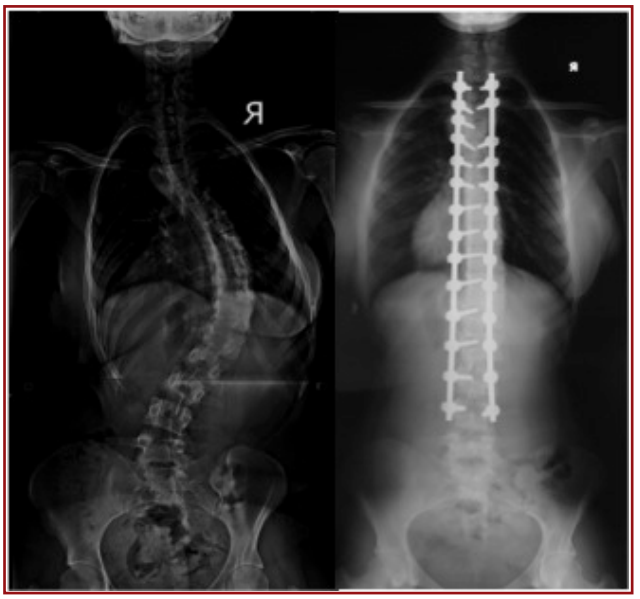

Figure-2. Preoperative and last follow up anteroposterior x-rays of 17 years old female patient with satisfying coronal curve correction

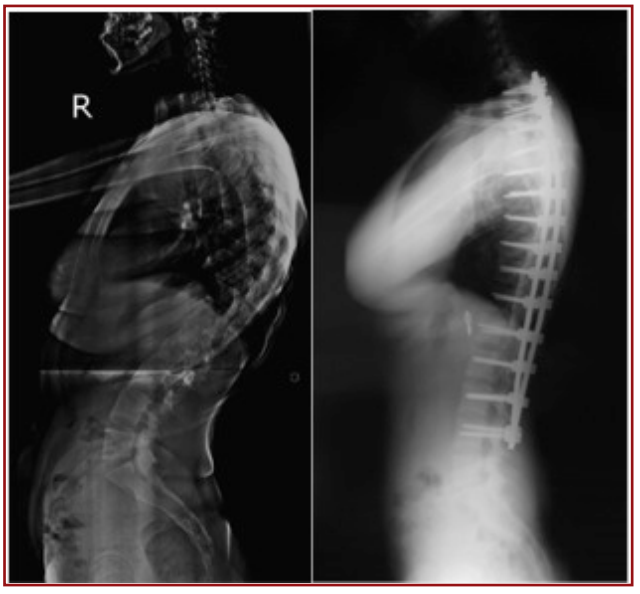

Figure-3. Preoperative and last follow up lateral x-rays showing sagittal plane changes.

RESULTS

Between 2003 and 2011, 253 patients had been operated using GD technique. 80 of 253 patients who met inclusion criteria's was included to our study. 71(89 %) female and 9 (11%) male patients enrolled to study. At the surgery time mean age was 15,1 (12 yo to 21 yo). Mean age was 14,7 yo (12 to 21yo) in females; 16,8 yo (13 yo -21 yo) in males. Mean follow up time was 19,8 months (7-37 months). Deformity classification was performed according to Lenke Classification. Subgroups were as type 1 21 patients (%26,5);type 2 4 patients (%5);type 3 28 patients (%35) Lenke type 5 26 patients (%32,5) and 1 patient had type 6 curve pattern. Most upper instrumented vertebra was T2 and most lower instrumented vertebra was L5. The mean fused levels were 11,3 (7-13).The longest fusion site was between T2 and L4.

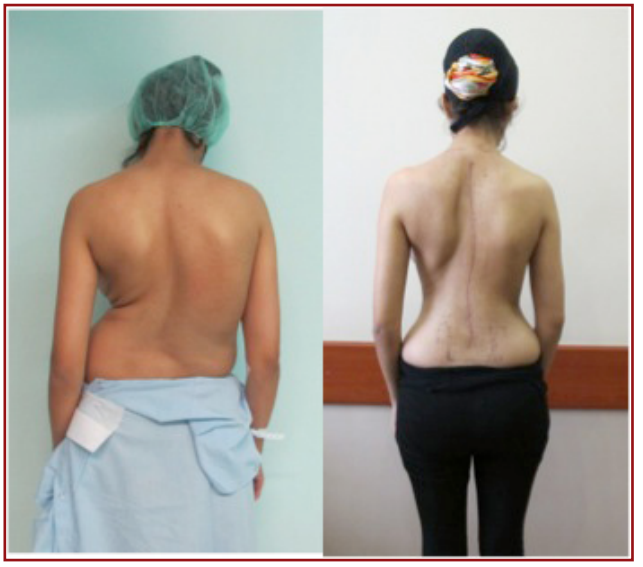

Figure-4. Preoperative and follow up clinical photographs with satisfying clinical appearance

Figure-5. Rib Hump correction without thoracoplasty of same patient.

Coronal profile major curve cobb angles were mean 48,9° (between 42° and 61°) in main thoracic curves; mean 45,8° (between 41°and 69°) in thoracolumbar curves; mean 42,6° (between 36° and 54°) in lumbar curves preoperatively. At last follow up coronal cobb angle was mean 3,2° in main thoracic group; mean 2 in thoracolumbar group and mean 4,5° in major lumbar curve group. Statistically there were no difference between early postop curve magnitude and last follow up curve magnitude (p>0,05). Mann Whitney U test revealed that Lenke type 1 curves was most beneficial group from the surgery in terms of curve correction in coronal plane.

Sagittal plane analysis were performed with thoracic kyphosis and lumbar lordosis. Preoperative thoracic kyphosis was mean 37,1° (between 33° and 49°) and preoperative lumbar lordosis

was mean 52° (between 34° and 59°).Thoracic kyphosis (TK) was mean 27,8° and lumbar lordosis (LL) was 44,1° at last follow up. Early postoperative and follow up magnitude difference was not meaningful statistically.(p>0,05)

Apical vertebra rotation (AVR) was determined according to Nash-Moe method on preoperative postoperative and follow up x-rays. Preoperative mean AVR was 2,26 (between 2 and 3) and 0,68 at last follow up. Statistically AVR correction with surgery was found to be meaningful. (p<0,05) (Table-1).

Major complication (neurologic deficit, deep wound infection requiring implant removal, need of revision because of pseudoarthrosis or implant failure) and minor complications (superficial wound infection) was not recorded. One patient was diagnosed superior mesenteric artery syndrome after surgery. She underwent duodenojejunostomy procedure and recovered from the condition. She is doing well now.

DISCUSSION

Adolescent idiopathic scoliosis (AIS) is a three-dimensional spinal deformity, composed of coronal, sagittal and axial plane abnormalities. Surgical treatment of AIS evolved historically from compression distraction rod applications to posterior pedicle screw instrumentation. Evolution to more powerful instrumentation, lead to better correction results with different correction maneuvers.

Harrington introduced hook rod system in early 1960s in surgical treatment of scoliosis [8]. Concave side distraction convex side compression maneuvers resulted in some coronal plane correction but sagittal and axial profile could not be managed with use of Harrington instrumentation. Flat back deformity, loss of correction, long fusion levels and pseudoarthrosis has been seen after use of Harrington rods [12]. At this point new instrumentation systems and corrective maneuvers has been developed to solve three plane deformity. Cotrel and Dubousset introduced the method of curve rotation technique with multi hook segmental instrumentation [4]. With the rod derotation maneuver toward concavity, It was named single concave rod rotation. Pedicle screw system development brought advantages of rigid fixation and easy manipulation of vertebral body through pedicles. The development of instrumentation over years has allowed increasing control of the coronal and sagittal plane deformities [22]. Pedicle screw constructs have become commonplace in AIS surgery. Studies comparing hook and pedicle screw constructs reported more better correction in coronal plane deformity with use of pedicle screw systems,but in sagittal plane pedicle screw systems caused hypokyphosis [14,22-23].

In the study of Fu et al.[6] at 2 years follow up ,thoracic kyphosis resulted less of the preoperative value (14,5° ± 6,5° vs. 15,8° ± 10,7°) in patients treated with screws, in contrast with increased kyphosis obtained at follow up with hook construct. Also increased implant density with pedicle screw constructs thought to be related thoracic hypokyphosis. Clements et al reported positive correlation between hypokyphosis and increasing implant density [2].

Early papers which studied Cotrel-Dubousset single rod derotation maneuver reported that the derotation could induce a three dimensional correction. However recent reports criticized the rotational correction even though they generally find the corrections are satisfactory in both coronal and sagittal plane [12].

Table-1. Patient demographics and measurement results.

		Preoperative	Follow Up
Sex			
Female	71(%89)		
Male	9 (%11)		
Mean age (yo)	15,1(12-21)		
Lenke Subtypes			
Type 1	21(%26,5)		
Type 2	4 (%5)		
Type 3	28(%35)		
Type 4	-		
Type 5	26(%32,5)		
Type 6	1 (%1)		
Coronal cobb angle(°)			
-Thoracic		48,9° (42°-61°)	3,2°(0°-9°)
-Thoracolumbar		45,8°(41°-69°)	2° (0°-8°)
-Lumbar		42,6°(36°-54°)	4,5°(0°-11°)
Sagittal cobb angle (°)			
T2-T12		37,1°(33°-49°)	27,8°(23°-41°)
Lumbar Lordosis (°)		52°(34°-59°)	44,1°(34°-47°)
Apical Vertebra Rotation		2,26 (2-3)	0,68(0-1)

Lee et al. introduced direct vertebral rotation (DVR) technique in 1999. DVR provided transverse plane vertebral rotation maneuver in addition to well-known single rod rotation posteromedialization effect. According to Lee, at first it was thought that DVR would only give better rotational correction than RD, however DVR provided better correction on coronal and sagittal planes [12]. Our present study showed satisfactory results in terms of coronal plane Cobb angles with rod derotation technique. In a prospective comparative cohort study of DVR versus RD, no significant difference was found between two groups in terms of coronal Cobb angle [24].

Pedicle screw use and derotation maneuvers may have a negative impact on the sagittal profile. Our results showed thoracic hypokyphosis with all pedicle screw construct and RD. Also thoracic pedicle screw instrumentation without a direct vertebral derotation, has been found to enhance a loss of sagittal profile in AIS investigating studies [16]. Studies confirmed the hypokyphotic effect of derotation maneuver with the exception of Lee et al that obtained a moderate increase of kyphosis with DVR, and Vallespir et al. that maintained the preoperative kyphosis [12,25]. The impression is that derotation with screw systems could increase lordosis trend on thoracic kyphosis in AIS patients. The derotation may have a lordogenic effect due to the translation of the overgrown vertebral body from the lateral to an anterior position. In the 3D simulation study of Watanabe, kyphosis was reduced after complete correction of the coronal and rotational deformity, but it was maintained after the coronal-only correction. These results proved the hypothesis that the vertebral derotation obtained by PS causes hypokyphosis of the thoracic spine [26].

In the present study axial correction of the apical vertebral bodies and rotational profiles simply measured from x rays as defined by Nash and Moe preoperatively and postoperatively [17]. Postoperative spinal instrumentation covered landmarks on standard x-rays. In the follow up x-rays we evaluated the pedicle screw direction and midline relation. CT has been largely accepted as the most accurate method to evaluate the vertebral rotation pre and postoperatively [1].

Axial vertebral rotation is thought to contribute to clinical rib hump. This rib hump is a major concern to patients and their families who consider it the second most important reason for surgery [19]. More recently attention has focused on strategies to improve correction of vertebral rotation with the key aim of further reducing rib hump. Surgeons have performed thoracoplasty to correct preoperative rib hump. Some authors stated long term negative effects of thoracoplasty especially on pulmonary function test, although some surgeons have found no long term deleterious effect of thoracoplasty in adolescents [11,21]. Pankowski et al [18] reported the decrease in rib hump in both DVR and RD group, he found significantly better correction was achieved by DVR in contrast Tang et al reported almost the same rib hump correction with DVR and RD [24]. Last studies explored relation between rotation techniques and health related quality of life (HRQOL) questionnaires [5]. DVR and RD groups showed similar results of HRQOL questionnaires. In a prospective comparative cohort study there were not significant difference between DVR and RD in terms of rib hump correction and patient based HRQOL assessment [24].

Our study limitations were small number of patients which cannot reflect general population, our study designed as retrospective case control study without control group; only we could compare preoperative and postoperative results. Apical vertebra rotation measure technique is open to criticism because of inadequate evaluation from postoperatively instrumented x-rays.

In conclusion, there is little proof favoring new derotation techniques compared with RD technique. There is some weak evidence, with negative effect of radiation exposure to growing teenagers, which suggests improved vertebral derotation on CT with these new techniques. DVR or vertebral coplanar alignment technique appear to require thoracoplasty to correct significant rib hump at similar rates to traditional RD. DVR and RD seems to cause similar thoracic hypokyphosis on sagittal plane which could be caused all pedicle screw instrumentation actually.

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Volume: 29, Issue: 1, January 2018 pp: 19-26 ORIGINAL ARTICLE

IS THE ROOT RETRACTION OR SACRIFICATION FEASIBLE FOR THE TREATMENT OF THORACOLUMBAR BURST FRACTURES WITH SINGLE STAGE POSTERIOR PEDICULOTOMY AND CORPECTOMY?

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ABSTRACT

Background: We retrospectively reviewed the surgical results of posterolateral transpedicular partial corpectomy, cage interbody fusion without anterior vertebral reconstruction in 91 consecutive patients with burst fractures due to spinal cord compression at the thoracic and lumbar spine.

Material and methods: From February 2009 to October 2015, the review included ninety-one patients (42 females, 49 males), operated on for the diagnoses of thoracic and lumbar burst fractures due to spinal cord compression who underwent unilateral transpedicular posterior partial vertebrectomy (UTPPV) with vertebral reconstruction. Canal decompression was provided by laminectomies, intracanalicular fragments were totally excised and vertebrectomy was provided via transpedicularly, additional adequate exploration provided by root sacrification in thoracal region and root retraction in lumbar region fractures. Neurologic assessment and progression of the patients were noted as Frankel classification preoperative, postoperative 6th and 12th month, and fracture type was noted as an AO classification.

Results: The mean age was 35.08 ± 9.33 years. Mean follow-up time was 15.42 ± 4.13 months, and there was significant correlation between canal encroachment and preoperative Frankel grade ($p<0.0001$). The mean kyphotic correction between preoperative and postoperative Cobb angle on anteroposterior radiographs were 27.33 degrees ± 3.51 to 4.38 ± 0.79, and restoration of vertebral height diameter was 42.68 ± 9.08 % to 84.32 ± 6.71 % postoperatively ($p<0.05$). Mean canal encroachment was 62.32 % ± 14.88. There were no intraoperative mortality or implant failures. There were no additional complications and neurologic sequel during these operations.

Conclusion: Unilateral pediculotomy performed through a posterior approach provides a reasonable exposure. Bony fragments can be accessed without the need for an anterior approach or the application of posterior instrumentation. The posterior approach has its advantages in emergency surgical conditions, and provides improved surgical exposure, compared to anterior or anterior/posterior approaches, and has a diminished rate of serious complications.

Key words: Unipedicular corpectomy, burst fracture, Frankel Grade, AO spine

Level of evidence: Retrospective clinical study, Level III

INTRODUCTION

Thoracic and lumbar vertebral injuries generally occur because of high-energy trauma. These injuries are most commonly seen after motor vehicle accidents in cases of blunt force trauma from a fall, or with an injury secondary to a gunshot wound. The most frequent motion etiology of trauma is flexion, though combined trauma forces such as compression, distraction and shear force trauma can be seen. When a vertical load on the corpus occurs, the ending plate compresses toward the vertebral corpus, and an increased direct load results in deformation of the ending plates. The result is a decrease for flow to the spongious bone of the vertebral corpus and a resulting decrease in the energy absorption of the bone. Fractures occur when the elastic limit of the vertebral corpus is exceeded [27].

Deformities occur at the end plates rather than the disk, when distraction or shear forces accompany flexion forces [10,12,14]. Neurological injury is classified as primary or secondary. Primary injuries occur as a result of direct damage to the tissues. Compression injuries can cause direct

nerve damage, in addition to secondary damage, by affecting vascular perfusion. In that manner, ischemic changes can occur.

Ischemic damage subsequently establishes a vicious mechanical and biochemical cycle. Mechanical ischemia begins as a result of primary traumatic damage, followed by cell damage and release of vasoactive material. The subsequent edema and vasoconstrictive processes result in increasing damage. Thoracic and lumbar vertebral injury is very rapidly diagnosed via radiodiagnostic methods. All patients with whole body injury are considered to have vertebral instability until proven otherwise. Vertebral injuries can be classified as major or minor injuries. Minor trauma classification could be considered in cases that involve fractures of the spinous and transverse processes, and the facet joint and pars interarticularis.

The mechanistic grouping known as AO classification, was published in 1994 by Magerl [22,23]. The classification was based on an analytic evaluation of 1445 cases, and consisted of three grades, categorized by increased importance of classical AO fractures, and based on 53 types of injuries [24].

The main treatment goal of thoracolumbar fractures are to protect neural tissue from further damage and rapidly returning a patient to usual activities through early mobilization and rehabilitation. This can be provided by neural decompression and reconstruction of the anatomic alignment of the spinal column. The surgery is conducted with anterior, posterior, and anteroposterior approaches. Anterior approaches are widely used for spine decompression. This technique requires experience and the interest of a surgeon. This technique provides a direct intervention to the spinal canal and more effective decompression [2,9].

An anterior approach to the lumbar or thoracic spine has some difficulties in itself. Visceral organ or vascular damage complications can be seen in the course of the procedure. The presence of hemo-pneumothorax or intra-abdominal visceral organ complications in multi traumatic patients can alter mortality and morbidity rates for anterior approaches. Multiple studies showed that posterior stabilization and fusion allowed better anatomic fracture reduction. 360-degree fusion and kyphotic correction also can be established via a posterior approach with posterior vertebrectomy and posterior segmental instrumentation. Posterior approaches to the burst fractures are usually used for cases without neurological deficits. Contrarily to some beliefs, kyphotic angle correction, and reduction of canal encroachment through a posterior approach can be performed safely in neurologically injured patients.

We present the unilateral transpedicular posterior partial vertebrectomy (UTPPV) approach inthoracolumbar burst fractured for 82 patients.

MATERIAL AND METHODS:

Medical records of 91 patients operated due to thoracolumbar burst fracture in our clinics between years 2009 to 2015 have been evaluated retrospectively. These patients were treated with UTPPV and a cage insertion technique, with or without root sacrification.

The surgical indications include canal encroachment over 40 %, loss of vertebral body height exceeding 20 %, kyphosis more than 20 degrees; and with/without neurologic deficits [11].

Patients who had thoracolumbar fractures, but with less than 40 % canal encroachment were not included in this study, as they were likely treated conservatively (for stable burst fractures only). Some patients showed additional polytrauma complications such as hemo-pneumo thorax were included in this study. Fractures of all patients were evaluated before and after operations using anterior-posterior and lateral radiographs and by computerized tomography (CT) (Figure-1).

The midsagittal diameters of the spinal canal at the injury level were compared with the average diameter of one level above and one level below, and were expressed as canal compromise, which was a percentage of narrowing [3].

Cobb angle [18,25] was evaluated preoperative, immediate and 12th month postoperatively and measured from the superior end plate of the normal vertebral body just above the fracture to the inferior end plate normal vertebral body just below of the fractured vertebral body. The percentage of vertebral body height loss was reported as fractions of anterior height between fractured vertebra and normal height of the adjacent vertebra below the fractured vertebrae [15].

Surgical technique: A posterior midline skin incision was made to adequately expose the fracture, at least two levels above and below the level. Patients underwent long-segment posterior fusion, total laminectomy and unilateral pediculotomy. Total laminectomy with one segment below the hemilaminectomy of the affected segments was performed, followed by unilateral facetectomies and complete unilateral pedicle resection to the base of the vertebral body. Pediculotomy usually was performed from the paresthetic site. On the pediculotomy side, via excessive foraminatomy thoracic and lumbar nerves were exposed at one level below and above the fractured vertebrae. For intervertebral fusion, adjacent level intervertebral discs to the fractured vertebrae were removed by discectomy with endplates.

In exploration of upper and lower levels, spine remaining roots were seen at the fracture site. Bony fragments in the channel were removed. Above the T12 thoracic level, exiting roots generally were ligated and harvested to finish the corpectomy completely and maximize a better space for cage insertion. Thoraco-lumbar (T12 and L1) and lumbar nerve roots were preserved during the entire procedure. The plane between the posterior longitudinal ligament and the dura was identified, and the anterior fractured intracanalicular vertebrae fragments were resected piece by piece to achieve adequate circumferential decompression. The corpectomy was done for approximately 50 % of the vertebral body to create adequate space for cages (Figure-2).

We decancellated the vertebral body with curettes and finished the transpedicular corpectomy with a high-speed bur. The posterior and lateral cortices of the vertebral body were removed, and no residual compression of the thecal sac remained. After the corpectomy, the entire construct was slightly distracted to restore vertebral body height (Figure-3).

The distraction maintained the alignment and did not induce kyphosis. We then selected an appropriately sized expandable cage, based on the endplate size and the size of the window allowed by the nerve root. The cage was first inserted perpendicular to the spinal canal past the thecal sac and nerve root, rotated into the proper position, and then expanded under fluoroscopic guidance. Autograft from the corpectomy was used for arthrodesis.

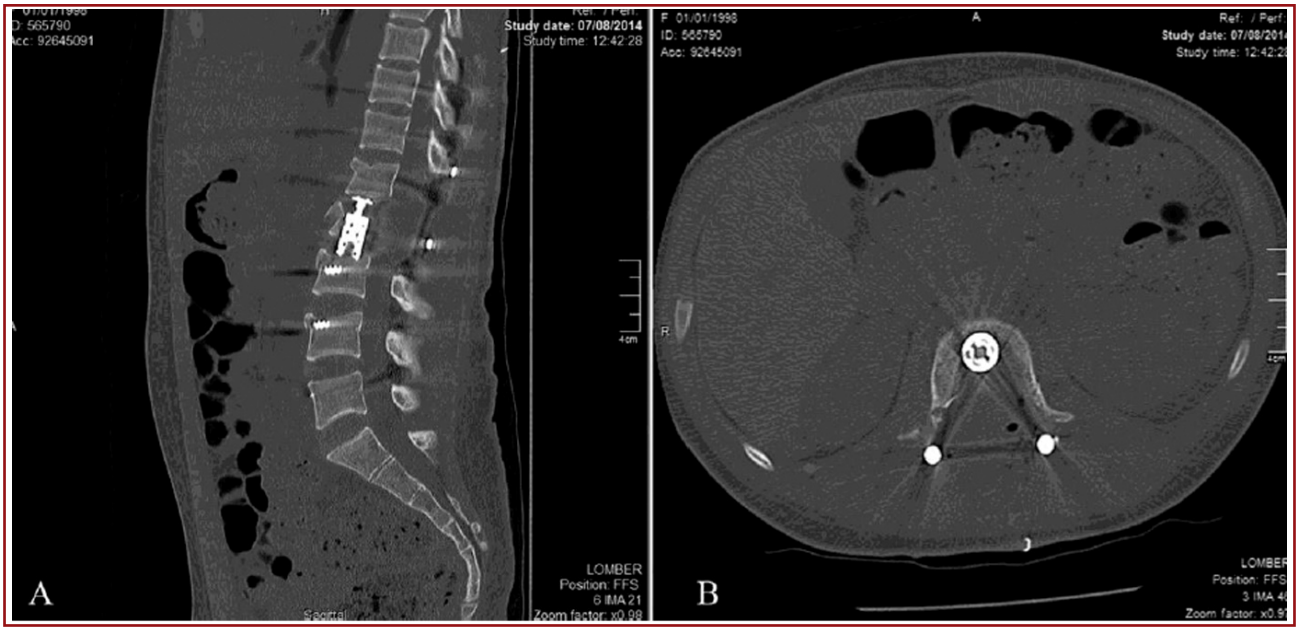

Figure-1.A,B. On sagittal 3D and axial CT images, burst fracture is seen in L2 vertebra. bone - fragments are seen in the spinal canal. Also there is grade 2 spondylolisthesis on L2 vertebra.

Figure-2.A,B. On sagital and axial CT images, there are posterior instrumentation materials from L5 vertebra to T11 vertebra. On axial images the right pedicle of L2 vertebra is not seen due to operation. There are no bone fragments in the spinal canal and no spondylolisthesis.

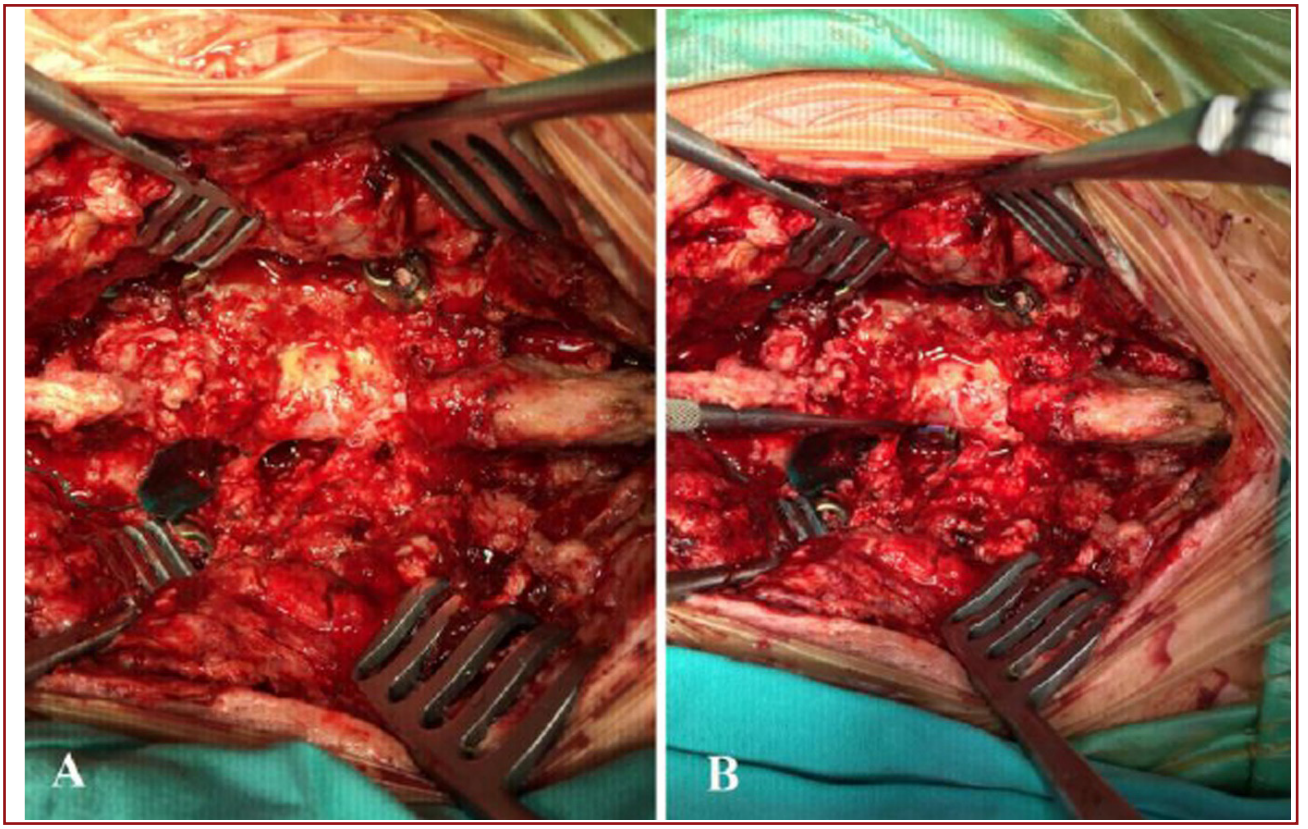

Figure-3. A. Intraoperative view of dural sac and nerve roots after corpectomy, **B.** inserted cage.

Statistical Analysis:

SPSS v21.0 for Windows (SPSS, Armonk, NY, USA) was used for statistical analysis. The variables were investigated using visual (probability plots, histogram) and analytical methods (Kolmogorov-Simirnov/Shapiro-Wilk's test) to determine whether or not they are normally distributed. Descriptive analyses were presented using means and standard deviations (SD) for normally distributed variables. The Student's t-test was used to compare the parameters. A p-value of less than 0.05 was considered to show a statistically significant result.

RESULTS:

Ninety-one patients (42 females, 49 males), who were operated for diagnoses of thoracic and lumbar burst fractures between 2009-2015, and were retrospectively evaluated. The mean age was 35.08 ± 9.33 (19–65) years. Patients with or without neurological deficit, as a result of an injury, were included in the study. Types of injuries included: motor vehicle accidents inside a vehicle (50 patients), falls from a height (21 patients), and motor vehicle accidents outside the vehicle (20 patients). Patients demographic results are shown in Table-1.

The spinal levels of injury were T11 (4 patients), T12 (15 patients), T12-L1 (3 patient), L1 (36 patients), L2 (27 patients), and L3 (6 patients). Neurologic deficits were seen in 66 patients. Twelve patients had paraplegia, 9 had paraparesis, 17 had monoparesis, 4 had bilateral foot drop and 24 had minor sensorial deficits. For severe neurological deficit, 10 (12.2 %) had their injuries in the thoracolumbar junction (4 patients T12, 6 patients L1). In the remaining 72 patients, the level of spinal trauma was unevenly distributed from T11 to L3 (Figure-4).

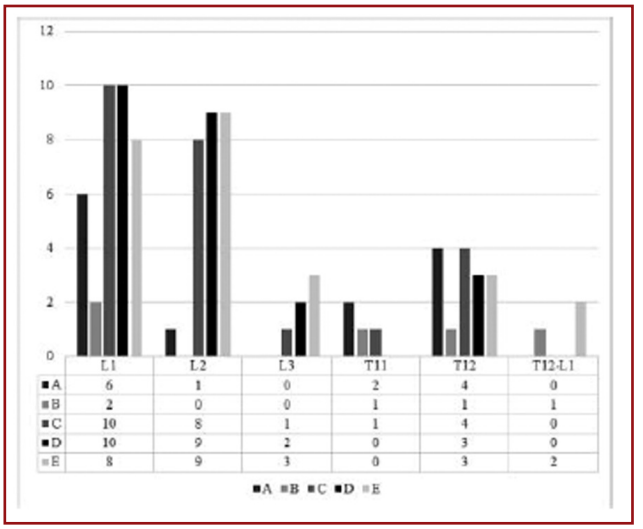

Figure-4. The distrubition of patients as fractured vertebrae levels and neurologic deficit- Frankel`s grades.

Table-1. Demographic and clinical factors of patients

Male-Female	**49-42**
Cause of Injury (n)	
Fall	21
Traffic Accident	50
Other	20
Level Of Injury (n)	
T11	4
T12	15
T12-L1	3
L1	36
L2	25
L3	6
Fracture Type (AO classification)	
A3	29
A4	30
B1	7
B2	20
C-N2	2
C-N3	3

Type A injuries (exclusive anterior column injury with vertebral body compression) were seen in 64.8 % of the patients. Within these, group A4 (burst fractures with fragments retropulsed into the spinal canal) was the most dominant (30 out of 59, 32.9 % of all patients; 29 patients with A3 fracture, 31.8 % of all patients). Type B injuries (anterior and posterior ligament injury with distraction) were found in 29.6 % of all patients (7 patients with B1 type, 20 patients with B2 type fractures). Type C injuries (anterior and posterior ligament injury with rotation) were seen in only one patient, 6.1 % of all patients; (5 patients with C type fracture).

In our study, severe neurologic deficits were seen in A4 and C type injuries and these fractures were frequently seen at the L1 level (6 patients), and T12 level (4 patients). The presence of a neurological deficit was very significantly associated with a high percentage of spinal canal stenosis independently of the level of the burst fracture. In our study, mean canal compromise was 62.32 % ± 14.88. The presence of a neurological deficit remains very significantly correlated with the percentage of spinal 125

canal encroachment ($p<0.0001$). Moreover, there is now a marginally significant correlation with the level of injury (the higher the level of the fracture, the greater the probability of a neurological deficit).

We evaluated preoperative and postoperative Cobb angle and vertebral body height diameters. The mean kyphotic correction between preoperative and postoperative cobb angle on anteroposterior radiographs were 27.33 degree ± 3.51 to 4.38 ± 0.79, and restoration of vertebral height diameter was 42.68 ± 9.08 % to 84.32 ± 6.71 % postoperatively ($p<0.05$). There were significant improvements in Cobb angle and vertebral height restoration.

We evaluated neurologic outcome according to the Frankel system. Preoperative and postoperative sixth and twelfth month Frankel values and intracanalicular bony fragments in the computerized tomography of the patients were evaluated. Preoperatively, 13 patients were assessed as Frankel A, 5 were assessed as Frankel B, 24 were assessed as Frankel C, 24 as Frankel D, and 25 patients as Frankel E. Postoperatively, for 12-month scores of Frankel, 62 patients were assessed as Frankel E, 7 as Frankel D, 7 as Frankel C, 2 as Frankel B and 13 as Frankel A. Postoperative spinal CTs revealed no intracanalicular fragments within the decompressed canal. According to Frankel's grading scale 66 patients displayed neurologic deficit on admission. Neurologic deterioration did not occur in any patient after surgery. The preoperative and postoperative Frankel grades were compared with a Wilcoxon test, and the median (50th percentiles) preoperative Frankel grade means C to postoperatively D for sixth months and the median (50th percentiles) preoperative Frankel grade means C to postoperatively E for twelfth months. Fifty-three out of 91 (58.2 %) patients exhibited neurologic improvement in Frankel B,C, and D groups. Among the 13 patients who presented Frankel A preoperatively, none changed scores postoperatively. One out of 3 patients who were Frankel B improved to Frankel C, two improving to Frankel D, and two did not change in Frankel score. Among the 24 patients who were graded as Frankel C, 17 of them improved to grade E and one improved to grade D postoperatively. Of 24 patients who were Frankel grade D, 20 of them made full neurologic recovery to Frankel E (Figure-5).

There was a significant relationship between canal encroachment with preoperative Frankel grade ($p<0.0001$). Severe neurologic deficits were seen in severe canal encroachments.

Pneumothorax and hemothorax were seen in 12 patients with A4 type fractures that frequently occurs in the thoracolumbar junction. The difference in presence of hemo-pneumothorax, regarding fracture types and injury level, was statistically significant between two groups ($p = 0.05$, $p=0.0001$ respectively). Additionally, hepatic contusion in 24 patients (29.3%), spleen contusion in 1 patient (1.2 %), and renal contusion in 10 patients (12.2 %) were detected.

In our study, mean operation time 4.05 min ± 0.55 min (3.15-5.25 minutes) and mean blood volume was 1267.07 cc ± 387.24 (750-2200 cc).

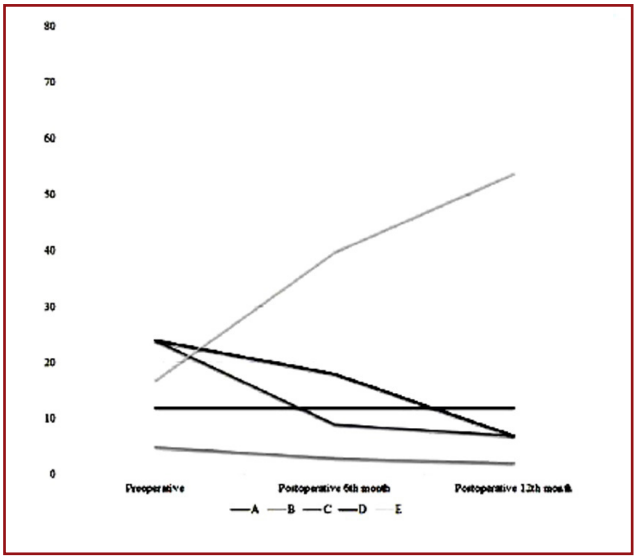

Figure-5. Patients preoperative, postoperative 6th and 12th month Frankel grade changes

DISCUSSION

Thoracic and lumbar vertebral fractures are commonly-seen injuries among neurosurgical emergencies. They are easily diagnosed by radiologic methods. With appropriate treatment strategies in spinal trauma, it should be possible to decompress the neural tissue, facilitate neurological recovery, restore spinal alignment and prevent loss of correction with neurological impairment. Urgent operations are planned according to the stability of the patient's vital signs and severity of the neurologic injury.

Surgical indications include: the presence of a neurological deficit, seatbelt injuries associated with posterior tissue damage, and burst fractures with two or more column injuries. Many surgical techniques have been identified in the literature. Among these, posterior instrumentation and decompression is the most frequently performed procedure. The anterior approach provides the possibility of a direct intervention to the intracanalicular fragments and more adequate decompression [2,9]. Although the anterior compression provides for effective decompression the spinal cord, an anterior approach to the lumbar or thoracal spine in itself presents some difficulties. Serious visceral organ or vascular damage and complications can occur during the course of the procedure. Moreover, additional polytrauma complications such as hemo-pneumothorax can aggravate co-morbidities.

Thoracotomy complications are divided into perioperative and postoperative complications. Injury to the lung parenchyma, superior and inferior vena cava and other vessels might be visualized during the thoracotomy procedure. Among postoperative complications, atelectasis, pneumothorax, pneumonia, and decreased diaphragmatic functions can be seen [29].

In comparison, with an anterior approach to the lumbar region, intraperitoneal organ injury, renal and ureteric injuries, peritoneal injuries, postoperative deep venous thrombosis, and ileus, and the development of incisional hernias may be observed [26]. Unilateral pediculotomy with a posterior vertebrectomy technique certainly could be used for burst fractures, especially in elderly patients in whom the anterior approach would be too morbid or alter patient co-morbidities. Surgeons should be comfortable with anatomy from an entirely posterior approach because the great vessels are just ventral to the limits of the corpectomy. The posterior approach for corpectomy provides a less risky approach for the thorax and abdominal wall through the intrathoracic and intraabdominal structures. A superior view is provided for posterior decompression (corpectomy and laminectomy), instrumentation and 360° fusion established with this surgical method. Posterior placement of expandable cages into the thoracic spine can be achieved with ligation of the nerve roots to maximize space for the corpectomy and cage insertion [5,28].

In addition, working medially ventral to the thecal sac is important, and comfort with the high-speed bur near dura is important. The goals of surgical treatment for unstable thoracolumbar burst fractures are to restore vertebral body height, kyphosis correction, decompress neural tissue, allow rapid mobilization and rehabilitation, decrease the complications of prolonged immobilization, prevent development of progressive deformity with neurologic deficit, and limit the number of instrumented vertebral motion segments [2-3]. Thus, with this single-staged procedure, we were able to obtain complete neural decompression, solid anterior column reconstruction with height restoration, and correction of kyphosis.

In contrast, posterior approaches to the thoraco-lumbar spine are less extensive and relatively simple. Complications of posterior instrumentation are evaluated as early and late complications. Inadequate decompression, iatrogenic injury, and complications occurring during instrumentation and fusion are among the early complications, while infection, pseudoarthrosis, atrophy in the paravertebral muscles, and pseudomeningocele are among the late complications.

Although occupation of the channel has a weak relation with neurological deficit, successful results obtained with early decompression suggest that early decompression in channel occupation might be a viable option [4,13,17]. Hashimoto and Lemons described an association with occlusion of the spinal canal and neurological deficit. Conversely, Fontijne introduced a relationship between spinal channel occlusion and neurological deficit. Fontijne did not, however, observe an association between the degree of occlusion of the channel and Frankel scale [6-7,19]. Our study showed that the presence of a neurological deficit was very significantly associated with a high percentage of spinal canal stenosis independently of the level of the burst fracture.

Aebi et al. [1] and Wiberg and Hauge [30] recommended early spinal cord reduction procedures (4–10 h) and the operative fixation of spinal fractures associated with spinal cord injuries (SCI). The body of evidence presented in these studies was in

favor of early decompression surgery, as this can potentially enhance neurological recovery in selected patients.

Like our study, various other organ injuries often accompany multitrauma patients. Because of this factor, shorter operative times play an important role in reducing and/or preventing co-morbid conditions [8].

The posterior approach in thoracolumbar spine fractures has the advantage of being familiar to the spine surgeon, avoidance of vital visceral/vascular structures, and allowing for safe surgical exploration. By utilizing a unilateral pediculotomy performed via a posterior approach, good exposure is achieved with easy access to the corpus, minimal blood volume and short operation time. Bony fragments can be accessed with posterior instrumentation, without necessitating any anterior intervention. The spinal channel is decompressed and no additional intervention is required [16,20-21].

Our study demonstrated that hemilaminectomy, facetectomy and pediculotomy facilitate the management of thoracolumbar burst fractures using posterior surgical approaches. For surgeons who are not comfortable with anterior approaches, a one stage, short time operation with a posterior approach addresses the efficiency of canal decompression and fracture reduction. Yet, it is not our intention to argue that posterior approaches are superior to other surgical methods, as treatment strategies need to be individually designed considering the condition of a patient, types and complications of fractures, experience and interests of doctors, and timing of the operations.

Unilateral pediculotomy performed through a posterior approach provides a reasonable exposure. Intracanalicular bony fragments can be excised without the need for an anterior approach or the application of posterior instrumentation. The posterior approach has advantages in emergency surgical conditions, and improved surgical exposure, compared to anterior or anterior/posterior approaches, and a diminished rate of serious complications.

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Volume: 29, Issue: 1, January 2018 pp: 27-32 ORIGINAL ARTICLE

2-YEAR RESULTS OF NUBAC™ DISC ARTHROPLASTY SYSTEM IMPLANTED FOR THE TREATMENT OF LUMBAR DİSC HERNIATION

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ABSTRACT

Purpose: To assess the 2 year results of lumbar disc herniation patients treated with NUBAC™ disc arthroplasty system.

Methods: 10 patients (<45 years), with large disc herniation, otherwise relatively well preserved disc who presents with recalcitrant leg pain refractory to conservative treatment were included to the study. NUBAC™ disc arthroplasty was performed via standard posterior approach. Per-operative and 2 year follow-up scores (VAS, ODI) were obtained. Plain X-rays were performed on the postoperative first day and 6, 12 and 24 months after surgery while MRI and dynamic X-Rays were performed on the postoperative 24 months. Furthermore, adjacent disc degeneration were evaluated on the T2-weighted midsagittal MR images according to Pfirrmann classification.

Results: 5 of 10 patients were male. Average patient age at the time of surgery was 32,3. Statistically significant difference was observed in the radicular pain group ($p<0.05$) while the difference was not significant in terms of low back pain ($p>0.05$) 2 years after surgery. Lumbar MRI's performed 2 years after surgery did not show any additional degenerative changes on the adjacent discs. Any vascular and/or neurological complication did not occur.

Conclusion: NUBAC™ is a promising device which may help surgeons to reduce pain while restoring motion and protect adjacent discs.

Key words: Disc herniaton, surgical treatment, NUBAC™ disc arthroplasty.

Level of Evidence: Retrospective clinical study, Level III.

INTRODUCTION

Lumbar disc herniation is the most common cause of sciatica. Ninety percent of acute attacks settle down with conservative treatment methods. The usual indication for surgery is to provide rapid relief of pain and disability while the absolute indications are progressive muscle weakness and impaired sphincter function. Micro-discectomy is the treatment of choice in the surgical treatment of lumbar disc herniation [11,12]. However, it is well known that significant proportion (5-15 %) of patients who undergo micro-discectomy may develop recurrent disc herniation or symptomatic low back pain due to progressive degenerative process Figure-1 [10].

Since decrease in the disc space height and dehydration are commonly seen after discectomy operations, partial disc replacement in the post-discectomy setting offers the theoretical benefit of slowing future degenerative changes by maintaining disc space height and normal motion [4,11].

Figure-1. NUBAC™ is a 2-piece articulated PEEK intradiskal arthroplasty device.

Nucleus replacement devices are a heterogeneous group of implants

composed of diverse biomaterials with varying biomechanical properties. NUBAC is a 2-piece mechanical nucleus. It is the first poly-ether-ether-ketone (PEEK) on PEEK articulated intradiscal arthroplasty device [10].

In this study, we report 2 year outcomes of lumbar disc herniation patients treated with NUBAC disc arthroplasty system.

MATERIALS AND METHODS

Patient Characteristics

From October 2007 to November 2011, a total of 13 patients underwent nucleus disc arthroplasty at the level L4-5 with the NUBAC disc arthroplasty system in our clinic. Ten patients with 2-year follow-up were included to the study.

Patient Selection

The inclusion criteria for disc arthroplasty were young patients (<45 years), with large disc herniation, otherwise relatively well preserved disc who presents with recalcitrant leg pain refractory to conservative treatment. Exclusion criteria were recurrent disc herniation, spondylolisthesis, spinal stenosis and disc height <5 mm (Figure-2).

Surgical Procedure

Standard posterior surgical approach was used in all cases. After the patient was placed in prone position, a 4-5 cm verticomedian skin incision was performed on the level L4-5. After the subperiosteal dissection, lamina and facet joint were exposed. The laminatomy, partial medial facetectomy and flavectomy were performed in traditional manner. After the removal of nucleus pulposus, L5 root was retracted medially and the proper NUBAC implant was inserted. The extent of the medial facetectomy was defined by the size of the NUBAC implant.

Clinical Assessment

Before surgery, all patients responded to a 10 point Visual Analog Scale (VAS) for radicular and axial low back pain. Functional outcomes were measured using the Oswestry Disability Index (ODI) scores. Peroperative and 2-year follow-up scores were obtained (Table -1). Disc heights were measured on the lateral plain X-rays. Plain X-rays were performed on the postoperative first day and 6, 12 and 24 months after surgery while magnetic resonance imaging (MRI) and dynamic X-Rays were performed on the postoperative 24 months (Figure-3).

Furthermore, adjacent disk degeneration were evaluated on the T2-weighted midsagittal MR images according to Pfirrmann classification (Figure-4) [15].

Figure-2. Sagittal **(a)** Axial **(b)** T2 weighted MR images showing L4-5 right paracentral disk herniation compressing the right L5 nerve root. Please note that the other disks are quite healthy.

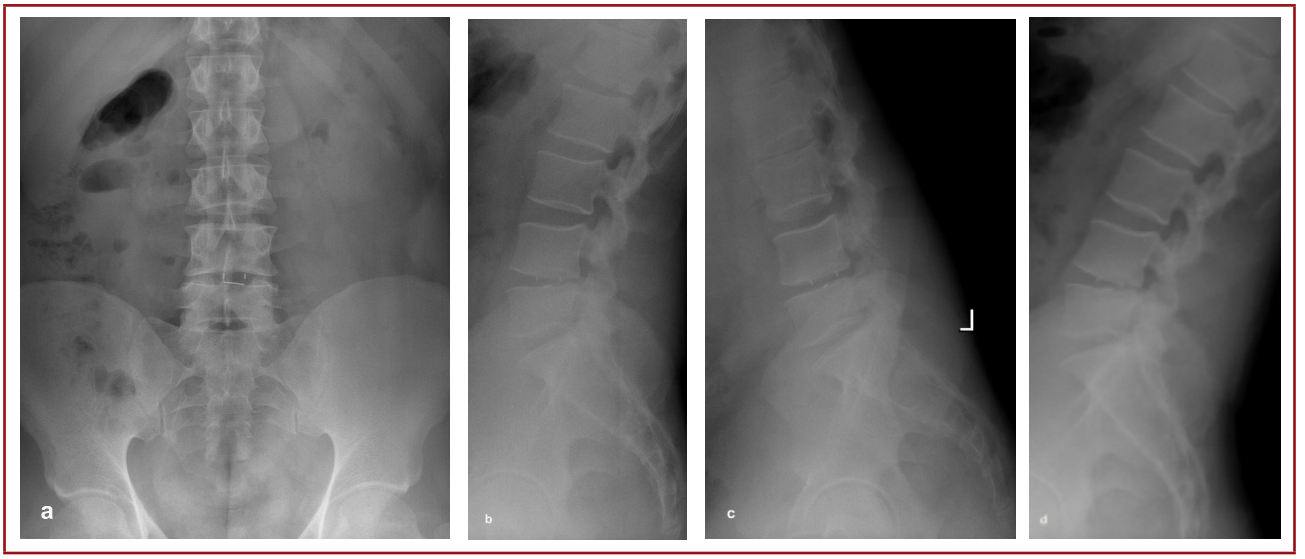

Figure-3. AP **(a)** Lateral **(b)** Hyperflexion **(c)** and Hyperextension **(d)** X-Ray images showing the position and regular functioning of NUBAC device 2 years after surgery.

Figure-4. Sagittal T2 weighted MR image revealing the still healthy adjacent disks 2 years after surgery.

Statistical Analysis

All the data collected throughout the clinical study were evaluated using SPSS 11.5 statistical software for Windows. Non-parametric analysis were performed using Wilcoxon signed rank test. A P value less than 0.05 was considered statistically significant.

RESULTS

5 of 10 patients were male. Average patient age at the time of surgery was 32,3 (ranging from 23 to 45). The median preoperative VAS score for axial LBP was 1 (minimum: 0, maximum: 3) which was increased to 1.5 (minimum:0, maximum:4) 2 years after surgery. This difference was not statistically significant ($p>0.05$). However, statistically significant difference was observed in the radicular pain group ($p<0.05$). The median preoperative VAS value for radicular pain was nine (minimum: 8, maximum: 10) which was decreased to 1 (minimum: 0, maximum: 4) 2 years postoperatively. The median preoperative ODI score of 10 % was increased to 14 %, 2 years after surgery. This difference was not statistically significant ($p>0.05$). Lumbar MRI's performed 2 years after surgery did not show any additional degenerative changes on the adjacent discs (Table-2).

No vascular and/or neurological complication did occur. 2 patients who were describing increased low back pain after NUBAC surgery had benefit of facet joint injection.

Table-1. Patient Demographics

Case	Age	Sex	Level	VAS(Preop) LBP/Leg Pain	VAS(Postop*) LBP/Leg pain	ODI(preop)	ODI(Postop*)
1	45	M	L4-5	1/10	0/0	10	8
2	33	F	L4-5	1/8	4/1	12	42
3	23	M	L4-5	3/9	0/4	20	14
4	30	M	L4-5	1/10	3/1	10	34
5	29	M	L4-5	0/9	2/0	10	34
6	27	F	L4-5	0/10	0/2	8	12
7	28	F	L4-5	1/8	1/1	10	10
8	32	F	L4-5	2/9	2/1	10	14
9	43	M	L4-5	1/8	2/1	10	14
10	33	F	L4-5	2/10	1/3	12	8

* 2 years, LBP: Low back pain, VAS: Visual Analog Scale, ODI: Oswestry Disability Index

Table-2. Magnetic resonance classification of adjacent intervertebral disks (Pfirrmann classification)

Case	Age	Sex	Preoperative L3-4/L5-S1	Postoperative* L3-4/L5-S1
1	45	M	2/3	2/3
2	33	F	2/4	2/4
3	23	M	2/3	2/3
4	30	M	2/3	2/3
5	29	M	3/2	3/2
6	27	F	2/2	2/2
7	28	F	2/1	2/1
8	32	F	1/2	1/2
9	43	M	3/3	3/3
10	33	F	2/2	2/2

* 2 year

DISCUSSION

The development of spine arthroplasty technology may help surgeons to relieve pain while restoring the motion and protect adjacent levels [4,10]. Arthroplasty can be divided into 2 subtitles as total disc replacement (TDR) and partial disc replacement (PDR) or nucleus replacement [10]. In TDR, entire disc including the anulus and endplates are replaced with a prosthesis while only degenerated nucleus is replaced in PDR [10].

There are several advantages of having a nucleus prosthesis over a total disc prosthesis. PDR is a minimally invasive procedure that involves limited exposure and annulotomy[4,10]. Surgeons have multiple approach options such as anterior retroperitoneal, lateral and posterior approaches [3,6]. However, risk of retropulsion or migration and subsidence are the two main problems related with the PDR [10,14].

There are two well-defined indications of PDR [4,10]. The first indication is to prevent recurrent disc herniation or progression of degeneration in selected young patients who have undergone discectomy. The second indication is to try to diminish mechanical low back pain due to early or moderate degenerative disc disease [10]. The main objective of having a nucleus prosthesis is to restore the disc anatomy and functions [4].

Bertagnoli et al published their experiences with the PDN® prosthetic disc nucleus device in 2002 [5]. They implanted this device in degenerative disc disease patients and indicated a surgical success rate of 88 %, coupled with a marked reduction in back pain and an increase in disc height. In 2003, Korge et al published 2 year clinical results of 5 patients implanted a coiling spiral as nucleus prosthesis for the treatment of lumbar disc herniation [13]. They reported promising results about the implant. Ahrens et al published 2-year efficacy and safety results from 2 prospective, non-randomized multicenter European studies of DASCOR® disc artroplasty device in Spine in 2009 [1]. They concluded that DASCOR device may be a safe and effective less-invasive surgical option for patients with DDD.

Functionally, nucleus replacement devices can be divided into 2 broad classifications as elastomeric and mechanical [10]. Elastomeric devices can also be further subdivided into hydrogel and nonhydrogel replacements. Mechanical devices can be subdivided into 1 and 2 piece designs. These devices are composed of various materials including metal, pyrolytic carbon and PEEK [10].

NUBAC™ (Pioneer Surgical Technology, USA) is a nucleus replacement device for use in the treatment of low back pain due to DDD [3,7-8]. It is unique between nucleus replacement devices since it incorporates articulation in its design [10]. It is composed of 2 pieces from PEEK and uses a ball and socket articulation for motion. It has been CE approved since 2005 and has been implanted in over minimum 250 patients worldwide [7-8,10].

Balsano et al reported the 2-year clinical outcome of 22 patients who underwent nucleus disc arthroplasty with NUBAC® device [3]. They concluded that NUBAC could be considered as a viable option for the treatment of low back pain due to degenerative disc disease. Similarly, Alpizar-Aguirre et al from Mexico reported clinical and radiological improvement after NUBAC implantation for the treatment of DDD [2]. A clinical trial (NCT00931515) evaluating the safety and effectiveness of NUBAC disc arthroplasty finished in 2012 [16].

In this study, we decided to use NUBAC device because of its unique articulated technology manufactured from PEEK. PEEK is commonly used in spine surgery because of its excellent mechanical strength, stability, biocompatibility and radiolucency [8]. Furthermore, Brown et al showed that wearing rates were relatively low and consistent thus suggesting long term durability [8]. Brown et al also compared the NUBAC device with the total joint arthroplasty implants in terms of particle load. And they found reduced particle load in NUBAC device group that diminish the risk to elicit an inflammatory response [7].

Since our patient population had a diagnosis of disc herniation at the level L4-5, we used the posterior approach to evacuate the disc and to place the NUBAC device. We performed the same surgical steps with Bucciero et al [9]. In contrary to Bucciero et al, we had to perform a wide hemilaminotomy and resection of one third or one half of the facet joint in order to achieve minimum nerve root retraction during NUBAC placement. Especially in small stature patients, it was not easy to place the NUBAC device properly with performing limited medial facetectomy. Surgeons should evacuate the nucleus pulposus entirely in order to rotate the implant properly and easily. Otherwise, implant does not rotate and stays in oblique position.

The extent of facetectomy is directly proportional with the postoperative LBP. In our series 2 of 4 patients experiencing increased LBP after surgery had benefit from facet joint injection. When we examined their surgery records and radiological images retrospectively, we had realized that their facetectomy was more than average.

According to our experience, we suggest that posterior route is more suitable for patients who have wide L4 lamina and/or suffer from L5-S1 disc herniations. If NUBAC device implantation is planned for the treatment of DDD, anterior retroperitoneal or anterolateral transpsoatic approach (ALPA) would be better to use in order to avoid paravertebral muscle denervation, facet joint violation and related pain [6].

As mentioned above, there is significant risk (5 %-15 %) of recurrent disc herniation after microdiscectomy alone [10]. In our patient group with NUBAC device, we did not encounter any recurrent disc herniation. The most important complications of nucleus devices placed via posterior route are device migration and subsidence [10,14]. We did not observe any device migration/retropulsion or subsidence in our study. Disc heights of the operated level did not decrease after surgery and during the 2 years of follow-up.

Adjacent segment degeneration is one of the pitfalls of fusion surgeries. Zigler et al reported that 5 years after index surgery adjacent segment degeneration was observed in 26,8 % of fusion patients [17-18]. Furthermore, this value was found 3 times greater than the TDR patients. In this study 2 years after surgery, patients underwent lumbar MRI to observe adjacent segment degeneration. Adjacent discs (L3-4/L5-S1) were graded according to Pfirmann classification. Any significant difference was not found in terms of adjacent segment degeneration.

In our patient population, leg pain diminished dramatically after NUBAC disc arthroplasty. The median preoperative VAS value for radicular pain was 9 (minimum:8, maximum:10) which was decreased to 1 (minimum:0, maximum:4) 2 years postoperatively. This difference was found statistically significant ($p<0.05$). It is hard to attribute this decrease to NUBAC implantation directly. This decrease seems mostly secondary to discectomy and root decompression. When we look at the ODI and VAS scores for low back pain, an increase was found between the preoperative and postoperative values. But this increase was not statistically significant ($p>0.05$). We blame facet joint violation for the responsible of this increased LBP after surgery.

Our study is unique since this is the first NUBAC study that is carried out in a homogenous, pure disc herniation group at the level L4-5. The disadvantage of our study is the limited number of patients with short follow-up time. To make a more precise, evidence based suggestion to perform NUBAC disc arthroplasty, a prospective, multicenter, randomized, controlled clinical trial with a long follow up time is needed. 190

Nucleus replacement systems are promising devices which may help surgeons to alleviate pain while restoring motion and protect adjacent discs. Indications and surgical techniques should be individualized according to benefit to risk and benefit to cost ratio.

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Volume: 29, Issue: 1, January 2018 pp: 33-39 ORIGINAL ARTICLE

THE EVALUATION OF THE INFECTIONS AFTER ALGOLOGIC POSTERIOR PARAVERTEBRAL INJECTIONS

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ABSTRACT

Background Data: Recently, the development of algology and the increase of algological initiatives have accompanied complications. Especially in patients with immune system disorders, epidural abscesses, facet joint septic arthritis, or abscess formation in paravertebral muscles have significantly increased after corticosteroid injections, especially applied to the disc, around nerve roots and facet joints.

Aim: The aim of this study is to evaluate the cases of infections after 1028 algological treatments in 3 hospitals.

Patients and Method: In this study, 24 patients who were referred to Orthopedics and Traumatology clinics with low back pain and fever, were evaluated retrospectively. 16 of the patients were male and 8 were females. The mean age was determined as 62.6 ± 10.4 (46-92). These patients were questioned for diabetes mellitus, history of tuberculosis, immunodeficiency syndromes and their epidemiological characteristics. The isolated microorganisms and complications associated with clinical findings have been evaluated and classified. In addition, it has been investigated whether the infections are eradicated or not in these treatments. Root blockage was found in 12 (50%) of the infected patients, facet joint injection in 6 (25%) and paravertebral intramuscular injection in 6 (25%). 4 (16.7%) of these patients developed epidural abscesses, 4 (16.7%) had facet joint septic arthritis, and 16 (66.6%) of them developed paravertebral intramuscular abscess formation. All of the patients were surgically drained and facet joint fusion was performed in the cases of septic arthritis.

Results: There were 1028 cases of algological intervention in the last two years in these three hospitals. It was determined that 24 or more of these cases developed superficial or deep infection. The infection rate was generally found to be as high as 2.34%. Additionally, It was found that 8 (33.3%) of the patients had received insulin-dependent diabetes mellitus treatment, 12 (50%) received oral antidiabetic drugs due to Type-2 diabetes, and 1 patient had a treated tuberculosis. No cases were found to have immunodeficiency (such as AIDS). Prophylactic antibiotics were not used in any of the patients. At the end of the treatment regimen, CRP and ESR values decreased statistically and came to normal values ($p < 0.05$). The variance analysis shows that the most important predisposing factors were; cigarette, DM and the processing conditions of the injections ($p < 0.05$).

Conclusion: It has been detected that the use of prophylactic antibiotics is particularly important in patients with impaired immune system and diabetes mellitus. It has been suggested that the most important measure in the prevention of infections in algological interventions is to perform these procedures in sterile conditions, especially in operating room conditions with positive pressured ventilation.

Key words: Paraspinal injection complication of algological intervention, infection, epidural abscess

Level of evidence: Retrospective clinical study, Level III.

INTRODUCTION

Throughout history, pain has become one of the most important health problems of human beings. Throughout life, every person has had at least one complaint of back pain [(1)].As a result, in modern medical applications, a medical discipline which deals with pain treatment has emerged. Many specialists working in this field are usually injecting analgesics

and corticosteroids into facet joints or foraminal areas to find causes leading to low back pain or for therapeutic purposes [8]. Algological intervention procedures have been used frequently in recent years, especially in destructive and metastatic involvement of the spine, such as malignant tumors, disc hernias or spinal stenosis, where neuronal structures are repressed [2] It has been determined that there are 5 major complications in these interventions [12]. **1)** Allergic reaction. Usually, the allergy is to the X-ray contrast or steroid; rarely to local anesthetic. Life threatening or severe allergies are rare. **2)** Bleeding. A rare complication, bleeding is more common for patients with underlying bleeding disorders or in patients on blood thinners. **3)** Discomfort at the point of the injection or worsening of pain symptoms. These symptoms are usually mild and short-lived. Long lasting increases in pain are rare. **4)** Nerve or spinal cord damage or paralysis. While very rare, damage to the spinal cord or spinal nerves can occur from direct trauma from the needle, or secondarily from infection, bleeding resulting in compression, or injection into an artery-causing blockage. **5)** Infection. Minor infections occur in less than 1 % to 2 % of all injections. Severe infections are rare, occurring in 0.1 % to 0.01 % of injections [2, 8].

In this study, the rates of superficial and deep infections that are rarely seen during paraspinal algological interventions were evaluated, the predisposing factors in these patients were investigated and treatment options were discussed.

PATIENTS AND METHODS

In this study, 24 patients who applied to 3 different hospitals with the complaint of low back pain and fever after para spinal injections during the last 2 years were evaluated retrospectively. There were 1028 cases in which the algological procedures were performed in these 3 hospitals and 24 (2.34%) of these cases were found to develop superficial or deep infection. 16 of the patients were male and 8 were females. The mean age was determined as 62.6 ± 10.4 (46-92). These patients were questioned for diabetes mellitus, history of tuberculosis or immunodeficiency syndrome and their epidemiological characteristics. The isolated microorganisms and complications associated with clinical findings have been evaluated and classified. It was also investigated whether the infections were eradicated after treatments. 24 patients who developed infection after algological injections were evaluated in terms of the causes of predisposing factors such as age, sex, smoking, diabetic, immunodeficiency disease, malignancy and the infected part the of the spine.

Clinical and Laboratory Examination

All of the patients were applied to the hospital with severe pain and high fever, and 4 (16.7%) patients had neurological deficits. Histories of all the patients were similar which was about paravertebral joint injection after drug-resistance back pain. In their laboratory test, CRP, ESR and WBC increases was established. Main CRP value was 11.5 ± 5.1 mg/dl and ESR value was 61.0± 17.7 mm/h in patient's first admittance. Four of the patients had neurological deficits. The lower limb muscle strength was 2/5 at 2 cases, 3/5 at 1 case and 4/5 at 1 case.

Radiological Evaluation

Definitive diagnosis was made with MR examinations. Root blockage was found in 12 (50%) of the infected patients, facet joint injection in 6 (25%) and paravertebral intramuscular injection in 6 (25%). 4 (16.7%) of these patients developed epidural abscesses, 4 (16.7%) had facet joint septic arthritis, and 16 (66.6%) of them developed paravertebral intramuscular abscess formation.

Surgical Technique

All of the patients were surgically drained and facet joint fusion and debridement was performed in cases of septic arthritis. Four patients with epidural abscess with neurological deficit underwent emergent posterior decompression and epidural abscess drainage with physiological saline and posterior short segment instrumentation with extensive decompression.

Four patients (16.7%) underwent epidural abscess drainage with posterior decompression, and 3 of these 4 patients underwent short segment posterior instrumentation for preservation of spinal stability (Figure-1).

In 4 patients with facet joint septic arthritis, articular debridement and facet fusion with local auto grafts was performed because of unilateral involvement.

In patients with paravertebral abscess formation, only a short incision was inserted into the abscess loin, abscess was drained, and the infected tissues were debrided. In patients with paravertebral abscess formation, abscess cavity is drained with a short incision and the infected tissues are debrided (Figure-2).

Microbiological Tests and Antibiotherapy

In 17 (70.8%) patients Staphylococcus aurous was produced, in 4 (16.7%) patients no micro-organism was produced. Pseudomonas aeruginosa, E. coli and Proteus and Klebsiella was produced in one of the patients each. (4.2%). Empirical antibiotherapy was given initially. After the bacteria was isolated from the culture specimen the regimen was changed.

Patients were followed up with CRP, and antibiotherapy was continued until the level of CRP fell below 0.5.

Statistical Analysis

SPSS v21.0 for Windows (SPSS, Armonk, NY, USA) was used for statistical analysis. Student T-test and one way ANOVA test and Pearson correlation tests were used. The probability value was taken as 0.05.

RESULTS

Twenty-four patients who had previously been injected from the waist and had fever and resistance to painkillers were included in this study. In the last 2 years, 16.7% of

the patients who underwent algological intervention were found to develop infection following the procedure. In the MRI study, 4 (16.7%) had epidural abscesses, 4 (16.7%) had facet joint septic arthritis and 16 (66.6%) had paravertebral intramuscular abscesses (Table-1).

In 17 (70.8%) patients Staphylococus aureus was produced, in 4 (16.7%) patients no micro-organism was produced. Pseudomonas aeuroginosa, E. coli and Proteus and Klebsiella was produced in one of the patients each (4.2%).

In all patients, paravertebral, epidural and facet joint septic arthritis were surgically debrided, using parenteral antibiotics for a mean of 4.7 ± 1.3 weeks, followed by oral antibiotics for 2 weeks. Antibiotherapy treatment was followed by a decrease in CRP of less than 0.5.

At the time of admission, CRP and ESR values were determined as 11.5 ± 5.1 mg / dl and 61.0 ± 17.7 mm / h, respectively. At the end of the treatment, it was determined that CRP and ESR values decreased significantly, and all patients had normal levels ($p < 0.05$). All patients who had epidural abscesses with neurologic deficit at the time of admission had full neurological improvement after operation.

All of the 4 (16.7 %) patients who developed epidural abscess were included in the 12 (50 %) patients who underwent root blockade. Patients with facet joint septic arthritis were all found to be from patients with root blockade. Almost all of the paravertebral intramuscular injection models have localized abscess formation in the muscle. Infection was eradicated in all patients after a mean of 4.7 ± 1.3 weeks parenteral and 2 weeks after oral antibiotherapy, and there was no recurrence of any infection except a patient within 2 years of follow-up. The recurrent patient (%4,2) has facet joint arthritis who was over 60 years old and was performed root blockade before. The wound was reopened in this patient and VAC treatment was applied and the wound was left to secondary healing.

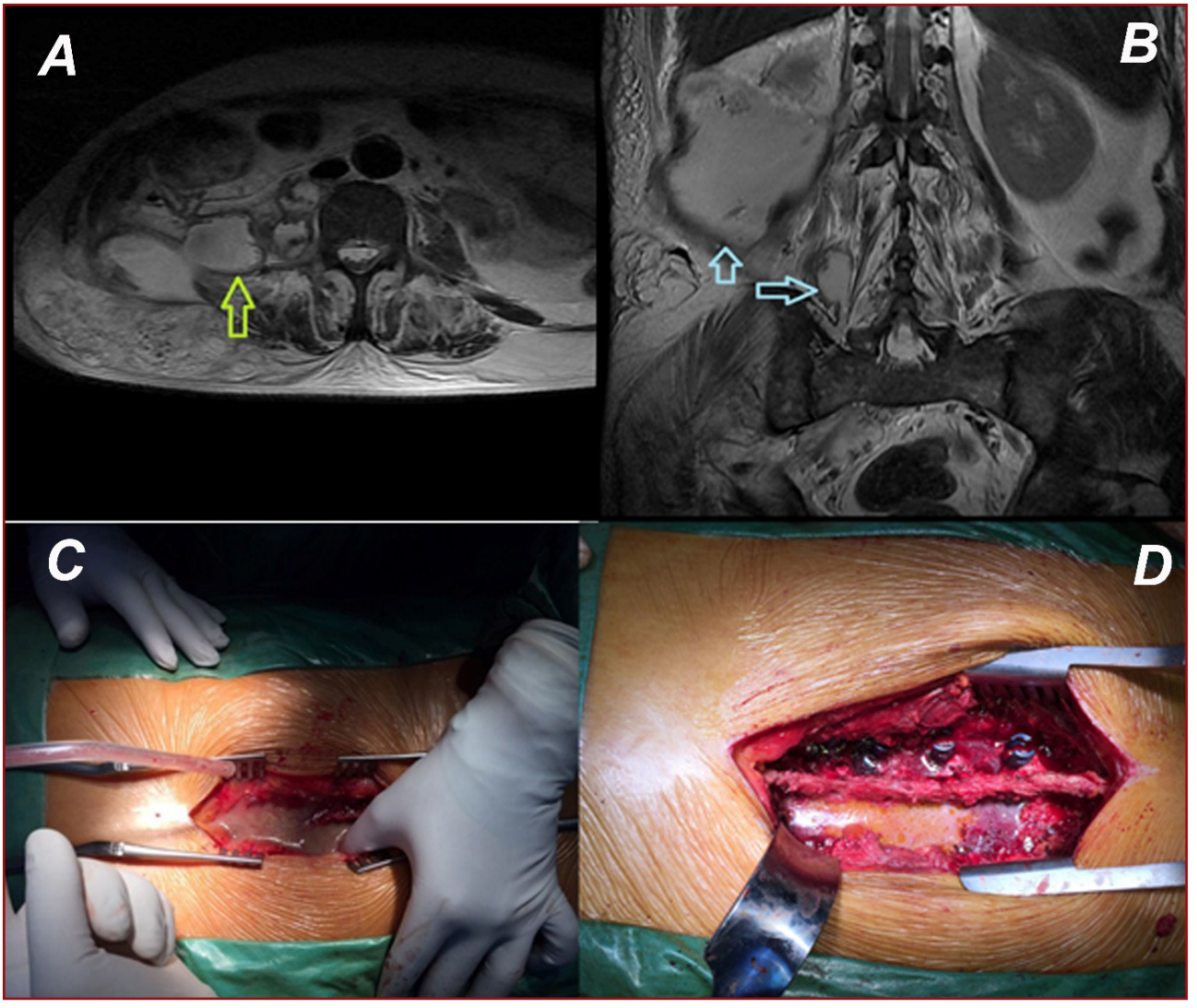

Figure-1. A) Epidural apse formasyonu gelişen ve retroperitoneal bölgeye apse yayılımı lan hastanın preoperatif aksiyel, **B)** coranal MR görüntüleri. Apse ok ile işaret ediliyor. **C)** Epidural apse drenajı için dekompresyon ve **D)** debridmanı takiben yapılan enstrümantasyon görülüyor.

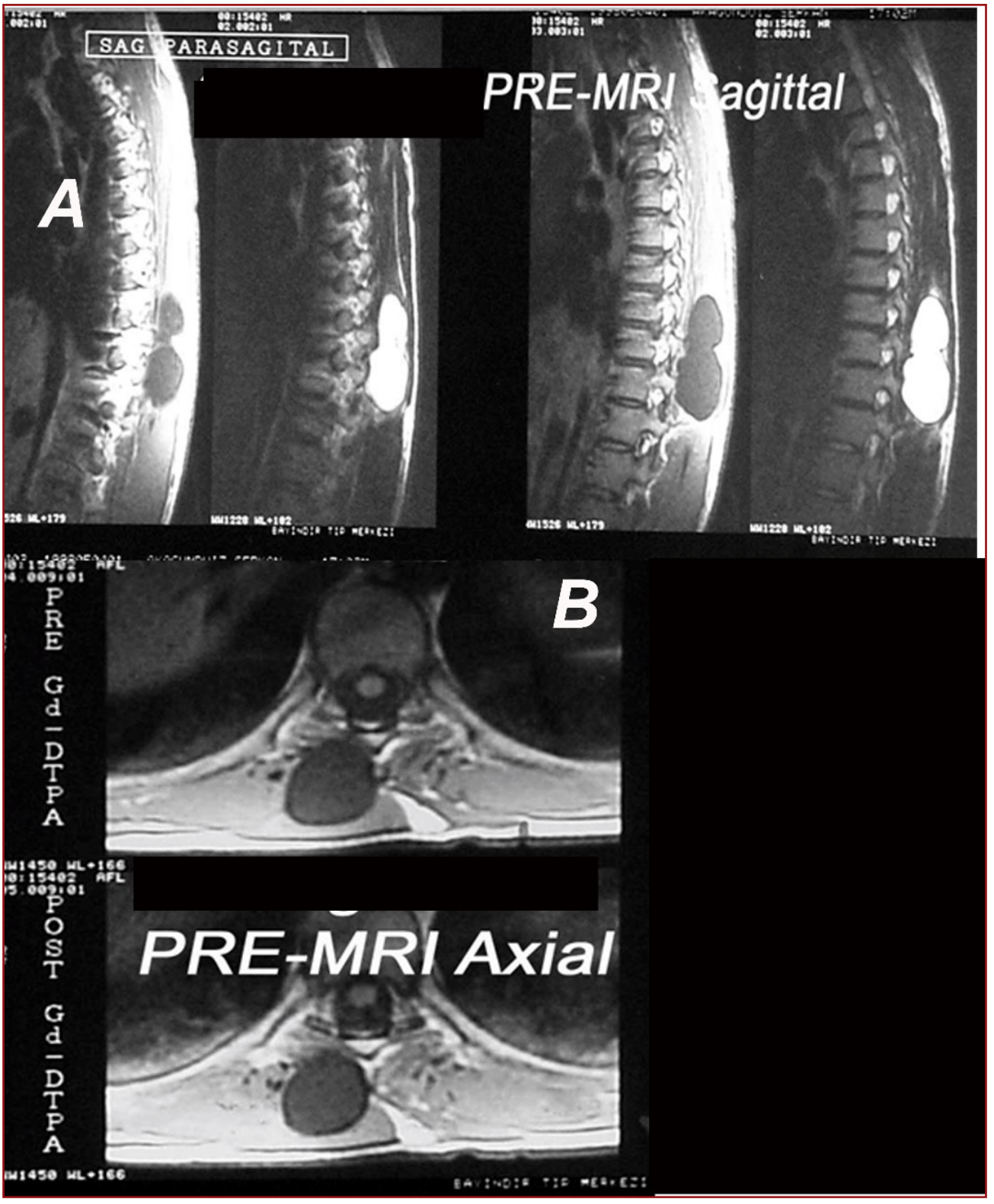

Figure-2. Paravertebral adele içinde apse formasyonu gelişen hastanın **A)** sagittal ve **B)** aksiyel MR görüntüleri.

Table-1. Hastaların epidemiyolojik bilgileri, laboratuvar değerleri, klinik bulguları ve predispozan faktörlerin var olup olmadığı görülüyor.

P-no.	Name	Sex	Age	AI	SI	CRP	ESR	MO	Where	TA (week)	Smoking	DM	ID	Operation	Recurrence	Last CRP	Last ESR
1	DF	F	66	FJI	FJA	7,7	64,6	SA	OPC	3	(+)	(+)	(-)	D+FJA	(-)	0.11	4,6
2	EG	M	74	FI	EA	22,4	105	PA	OPC	6	(+)	(+)	(-)	D+L+PE	(+)	0.42	3,2
3	FG	M	60	FI	EA	12,6	53	SA	OPC	3	(+)	(+)	(-)	D+L+PE	(-)	0.05	3,4
4	DD	M	92	FI	EA	16,4	102	EC+P	OPC	6	(+)	(+)	(-)	D+L+PE	(+)	0.5	4,4
5	AC	F	75	FI	EA	9,9	78	SA	OPC	6	(+)	(+)	(-)	D+L	(-)	0.5	4,9
6	SS	M	46	FI	PSA	17,5	44,4	(-)	OPC	6	(+)	(+)	(-)	Drenage	(-)	0.5	5
7	AG	M	49	FI	PSA	11,6	56,2	SA	OPC	6	(+)	(+)	(-)	Drenage	(-)	0.01	3,4
8	SD	M	65	PSM	PSA	6,5	44,9	SA	OPC	4	(+)	(+)	(-)	Drenage	(-)	0.04	0,5
9	DE	F	61	PSM	PSA	5,7	48,9	(-)	OPC	4	(-)	(-)	(-)	Drenage	(-)	0.1	0,5
10	KA	M	62	FI	PSA	7,4	44,2	(-)	OPC	4	(+)	(+)	(-)	Drenage	(-)	0.22	0,5
11	ST	F	73	PSM	PSA	4,4	62,4	SA	OPC	3	(-)	(-)	(-)	Drenage	(-)	0.05	0,5
12	SR	M	51	FJI	FJA	11,4	68,8	KP	OPC	4	(+)	(+)	(-)	D+FJA	(-)	0.42	0,5
13	CF	F	56	FJI	PSA	11,9	69,7	SA	OPC	4	(+)	(+)	(-)	Drenage	(-)	0.44	0,5
14	SH	M	61	FJI	FJA	11,9	74,1	SA	OPC	4	(+)	(+)	(-)	D+FJA	(-)	0.44	0,5
15	BA	M	77	FJI	PSA	11,3	68,2	SA	OPC	4	(+)	(+)	(-)	D+FJA	(-)	0.43	0,5
16	BT	M	45	FI	PSA	18,4	89,8	SA	OPC	6	(+)	(+)	(-)	Drenage	(-)	0.33	0,5
17	YY	F	62	FI	FJA	25,6	86,9	SA	OPC	8	(+)	(+)	(-)	Drenage	(-)	0.49	4,9
18	YG	M	66	PSM	PSA	6,7	59,8	SA	OPC	4	(+)	(-)	(-)	Drenage	(-)	0.05	1,1
19	ZD	M	57	PSM	PSA	7,1	35,9	(-)	OPC	4	(+)	(-)	(-)	Drenage	(-)	0.12	2,2
20	SM	F	65	FJI	PSA	12,6	67,4	SA	OPC	6	(+)	(+)	(-)	Drenage	(-)	0.21	2,8
21	MA	M	61	FI	PSA	12,7	68,9	SA	OPC	6	(+)	(+)	(-)	Drenage	(-)	0.23	3,9
22	TE	M	49	FI	PSA	11,7	71,4	SA	OPC	6	(+)	(+)	(-)	Drenage	(-)	0.11	2,9
23	NA	F	64	FI	PSA	10,9	58,9	SA	OPC	6	(+)	(+)	(-)	Drenage	(-)	0.07	0,5
24	SK	M	66	PSM	PSA	7,7	44,8	SA	OPC	4	(+)	(+)	(-)	Drenage	(-)	0.05	3,2
Av.			62,625			11,48092077	61,0025			4,7320416						0	2,265073029
SD			10,37617			5,115662225	17,66475			1,3010412						0	1,726825725

P-No: Number of patient, AI: Algologic intervention, SI: Side of infection, MO: Mikroorganisma, TA: The time of antibiotherapy, DM: Diabetes mellitus, ID: Immun deficiency
EA: Epidural abscess, FI: Foraminal Injection, PSM: Paraspinal muscle injection, FJI: Faset joint injection, FJA: Septic arthrit of faset joint, PSA: Paraspinal abscess in the muscles
SA: Staph. Aereus, EC+P: E.Coli ve Proteus, PA: Pseudomanas Auregenesa, OPC: Outpatient clinic, OT: Operation theatre, D+FJA: Drenaj+faset eklem arthrodezi,
D+L+PE: Laminektomi ile dekompresyon, debridman ve posterior enstrümantasyon, Av. Average, SD: Standart deviation

The age and gender of the patient were not correlated with infection rates (r-age: 0.11, r-sex: 0.06, p> 0.05).it was determined that the patients diabetic status, smoking habits and injection molding environment had direct correlation with infection severity (r-diabet: 0.66, r-smoking: 0.56, r-injection environment: 0.76, p< 0.01) and these three variables were found to have one way similar variant analysis. (p< 0.05).

DISCUSSION

Pyogenic infections of the spine, especially in elderly patients, arise in the presence of predisposing factors and by micro-organisms that hematogenously originate from a primary infection site. These predisposing factors are; immunodeficiency diseases, immune suppressive treatment of the patient, diabetes mellitus, metabolic diseases malabsorption syndromes and malignancy [1,6] . Other important mechanisms in spinal infections are contaminations after surgical interventions [7]. Postoperative spine infections generally occur in cases where sterilization conditions are not observed and active infection focuses are ignored during the operation. That is why it is very important that the operation area, the operating room, the operators' hands, and the operating material and instruments used are as sterile as possible [7]. In general, infection is very rare in spinal and epidural anesthesia [5,9]. The main complication of such attempts is that the risk of injury to the neural structures and anesthesia are maintained at higher levels than desired [8]. Infection in paravertebral algological injections is even less common. Minor infections occur in less than 1 % to 2 % of all injections. Severe infections are rare, occurring in 0.1 % to 0.01 % of injections [2,8]. In this study, it was determined that there were 24 cases of infection after algological invasive procedures and that the prevalence of infection rate was 2.34 %, which is consistent with the rates given in the literature.

In this study, 4 (16.7 %) patients had epidural abscesses, 4 (16.7 %) facet joint septic arthritis and 16 (66.6 %) paravertebral intramuscular abscesses. All of the 4 (16.7 %) patients who developed epidural abscess were found in 12 (50 %) patients who underwent root blockade. Four (16.7 %) of the patients with facet joint septic arthritis were also found to be from patients with root blockade. Almost all of the paravertebral intramuscular injection models have localized abscess formation in the muscle. Although no significant statistical correlation was found, it is thought that foraminal injections were more risky for epidural abscess and facet joint arthritis.

Paravertebral injection for back pain is wide spreading with clinicians for severe back pain diseases. It is believe that interarticularis steroid injection is the important way for the diagnosis and treatment of the paravertebral facet and other joint inflammatory disease. Paraspinal abscess are rare seen diseases and delay in diagnosis. The main aim of the paraspinal abscess is eradication of the infection, measuring of recurrent and neurologic deficit, remove of the back pain and stabilization of the spinal and paraspinal integrity. Although diagnosis is delay, surgical treatment and correct antibiotherapy results is successful and have good prognosis. In this study, the microbiologic agent is generally Staphylococcus Aureus (70.8 %).

No growth was detected in culture in 4 cases. In the literature, negative culture rate is reported very high (8). In these patients, empirical antibiotherapy was started until the antibiotic susceptibility test .Parenteral antibiotics are used for 3-4 weeks to the patients with paravertebral intramuscular abscesses and 6 weeks to the patients with epidural abscess and facet joint arthritis, and subsequently oral antibiotics were used for 2 weeks. antibiotherapy continued until the level of CRP decreases below 0.5.

Four patients (16.7%) were diagnosed as epidural abscess, all underwent extensive decompression and three were treated surgically by posterior instrumentation. Postoperative neurological situations were completely resolved in these patients with various grades of neurological deficits.

There are about 40 cases published in the literature until the present day that septic arthritis develops after intra-articular steroid injections. Two facet joint arthritis included in this study are 2 new cases participating in this issue. Both of these cases developed after injection of facet joints and were surgically treated. Cook and colleagues published cases of paraspinal abscesses in 1999 [4].

Alcock et al. [3] reported that epidural abscess formation developed in a patient with facet joint infection in 2003, and Rhue et al. (2011) presented a case of epidural abscess and paraspinal abscess in 2011.[10] Pilleul and Garcia mentioned about the importance of MR in early diagnosis in patients with facet joint arthritis [8]. In this study, the entire paravertebral abscess formations were diagnosed with MR.

As with all pyogenic post-operative infections, the predisposing factors for infection development after algological processing are approximately the same [2]. In this study, it was determined that age and gender did not play a role in the predisposition. Especially in patients with diabetes, smoking and outpatient clinics were found to be statistically significant (p <0.05). According to the data of this study, patients with diabetes must quit smoking and algological procedures should be performed under positive pressure surgical theater conditions.

The most important limitation of this study is that the rate of predisposing factors in all algological treated patients is not taken into consideration and there is no comparison with infected patients. For this reason, it is clear that a prospective study will be more realistic in terms of determining the incidence of paraspinal infection in all algological procedures over a period of time. Obviously only a prevalence value obtained in this study.

Horlocker, suggest that the behavioral habits of the anesthesiologist are one of the determining factors in increasing the incidence of infection at spinal and epidural anesthesia even though all sterilization conditions are provided. It has been observed that the anesthesiologists or algologists who entered the treatment did not wash as if they

had entered an operation, they did not usually wear sterile gowns and repeated the operation with the same injectors [5].

As a result, algological procedures should be performed under maximum sterile conditions and compliance with sterilization rules, if possible in positive pressure operating rooms and prophylactic antibiotics should be used to prevent paraspinal infections if there are predisposing factors in the patient.

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Volume: 29, Issue: 1, January 2018 pp: 41-44 ORIGINAL ARTICLE

CERVICAL DEGENERATIVE DISC DISEASE: ANALYSIS OF CLINICAL SERIES

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ABSTRACT

Objective: The aim of the study is to analyze the surgeries for cervical degenerative disc disease with anterior approach in a year.

Materials and Method: We inspected 82 patients who were operated for cervical spinal problems between January-2017 and December-2017 at Department of Neurosurgery. The parameters that evaluated are the level of disease, side of the cord compression and type of surgery.

Results: Data of a total of 82 patients were included in the study. Mean age of the participants was 48,9 ± 11,1 years, M/F was 36 / 46 (43.9 % vs. 56.1 %). The lesions were on the left side in 44 cases (53.7 %), on the right side in 30 cases (36,6 %), and bilateral in 8 cases (9,8 %). Most frequent level was C5-6, C6-7 (n=17; 20,7 %). 79,3 % of the patients had cage operation, and 17,1 % had cage + plate. The comparisons of the clinical parameters between males and females revealed that age (p=0,091), lesion side (p=0,169), level (p=0,414) and operation type (p=0,599) were similar between genders.

Conclusions: Anterior cervical discectomy and fusion is the most efficient, safe and selected surgical technique in our clinic for the treatment of degenerative cervical disc diseases.

Key Words: Cervical degenerative disc disease, anterior cervical discectomy, cervical radiculopathy.

Level of Evidence: Retrospective clinical study, Level III

INTRODUCTION

The most suggested surgery technique for cervical degenerative disc diseases is anterior cervical discectomy and fusion (ACDF). Many trials have been carried out to get better results from the procedures, and it was essential to develop new graft materials and implants but these changes could not always guarantee better results [16].

Lahey and Warren described anterior cervical approach to expose esophageal diverticula [9]. Then Smith and Robinson had first applied this approach to cervical spine and reported the result of anterior cervical interbody fusion by using a horseshoe-shaped graft harvested from iliac crest but there was no attempt to remove the structure compressing neural structure and simply disc was removed and autologous bone graft was filled in the hollow space to conduct the fusion [15].

Cloward reported interbody arthrodesis by using dowel type graft [2]. It is applied Wiltberger's lumbar interbody dowel fusion technique on cervical spine, and unlike Smith-Robinson technique, it removed not only discs but also all lesions that compressing the neural structure anteriorly under direct visualization, and used a large drill to prepare the area for bone graft [2].

After its introduction in the treatment of degenerative cervical lesions, ACDF is widely used and is reported to produce good results. In our study we try to analyze our experience of anterior approach cervical procedures for cervical degenerative disc diseases in a year retrospectively.

MATERIALS AND METHODS

We inspected 82 patients who were operated for degenerative cervical disc

disease with the anterior cervical approach technique between January-2017 and December-2017 at Department of Neurosurgery. Cervical stenosis, fractures and spondylopaties excluded from the study. The information were collected from the patients file achieves retrospectively. Radiological data were inspected from the PACS system. The parameters that evaluated are the level of discopathy, side of the disc herniation and type of surgery.

Statistical Analyses

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

RESULTS

Data of a total of 82 patients were included in the study. Mean age of the participants was 48,9 ± 11,1 years, M/F was 36 / 46 (43.9 % vs. 56.1 %). The lesions were on the left side in 44 cases (53.7 %), on the right side in 30 cases (36,6 %), and bilateral in 8 cases (9,8 %). Most frequent level was C5-6, C6-7 (n=17; 20,7 %). 79,3 % of the patients had cage operation, and 17,1 % had cage + plate (Table-1).

The comparisons of the clinical parameters between males and females revealed that age (p=0,091), lesion side (p=0,169), level (p=0,414) and operation type (p=0,599) were similar between genders (Table-2).

Table-1. General characteristics of patients

	Mean	**SD**
Age	48,9	11,1
	n	**%**
Sex		
Male	36	43,9
Female	46	56,1
Side		
Left	44	53,7
Right	30	36,6
Bilateral	8	9,8
Level		
C2-3 sequestrated DH	1	1,2
C3-4, C4-5	2	2,4
C3-4, C4-5 DH + C5-C7 OPLL	1	1,2
C3-4, C4-5, C5-6	6	7,3
C3-4, C4-5, C5-6, C6-7	1	1,2
C4-5 operated DH and C4-5, C5-6, C6-7	1	1,2
C4-5, C5-6	6	7,3
C4-5, C5-6, C6-7	13	15,9
C4-5, C6-7	2	2,4
C5-6	16	19,5
C5-6, C6-7	17	20,7
C5-6, C6-7, C7-T1	1	1,2
C6-7	14	17,1
C7-T1	1	1,2
Operation		
Cage	65	79,3
Cage+plate	14	17,1
Revision	3	3,7

Table-2. Comparisons of clinical parameters between males and females

	Male	Female	p
	Mean±SD	**Mean±SD**	
Age	46,4±9,5	50,9±11,9	0,091
	n (%)	**n (%)**	
Side			0,169
Left	21 (58,3)	23 (50)	
Right	14 (38,9)	16 (34,8)	
Bilateral	1 (2,8)	7 (15,2)	
Level			0,414
C2-3 sequestrated DH	1 (2,8)	-	
C3-4, C4-5	2 (5,6)	-	
C3-4, C4-5 DH + C5-C7 OPLL	-	1 (2,2)	
C3-4, C4-5, C5-6	3 (8,3)	3 (6,5)	
C3-4, C4-5, C5-6, C6-7	-	1 (2,2)	
C4-5 operated DH and C4-5, C5-6, C6-7 Discopathy	-	1 (2,2)	
C4-5, C5-6	4 (11,1)	2 (4,3)	
C4-5, C5-6, C6-7	7 (19,4)	6 (13)	
C4-5, C6-7	-	2 (4,3)	
C5-6	5 (13,9)	11 (23,9)	
C5-6, C6-7	6 (16,7)	11 (23,9)	
C5-6, C6-7, C7-T1	1 (2,8)	-	
C6-7	7 (19,4)	7 (15,2)	
C7-T1	-	1 (2,2)	
Operation			0,599
Cage	29 (80,6)	36 (78,3)	
Cage+plate	5 (13,9)	9 (19,6)	
Revision	2 (5,6)	1 (2,2)	

DISCUSSION

Cervical degenerative disc disease is a common cause of pain and disability. Most symptomatic cases present between the ages of 40-60, although many individuals never develop symptoms [5]. Cervical radiculopathy is a common cause of pain and can result in progressive neurological deficits [6]. Many conservative treatment modalities like physical therapy and injection were described. MRI studies have documented the presence of cervical degenerative disc disease in 60 % of asymptomatic individuals aged greater than 40 years and 80% of patients over the age of 80 years [10,11].

Anterior cervical discectomy and fusion (ACDF) is a standard surgical procedure in the treatment of symptomatic cervical radiculopathy and myelopathy [7]. It affords the surgeon the ability to provide direct (from the discectomy) and indirect (through restoration of disc height) decompression and stabilization [4]. Various implant and graft devices have been developed for use with ACDF [18]. The anatomy of cervical spine must be well known for the better results of the operations [8].

Kim et al reported the largest serie operated for cervical radiculopathy with 1420 cases [6]. They found that the levels most often affected were C6 and C7, the most common primary procedure performed to treat radiculopathy was ACDF (50 % of cases), the overall revision rate was 6.4 % for cases where the index procedure was performed at the same institution and clinical adjacent segment pathology was the most common reason for revision surgery comprising 4.2 % of cases at 3.3-year follow-up [6].

Despite the overall success of ACDF, the complex and potentially dangerous anatomy of an anterior cervical approach has been associated with high complication rates [12,17]. Complications of ACDF could be exampled as dissection injuries (vascular, esophageal, and tracheal), nerve injuries, hyperostosis, CSF fistula and bone graft site injuries[3].

Many of the complications are hypothesized to be related to increased tissue edema and damage due to retractor placement, increased operative time, and prolonged intubation [12]. The donor site complication due to the use of host bone led to the morbidity rate of 20% or higher, and it is presented as pain in the donor site, seroma, hematoma, infection, hip fracture, and Meralgia Paresthetica [14]. Allogenic bone graft and synthetic devices were suggested to resolve those problems.

TDR has been proposed as an alternative treatment to ACDF. Cervical arthroplasty maintains motion and believed to decrease the adjacent segment disease and reduce the rate of reoperations [1]. Literature have shown similar outcomes for ACDF and TDR(13). TDR is not indicated for cervical disease at more than 2 levels. These devices are indicated for skeletally mature patients for reconstruction of disc following discectomy at a single level or adjacent levels for radiculopathy or myelopathy. In our series we did not use any TDR.

Mayo et al described a significant surgical learning curve associated with ACDF in their study and they reported that as a surgeon performs more operations, decreases in procedural time and estimated blood loss are observed [12]. The most meaningful portion of improvement occurs during the first 60 cases, with arthrodesis rate increasing over a longer time period; however, no difference in hospital length of stay, complication rate, or improvements in postoperative pain were demonstrated with increased surgeon experience [12].

CONCLUSION

Anterior cervical discectomy and fusion is the most efficient, safe and most selected surgical technique in our clinic for the treatment of degenerative cervical disc diseases.

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Volume: 29, Issue: 1, January 2018 pp: 45-48 CASE REPORT

TUMOR-LIKE SPONTANEOUS LUMBAR EPIDURAL HEMATOMA IN A PATIENT UNDER ANTICOAGULANT TREATMENT

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ABSTRACT

Spontaneous spinal epidural hematomas occur relatively rare in comparison with postoperative spinal epidural hematomas. Usually, patients present themselves with extreme radicular pain, axial pain depending on the level of hematoma, and progressive neurological deficit. Spinal epidural hematoma is a neurosurgical emergency characterized in the spinal epidural space. Whatever the reason is behind the hematomas, for patients with progressive spinal cord compression symptoms, surgical operation is usually preferred.

Key words: Anticoagulant treatment, epidural hematoma, surgical treatment

Level of evidence: Case report, Level IV

INTRODUCTION

Spontaneous spinal epidural hematomas (SEH) is a rare condition, and it usually occurs after spinal surgery with the rate of occurrence being 0.1 – 3 % [11,15]. Most epidural hematomas that occur after spinal surgery are asymptomatic; however, in the rare instance that a spinal epidural hematoma becomes clinically significant, devastating neurologic complications can result. Its symptoms vary. Clinically, SEH has been reported with hemiparesis, paraparesis, and tetraparesis [1,7,13,18]. Meningitis, Gullian Barre, subarachnoid bleeding, and stroke are also in the definitive diagnosis. There are also some risk factors for spinal epidural hematoma after spinal surgery, such as multilevel procedures, preoperative coagulopathy, postoperative coagulopathy, anticoagulation therapy, being older than 60 years of age, preoperative nonsteroidal anti-inflammatory drugs (NSAIDs), Rh-positive blood type, hemoglobin being less than 10 g/L, and surgical blood loss of 1 L or more [6,8,11,13].

Spontaneous spinal epidural hematomas (SSEH) occur relatively rare in comparison with postoperative spinal epidural hematomas (SEHs). The rate of incidence of SSEH is estimated to be 0.1 patient per 100 000 individuals and it is often seen in patients above the age of 50 [3,6-7].

CASE REPORT

A 50-year-old female patient presented back pain and left leg pain. She had no history of trauma or sciatic leg pain. Upon physical examination, bilateral Laseque test was positive with 60 degrees of elevation, and she demonstrated decrease sensation the S1 dermatome. She was using Coumadin for heart valve disease. After the laboratory test, her INR was 3.6. There was round shaped, cystic and heterogenic lesion pressing on the S1 root that appeared hyper intense on the T1 and T2-weighted lumber MR images (Figure-1).

We planned the surgical operation and stopped using Coumadin. When INR was under 2, we gave clexane 0.6. When the INR score was 1.5, we decided to start the operation and thus stopped the previous clexane dose. We performed left hemi laminectomy.

Membranous hemorrhagic lesion was removed from the epidural field and sent to the pathology lab. We cleaned the neural tissues and responded to the patient's postop complaints successfully.

We gave Clexane and Coumadin simultaneously after the surgery. When the INR was above 2, we stopped giving the clexane and continued the treatment only with Coumadin and anticoagulants.

Pathology results were sported as the lesion with blood and fibrin elements. In the MRI images after 1 year, the blood was seen to be resorbed (Figure-2).

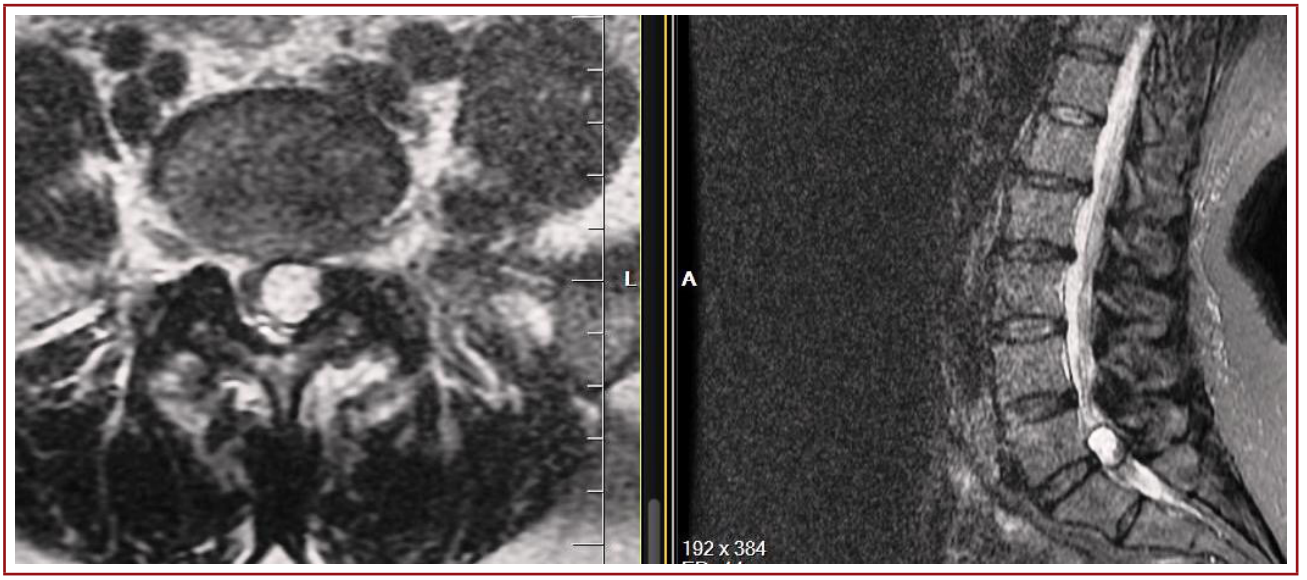

Figure-1. There was round shaped, cystic and heterogenic lesion pressing on the S1 root that appeared hyper intense on the T1 and T2-weighted lumbar MR images.

Figure-2. In the MRI images after 1 year, the blood was seen to be resorbed on lumbar region.

DISCUSSION

Non-traumatic spinal epidural hematomas are extremely rare complications. The first case of SSEH was reported by Jackson in 1869 [8], and there have been numerous reports published in the literature ever since [3]. Usually, patients present themselves with extreme radicular pain, axial pain depending on the level of hematoma, and progressive neurological deficit [9,14,16].

The origin of SSEH being venous or arterial is a debated topic [19]. Most authors agree that the rupture of the valve less epidural venous system is the bleeding source of hematoma. Congestion that occurs before the ruptures of vein form the basis of the physiopathological mechanism [4,10,17].

Although the cause of the disease has not exactly been made clear, some researchers have reported that it is the result of venous epidural plexus defects [5]. Beatty and Winston suggests that even the epidural hemorrhages connected to anticoagulation therapy or lumbar puncture could be better conceptualized as arterial hemorrhages [2,12].

MRI is a useful neuroimaging tool of choice. We can see the correct position of the hematoma, cord compression and spinal cord edema [5]. In the acute phase, findings of MRG are as follows: (a) under variable signal intensity (the hematoma shows as isointense or hyperintense regarding to the spinal cord on the T1 weighted images and as a hypointense signal on the T2 weighted images) (b) covering up the epidural fat (c) adjacent the bone structures and continuity (d) compression of the epidural fat subarachnoid area and spinal cord (e) hematoma is generally localize posterolateral of spinal canal [3-4,12,14].

Most of the researchers agree that preoperative neurological status is a more important factor than neurological recovery [2,4,19]. Foo and Rossier examine 158 patients with spinal epidural hematomas and describe their surgical treatment results. They find that before the operation motor recovery was present in 63 (92.6 %) of the 68 patients whose preoperative sensory or motor lesions were incomplete, but only in 24 (45.3 %) of the 53 subjects with complete cord lesions [4].

Whatever the reason is behind the hematomas, for patients with progressive spinal cord compression symptoms, surgical operation is usually preferred [2,5,7,16]. The success of the operation depends on how much time has passed between the beginning of the symptoms and the surgical operation [3-4,17]. The results of the operation are better for the cases where the SSEH is localized in lumbosacral areas than the cases where it is localized in thoracal areas or the cases where hematomas are localized at a vertebra level [1,3-4]. Spinal channel is narrower in thoracic and cervical areas than in lumber areas. Therefore, the distance where the hematomas will localize is smaller in cervical and thoracal areas than in lumber areas. Also, because in lumber areas there is a larger epidural distance for the localized epidural hematomas, in such cases, clinical process is more insidious [5,17,19]. Multilevel thoracic spinal epidural hematoma could be treated with hemilaminectomy and hematoma draining. Total laminectomies, because they could cause additional pressure on the spinal cord, could cause iatrogenic damage [8,10-11]. If the symptoms are clinically not progressive or if there is an indication of an early recovery, surgery is not found necessary [12].

Boukobza et al. report 11 spinal epidural cases. Among these, 5 of them are treated with conservative methods. In three of those treated with MRG, hematoma is observed to have disappeared after 6 days, and in 2 of those treated with MRG, after two months [2,5]. Our case gave similar symptoms as to acute beginnings and sciatic-like pain patterns. We first thought of lumber disk hernia during the diagnosis and assigned the patient an urgent lumber MRI. MRI images showed that the bulk-like structure that gave the symptom of pressing symptoms is indeed hematoma. Thus, we took the patient immediately to the surgery room.

Based on the information from previous research, we find that the use of anticoagulant could cause SSEH cases, surgical treatment results correlates with the patient's preoperational neurological examination, the duration between the symptom and the treatment is important for surgical success; and conservative ways of treatment could be an option in patients with decreasing symptoms and nonexistent neurological deficits.

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Volume: 29, Issue: 1, January 2018 pp: 49-52 CASE REPORT

HEMATOMA OF LIGAMENTUM FLAVUM CAUSE TO DROP FOOT

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ABSTRACT

Ligamentum flavum hematoma is a very rare entity that can occur in any part of the spine. Etiology is still unclear while the minor trauma and ligamentum flavum degeneration are the potential suspects. Patients can present with either radiculopathy or myelopathy according to the location. MRI is the most important tool for the proper diagnosis. The differential diagnosis include juxtafacet cysts, disk herniation and spinal cord tumors. Treatment is usually surgical with favorable surgical outcomes. Ligamentum flavum hematoma should be kept in mind in the differential diagnosis of intraspinal cystic lesions that lead to neurological deficits.

Key words: Ligamentum flavum, hematoma, drop foot, intraspinal cyst

Level of evidence: Case report, Level IV

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INTRODUCTION

Foot drop due to lumbar radiculopathy is commonly seen as a result of disk herniation, spondylosis, tumor and abscess formation [14-15,18]. Less frequent is ligamentum flavum pathologies including hypertrophy, calcification, buckling and cyst formation [2,17]. We report an extremely rare case of ligamentum flavum hematoma (LFH) that leads to foot drop.

CASE REPORT

History and Neurological Examination

A 55-year-old male patient was admitted to our neurosurgery department with the chief complaints of buttock pain and foot weakness on the right side. His right buttock pain that has been radiating to his right leg and foot had started nearly 2 months ago. And 2 days ago, he had noticed that he could not move his right foot towards himself. He has no history of any systemic illness, trauma or anticoagulant treatment. His neurological examination revealed paresis of the right foot and toe dorsiflexion (tibialis anterior muscle 2/5 and extansor halluces longus 1/5 strength on manual muscle testing) and hypoesthesia of right L4/L5 dermatomes. Deep tendon reflexes of the lower extremities were normal as well as bladder and bowel function. Straight leg raising test was negative.

Imaging

Lumbar MRI demonstrated an ovoid mass lesion that 25 was compressing the right L5 root. The lesion was hypointense on T1 weighted images and hyperintense on T2 weighted images. Minimal enhancement was noted after contrast injection.

Operation

Patient underwent decompression surgery under general anesthesia. A 3-4 cm long median skin incision was made on the level L4-5. After the right fascia was dissected, muscles were retracted by the help of a Casper retractor. Under the operating microscope, the inferior half of the L4 lamina was removed by preserving facet joint. Any cyst was not observed related with the facet joint. The ligamentum flavum was identified as a thick, solid, brownish mass that was firmly adherent to the thecal sac. It was removed completely following the releasing of adhesions from thecal sac microsurgically. Satisfactory decompression of right L5 root was obtained. Any disk herniation or tumor mass was not found. Posterior

instrumentation was not necessary since the facet joint remained intact.

Pathological Findings

Histopathological examination showed presence of fresh hemorrhage affecting the ligamentous and synovial connective tissue.

Postoperative Course

The patient had immediate pain relief early after surgery. Neurological examination demonstrated normal strength at anterior tibial and 4/5 muscle strength at extensor hallucis longus muscles at 1 month follow-up.

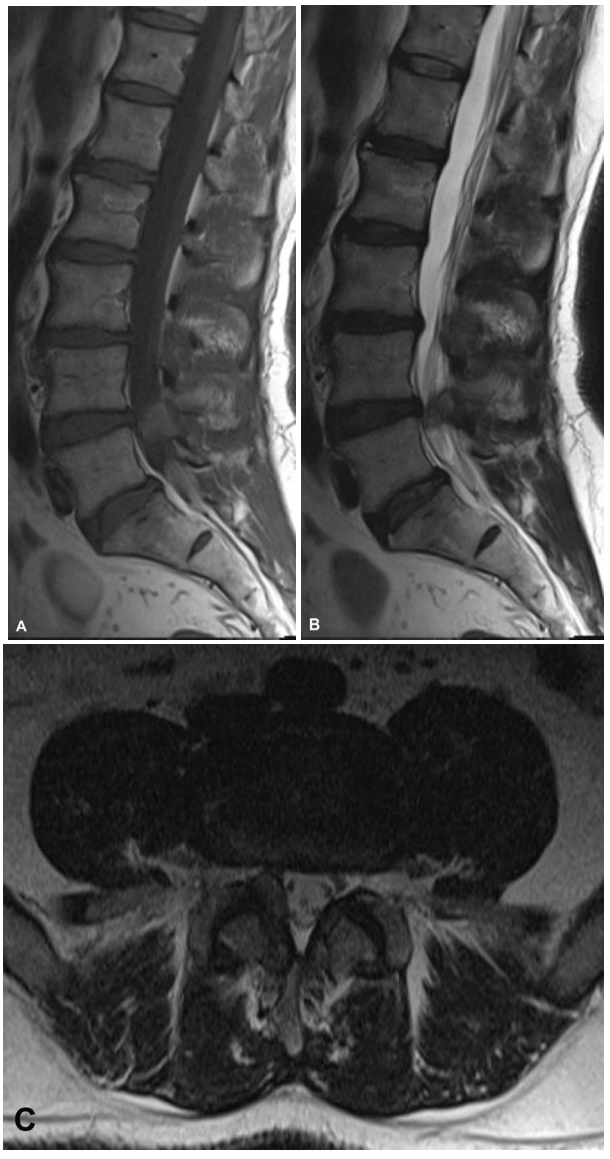

Figure 1. Posterior epidural mass lesion is seen that is hypointense on **(a)** sagittal T1-weighted MR image and heterogenous on **(b)** sagittal T2-weighted MR image. This mass lesion exerts significant compression to right L5 root **(c)** Axial T2-weighted MR image.

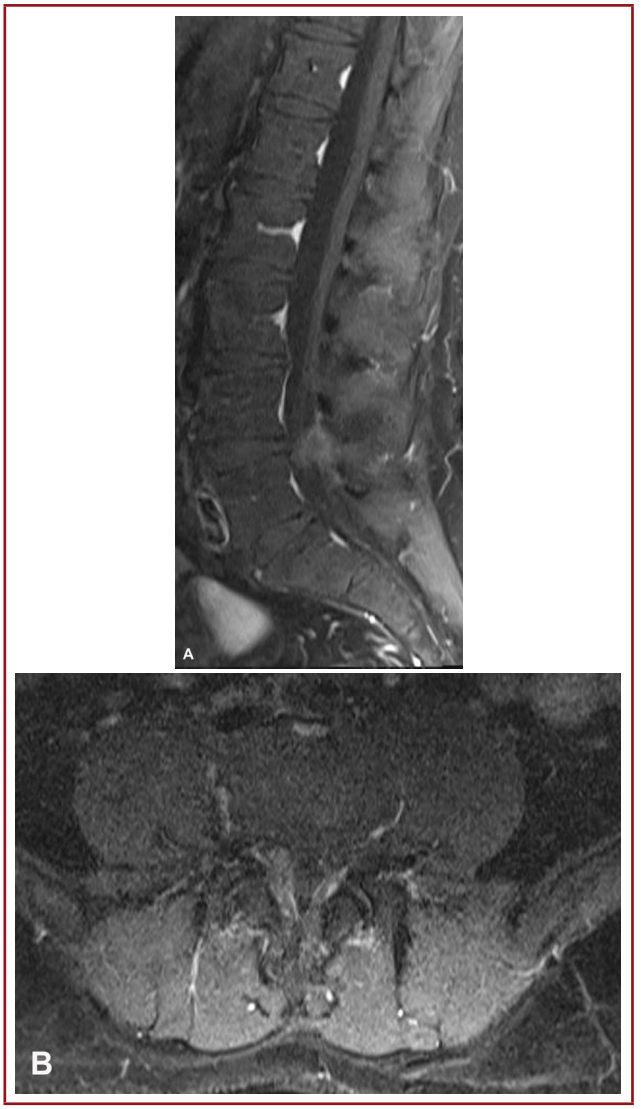

Figure 2. T1-weighted **(a)** Sagittal and **(b)** axial images show weak enhancement after contrast injection.

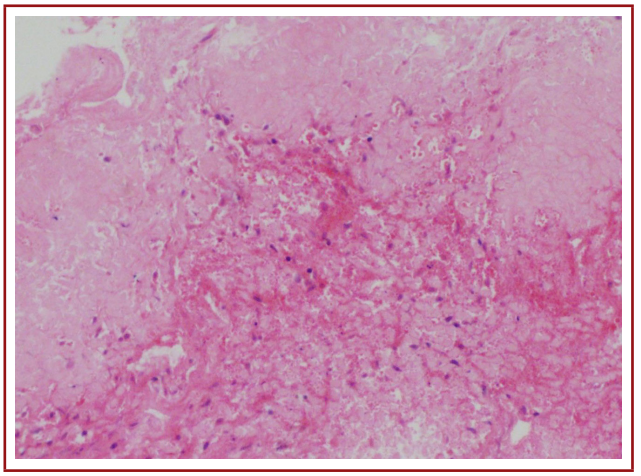

Figure 3. Histopathological examination demonstrate presence of erithrocytes in ligamentous connective tissue (Hematoxylin and Eosin x200).

DISCUSSION

Ligamentum flavum (LF) is a discontinuous structure starting from C2 vertebra to sacrum [4,14]. It extends from the middle portion of the superior lamina to the cranial part of the inferior lamina. Laterally, it fuses with the facet joint capsule [11,14,17]. It helps to maintain an upright posture and resume an upright posture after bending [14,18]. LF is a well-defined elastic structure that includes elastic (80 %) and collagen (20 %) fibers and contains a few thin walled blood vessels in young healthy adults [14]. However, increased collagen consistency and more blood vessels are seen in the degenerative LF [14].

Ligamentum flavum hematoma (LFH) is an extremely rare entity that was reported first by Sweasey et al in 1992.14 Since then, there are various publications reporting LFH in the cervical, thoracic and lumbar regions of the spine [1,3,5-9,13-14,18]. Analysis of previous case reports demonstrated that LFH has some significant properties as follows; the lumbar region especially lower segments are the most affected part of the spine. Most patients are middle aged or elderly males with the history of hypertension. Trivial trauma precedes the onset of symptoms [4,18]. Our patient is also a middle-aged man but no history of trauma or any systemic illness exists. Similar to the literature, L4-5 level is affected in our patient.

The exact mechanism of the hematoma development in ligamentum flavum is still unclear. However, some mechanisms have been proposed to explain. The most popular mechanism involves the rupture of the tiny and irregular blood vessels in the ligamentum flavum that occurs secondary to increased abdominal and spinal epidural pressure after a minor trauma even sneezing and straining [14-15,18]. The second suspected mechanism explains the hematoma formation by the blood flow from the facet joint to the degenerated ligamentum flavum forming hematoma inside [2,10].

Nishida et al blamed the synovial hyperplasia with an increased number of capillary vessels at the facet joint capsule as the source of hematoma [11]. However, confusion was present about how the blood goes from the facet joint to the degenerated LF until the study of Wilby et al [17]. In their clinicopathologic study, they demonstrated bursa-like channels originating from the medial aspect of facet joints, where the joint capsule is a part of the ligamentum flavum, and extended within the ligamentum flavum in variable lengths [17]. Thus, the pathophysiology of the synovial cysts on the ligamentum flavum and the LFH has been better understood.

Magnetic resonance imaging (MRI) is the most important tool in order to diagnose LFH [7,14-15,18]. In some doubtful cases, CT scans could also be ordered as supplements to MRIs. The intensity of the lesion on MRIs can demonstrate some changes according to the deoxyhemoglobin or methemoglobin contents of the hematoma. In other words, stage of the hematoma is the main determinant on the intensity of the MRI [7,14-15,18]. In most LFH cases, mass lesions are hyperintense on T1 weighted MR images while heterogeneous intensity is seen on T2 weighted images. Peripheral enhancement can be observed after the administration of contrast material.

The differential diagnosis of LFH include juxtafacet cysts (synovial cyst, ganglion cyst, degenerative micro cysts and osteophyte impingement cysts), disk herniation and spinal cord tumors [17]. Since juxtafacet cysts all look like similar on imaging methods, it is not easy to differentiate this lesions based on only the morphology or contrast enhancement. Synovial cysts have an extensive synovial cell lining and they are either communicated directly with the facet joint or located in the ligamentum flavum far away from the facet joint but connected to it via bursa-like channel [17]. Ganglion cysts do not communicate with joints. They lack a special cellular lining and contain viscous fluid [17].

Although a herniated disk fragment can migrate to a posterior or posterolateral location in spinal canal, they are much more common in the anterior part. Furthermore, LFHs are incorrectly diagnosed as spinal cord tumors since LFH has a round shape on MRI. However, LFH is always attached to the ligamentum flavum and shows weak enhancement after contrast injection [15,17].

Treatment consists of both conservative and surgical methods. Patients who are experiencing severe pain in spite of narcotic analgesic therapy and patients withsignificant neurologic deficits are good candidates for surgical treatment [1,3,5,8,18].

Surgical techniques consists of both open and microsurgical techniques [1,3,5,8,16,18]. Furthermore, recent reports also indicated that endoscopic surgery could also be a reasonable alternative to classic methods [12]. If the LFH is located on the midline on MRI, total laminectomy can be performed to resection of LF. However, if the lesion is settled paracentral near the facet joint, fenestration under the operating microscope can be the best option in order to preserve facet joint and dissect the LF from the thecal sac without dural tear occur [16]. Surgical outcomes are almost excellent [1,4-5,7-9,14-16,18].

Literature search shows a few numbers of patients suffering from LFH in a wide spectrum of L5 radiculopathy from sciatica only to severe neurological deficits [3,5,7]. To the best of authors' knowledge, our report is the second case with a foot drop that developed secondary to LFH in the English literature. Different from the first report, our patient was diagnosed and operated via microsurgery just 2 days after the symptoms' onset. Thus, more favorable and faster outcome was achieved in terms of neurological deficits.

In conclusion, ligamentum flavum hematoma is a very rare entity. It can occur in any region of spine from axis to sacrum. It should be kept in mind in the differential diagnosis of intraspinal cystic lesions that lead to neurological deficits.

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Volume: 29, Issue: 1, January 2018 pp: 53-55 CASE REPORT

PERIOPERATIVE CARDIAC ARREST OF A YOUNG MALE DURING KYPHOSIS OPERATION: CASE REPORT

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ABSTRACT

There are complications related to blood loss, impaired liquid-electrolyte balance, drug side effects due to anesthetic applications and overdose complications due to airway and ventilation problems, central venous intervention, iatrogenic neurological and vascular injuries, internal organ injuries, cardiac arrest due to vagal reaction or any other idiopathic causes in spinal surgery. The aim of our study is to pass on our experience about cardiopulmonary arrest development, which is a rare complication in a perioperative period, and treatment of this situation in a patient with Scheuermann's kyphosis who is planned to operate with posterior surgery. Our patient was a male, 17 years old, 170 cm long, weighing 50 kg with a T3-T12 lateral cobb angle of 77 degrees thoracic kyphosis without waist and back pain. During the operation, hyperkalemia, which was thought to be related to hemolysis and massive blood transfusion, was noticed as a pathological finding in the blood tests. The patient intervened with the defibrillator after starting ventricular fibrillation and spontaneous breathing after 45 minutes of resuscitation. He was taken to intensive care unit immediately. He was transferred to in-room service after 9 days. Post-operative evaluation of the patient did not reveal any neurological deficits due to global ischemia secondary to cardiac arrest or because of the surgical procedure. He was discharged after 4 days and started to work after 5 months. We thought that cardiac arrest development is associated with massive transfusion and /or hyperkalemia secondary to hemolysis. The cause of hemolysis was not clearly demonstrated.

Key words: Perioperative, cardiac arrest, kyphosis, spinal, Scheuermann

Level of Evidence: Case Report, Level IV

INTRODUCTION

In spinal deformity surgery there are complications related to blood loss, impaired liquid-electrolyte balance, drug side effects due to anesthetic applications and overdose complications due to airway and ventilation problems, central venous intervention, iatrogenic neurological (cauda equina syndrome, spinal cord injury, nerve root damage) and vascular injuries, internal organ injuries (bowel, bladder injury etc.) ,dead, malignant hypothermia, cardiac arrest due to vagal reaction or any other idiopathic causes [6,8].

Surgeon should be prepared for the potential complications of the surgery while preparing the patients for spinal surgery and the medical condition of the patient needs to be evaluated carefully. The most important determinants of the patient's health status and perioperative complications are comorbid diseases of the patient[1]. These diseases include lung diseases such as asthma, heart diseases such as coronary artery disease and cardiomyopathy, diabetes mellitus, hypertension, spinal cord injury and other chronic diseases [1]. Internal medicine doctors, anesthesiologists, should carefully assess patients pre-operatively and pediatric physicians for pediatric patients, and psychiatric doctors for patients who are taking medicines, and drug modifications should be recommended in patients with regular medication use.

It is important to describe the perioperative period and cardiac arrest terms in this study. The definition of perioperative period varies in many studies. It is defined as only intraoperative period [3], intraoperative period and time until wake up after anesthesia [7], postoperative

first 24 hours [8], postoperative first 2 days [4], postoperative first week and postoperative first month [2]. In our study, we mean intraoperative period by using the perioperative period term. Cardiac arrest can be defined as a condition requiring resuscitation by either closed or open heart massage [10].

The aim of our study is to pass on our experience about cardiopulmonary arrest development, which is a rare complication in a perioperative period, and treatment of this situation in a patient with Scheuermann's kyphosis who is planned to operate with posterior surgery.

CASE REPORT

Our patient was a male, 17 years old, 170 cm long, weighing 50 kg with a T3-T12 lateral cobb angle of 77 degrees thoracic kyphosis without waist and back pain. The patient underwent central venous catheter under general anesthesia. The patient were placed in the prone position with both shoulder and iliac crests with appropriate cushion supports. After the patient's paraspinal muscles were stripped, the thoracic spine vertebrae left-side T3-L1 facet joints vertebrae were revealed. Facet joint osteotomies were performed. Polyaxial screws were inserted into the left side vertebral pedicles up to T3 to L1. Approximately 2 hours and 15 minutes after the start of the operation, the anesthesia team stated that the cardiopulmonary arrest of the patient with mild restrictive pulmonary disease in the previous pulmonary function test was developed. The patient had no cardiac problems before the operation at the same time. The patient's incision was closed with a sterile sponge and pads and the patient's face was turned down and resuscitation was performed. Blood samples for blood gas and biochemical examination were taken while resuscitation was ongoing. Hyperkalemia, which was thought to be related to hemolysis and massive blood transfusion, was noticed as a pathological finding in the blood tests. The patient intervened with the defibrillator after starting ventricular fibrillation and spontaneous breathing after 45 minutes of resuscitation. Thoracal rib fractures and pneumothorax were noted during resuscitation. The patient was again turned over and the skin was closed with a stapler and taken to intensive care unit immediately. He was transferred to in-room service after 9 days. Post-operative evaluation of the patient did not reveal any neurological deficits due to global ischemia secondary to cardiac arrest or because of the surgical procedure. He was discharged after 4 days and started to work after 5 months.

We assessed the patient 10 months after the operation. He said there was no backache or backache. The lateral Cobb angle between the T3-T12 vertebrae was found to be 78 degrees **(Figure-1)**.

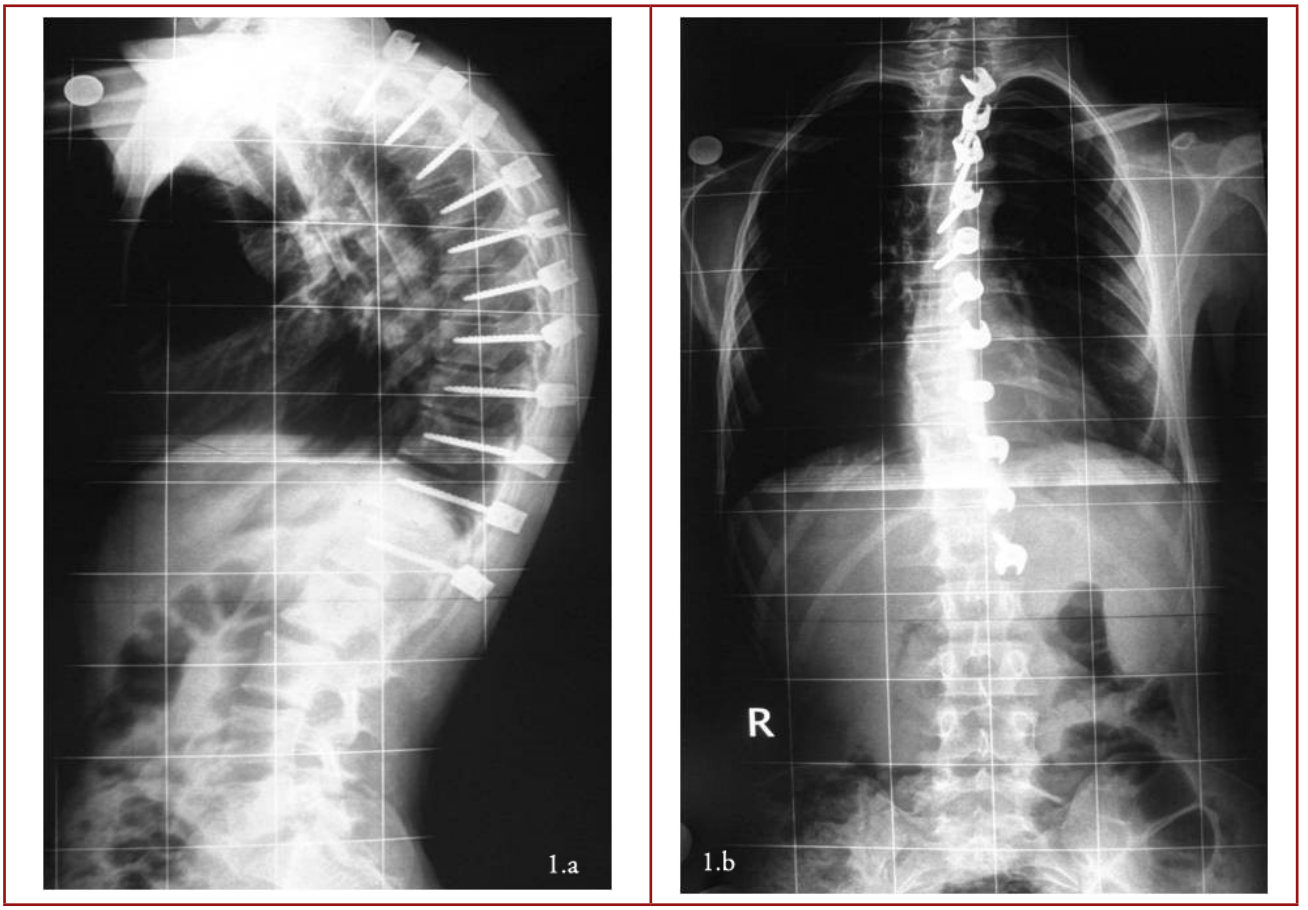

Figure-1. a. Postoperative lateral radiographic image. **b.** Postoperative AP radiographic imag

DISCUSSION

A large number of studies have been reported involving large, multi-center and large number of patients with perioperative cardiac arrest development. The incidence of perioperative cardiac arrest in these studies has been reported at a range of 4.6 / 10000-19,7 / 10000 [8-10].

Sprung et al. is stated that perioperative cardiac arrest is not related to anesthesia in most of the cardiac arrest events [10]. The most common etiology of perioperative cardiac arrest associated with anesthesia is neuromuscular blocker drugs. It has been asserted that neuromuscular blockers also cause cardiac arrest by causing hypoxia or causing drug-induced asystole [10]. According to this study, the prognosis after cardiac arrest was not related to age [10]. In the same study, it was also reported that it is associated with poor prognosis if accompanied by asystole with cardiac arrest. However, when an asystole cardiac arrest associated with anesthesia occurs, it is reported to have a better prognosis [10].

Newland C et al. found that about 10 % of cardiac arrest was associated with anesthesia in a large series of studies, they also found that 40 % of these anesthesia related cardiac arrest event were caused by drugs, 20 % of these by central venous interventions, 20 % by sinusoidal airway problems, 13 % by vagal reflex and unknown causes and 7 % of these by myocardial infarction [8]. In the same study, perioperative cardiac arrest was most commonly reported to occur at the operations, which are performed under general anesthesia.

Morgan et al. presented in their study that the most important cause of anesthesia-related cardiac arrest development is perioperative drug use. Other causes are vagal stimulation, hypoventilation, bleeding, and anaphylaxis [6]. These results support Newland et al. Since there are very few studies published in the field of orthopedic and spinal surgery related to the development of perioperative cardiac arrest, most of our literature searches were from sources related to anesthesia. Because the studies we have included in the article are extensive studies involving a large number of centers with a large patient population, the results they have concluded become a guide for us. As noted in most studies, we did not entirely blame the factors related to anesthesia for the development of cardiac arrest. Massive transfusion and / or hyperkalemia secondary to hemolysis are held responsible for asystole cardiac arrest development in our study. The cause of hemolysis was not clear.

One of the most important points in our study was that the patient responded to resuscitation 45 minutes after the onset of cardiopulmonary arrest. Although anesthesia and reanimation specialists mentions that the long duration of resuscitation may lead to brain death or neurological damage, knowing that patients return to life without any neurological sequelae will be used as a beneficial experience for surgeons dealing with spinal surgery.

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LUMBAR SPINAL ASPERGILLUS ABSCESS IN AN IMMUNOCOMPETENT PATIENT

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ABSTRACT

Only a few species of Aspergillus cause infections in humans. But, these infections lead highly mortal abscesses by located in the central nervous system and spine. It is accentuated frequently in the literature that these infections were seen in immunocompromised patients. The aim of this case report is that spinal involvement of Aspergillus should be kept in mind even in immunocompetent patients initially considered as tuberculosis by radiology. Mortality rate may be reduced by surgical decompression and rigorous antifungal therapy.

Key words: Aspergillus, Spinal abscess, Spinal tumor, Surgery

Level of evidence: Case report, Level IV.

INTRODUCTION

Aspergillus species is a widely present fungus existing in soil and decaying plants [(1)]. Vertebral involvement in aspergillosis is quite rare, and carries a high mortality rate for untreated cases [(2)]. Spinal epidural Aspergillus abscesses occur mostly in immunocompromised patients [(3)]. This rare abscess causes rapidly developing compressive symptoms. Most of the previous reports in the literature, spinal epidural Aspergillus abscess developed in immunocompromised patients. The aim of this case report is to present quite rare spinal extradural Aspergillus abscess and to draw attention that spinal Aspergillus abscess may cause compressive symptoms in immunocompetent patients also.

CASE REPORT

A 63-year-old male was admitted in December 2015 with complaining of back pain radiating to both legs more severe in the right one for a month. Numbness and burning pain in right leg became intensified, and a rapidly progressive right foot weakness supervened in the last week. Walking distance of the patient was getting decreased to 10 meters because of severe pain. Back pain was becoming more severe by bending forward. Neurological examination revealed slight positivity in the right straight leg rising, hyperalgesia in the right L3 dermatome and the right side hyperactive deep tendon reflexes. Mild tenderness by touching was detected on the L2-3 level on the right side of the backbone. There was no history of trauma or strain. An MRI revealed a low signal intracanalicular, 1x1x1,5 cm., round shaped, mass lesion at the right lower corner of the L2 vertebra on the sagittal T2W sequence. The lesion is seen as compressing the techal sac on the axial sequence (Fig. 1 A,B).

The patient was operated in prone position under operating microscope. Grayish white, approximately 1x1x1,5 cm., caudally located mass at the right L2-3 level was resected with its capsule. Techal sac was decompressed. Histopathologic examination disclosed basophilic material showed calcific degeneration with fungal hyphae and their dichotomous branching diagnostic for Aspergillus (Fig. 2).

After this diagnosis patient was investigated for immune system disorders such as AIDS, sexually transmitted disease, and was checked up on using immunsuppresor drugs, steroids etc. No finding supported immune deficiency or compromising was revealed.

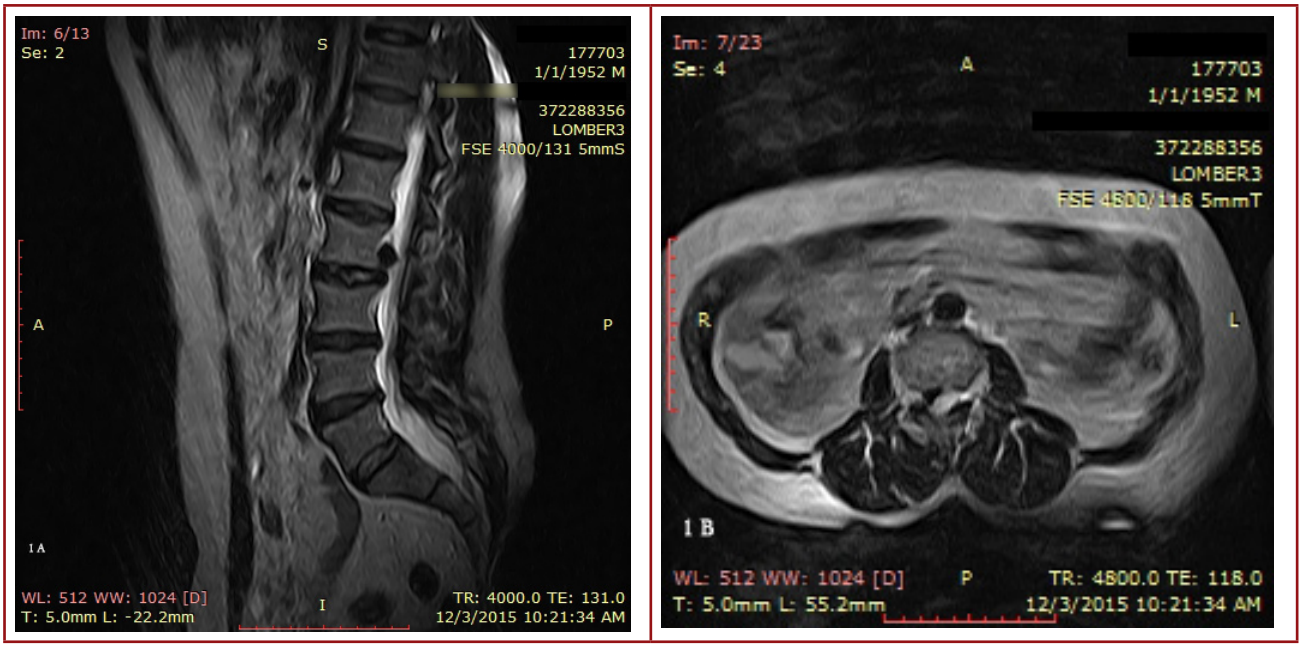

Figure-1. Sagittal **(A)** and axial **(B)** T2W MRI's shows intracanalicular low signal 1x1x1,5 cm. mass lesion compressing techal sac on lower right corner of the L2 vertebra.

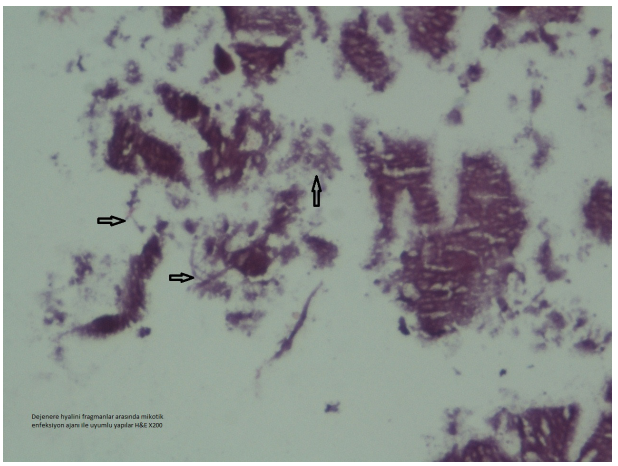

Figure-2. Photomicrograph (H&Ex250) revealed mycotic agents in degenerated hyaline field, hypha and conidia (arrows).

DISCUSSION

Aspergillus species can be found widely everywhere, but their invasive infections are quite rare with incidence of 12/1 000 000 population per year [3], and occur in immunocompromised patients frequently [1,2]. Only a few are pathogenic among approximately 300 known species [2].

A. flavus and fumigatus are the most widely species causing clinical diseases [4]. Its disseminated infection associated with a high mortality rate despite treatment [5]. New and safe treatment modalities cannot change this high mortality. Voriconazole treatment when adding surgery gives encouraging results for CNS Aspergillosis [6]. Vertebral or spinal aspergillosis may develop by hematogenous spread or by direct extension [7]. Radiologically differentiation of spinal Aspergillosis from tuberculosis is very difficult [1]. However disc space collapse is seen in tuberculosis frequently, whereas aspergillosis lesion tends to grow circumferentially and destroys all the surrounding vertebral structures [8].

Spinal aspergillosis develops as an infective vasculopathy-mediated sepsis or hemorrhage causing osteomyelitis evolving spinal abscess.

Therapy of spinal Aspergillus abscess must be multimodal. Drainage of abscess and appropriate antifungal medication are the backbone of therapy. Surgery provides decompression of neural structures and sample for histopathologic examination [9]. Mortality and morbidity are 95 % roughly despite the best treatment [10].

This presented case has some unique characteristics. First of all the patient did not have any immunocompromised condition. Secondly, his abscess located in quite rare region on the spine. In previously reported cases, Aspergillus abscess caused myelopathy, because of their location in cervico-thoracic region. In presented cases location is L2-3 disc space, so abscess caused radiculopathy. Thirdly, after operation and aggressive antifungal therapy, the patient improved well. As a conclusion, spinal involvement of Aspergillus should be kept in mind even in immunocompetent patients initially considered as tuberculosis by radiology.

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Volume: 29, Issue: 1, January 2018 pp: 61-64 CASE REPORT

MESENCHYMAL CHONDROSARCOMA OF THE SPINE, A GIANT RETROPERITONEAL MASS: A CASE REPORT AND REVIEW OF LITERATURE

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ABSTRACT

Spinal chondrosarcomas are rare lesions of spine and should be completely resected and resistant to adjuvant chemotherapy and radiotherapy. Partial removal of the tumor with the combination of adjuvant radiotherapy may be preferred for palliation of symptoms for advanced stage tumors. Here in, we present a 48-year-old male patient having a giant retroperitoneal mesenchymal chondrosarcoma originated spinal column.

Malignant lesions on the spine are challenging cases for both orthopedic surgeons and neurosurgeons. After years of experience, these tumors can be successfully treated. These operations, which have catastrophic complications such as paraplegia or tetraplegia, infection and sepsis, need to be performed in experienced centers. Under the light of this work and the literature, the idea was obtained which is it is necessary to make good planning before the first surgery in the primary chondrosarcomas of the spine and to protect the neural structures from being easily sacrificed during mass excision and to preserve the enblock total vertebra excision in order to prevent recurrence, prolong the life expectancy and improve the comfort of life.

Key words: Mesenchymal chondrosarcoma, paraplegia, primary malign spinal tumors
Level of evidence: Case report, Level IV

INTRODUCTION

Chondrosarcoma is an uncommon malignancy, which arises from a cartilaginous origin that accounts for 10 % of primary bone tumors [(15)]. Lichtenstein and Bernstein first identified them in 1959. Chondrosarcomas are classified into three subgroups, which are myxoid, mesenchymal and well differentiated. Mesenchymal chondrosarcomas are infrequent, aggressive and has extremely poor prognosis with rapid progression compared with the other two subtypes. Extra skeletal localizations are infrequent. Orbit, cranial and spinal meningeal sheets, lower limbs are where the most frequently observed [(7)].

En-bloc resection in the surgery is the preferred form of treatment. Palliative resection with or without chemotherapy and radiotherapy may reduce symptoms, especially pain when resection is not possible or in case of distant metastasis, but life expectancy is extremely short. In this paper, we present a 48-year-old male patient having a giant retroperitoneal mesenchymal chondrosarcoma.

CASE REPORT

A 45 year-old male patient admitted to clinic with complaint of abdominal tenderness, distension and pain. In his history, he underwent tibial surgery 8 years ago with the pathological diagnosis of osteosarcoma. After 6 months, cause of metastatic lung cancer, he had been operated four time for partial lung excision. Since 6 years he had well health and he had started to the work. One year ago, patient had complains of severe back pain and weakness in the legs. After physical and radiological examination, he diagnosed to have a spinal tumor in lumbar region. He had an unsuccessful surgery and tumor mass could not be removed also he had paraplegia after surgery. Two months after the operation, the patient admitted the hospital with severe fever. The patient was diagnosed as sepsis and who needs intensive care is referred to our hospital. In

the patient's examinations, leukocytes are 13000/mm^3(4600-10200/mm^3), c-reactive protein is 15.2 gr/dL(0-0.5mg/dL). Enterococcus faecalis is found in the culture taken from the puss in the surgical area.

The patient has taken to the operation. In the prone position, old incision was used. After debridement, posterior instrumentation was removed. Laminectomy area was widened and medulla spinalis damaged was noticed. Than posterolateraly, the tumoral mass was excised totally and the titanium cage with the bone cement was put in the vertebrectomy side posterolaterally. After the operation, he is recovered from sepsis. The patient is discharged on the 21st day after surgery.

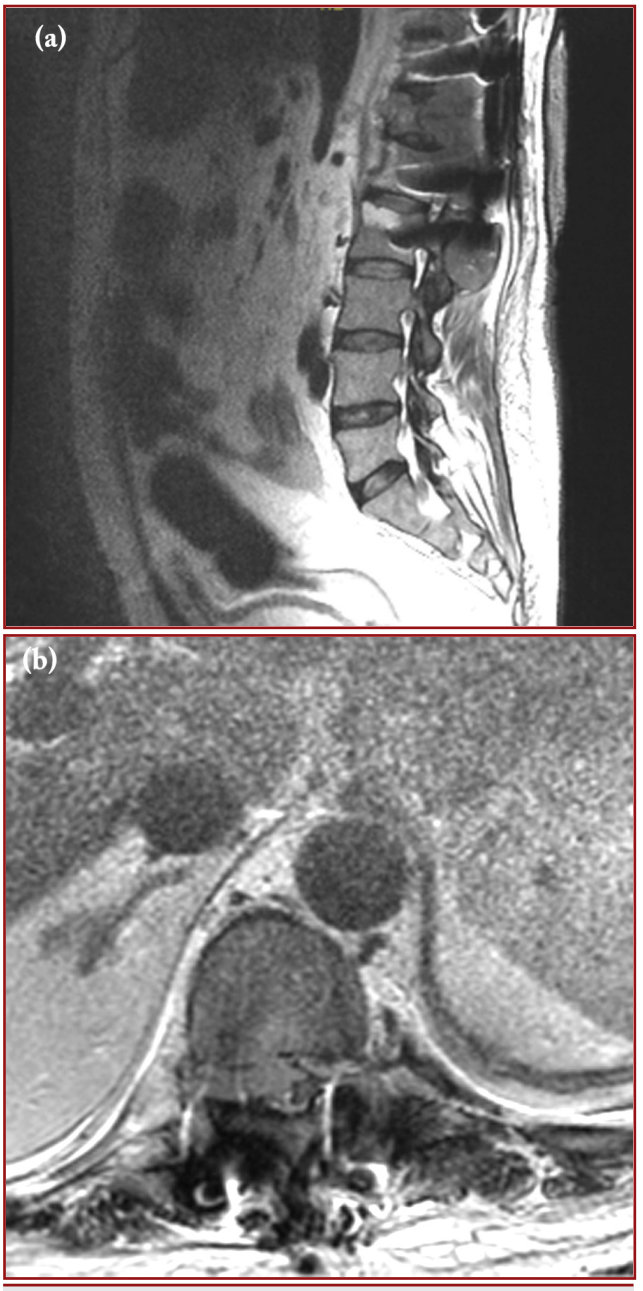

Figure-1. a) Sagittal and **b)** axial MR imaging of the patient with sepsis. Abscess formation was seen in the paravertebral area. Complete damage of spinal cord has been noticed.

Six months after the last operation, the patient admitted to clinic with a complaint of abdominal tenderness, distension and pain. In computed tomography (CT), two retroperitoneal localized, calcified, necrotic masses were found which are 20 cm and 35 cm in diameter. The patient undergone debulking surgery. Both masses are removed. During surgery, it was seen that, masses originated from the lumbar spine. Patient was followed up in the intensive care unit for 5 days and discharged on the 14th day. The result of the pathologic specimen was malign mesenchymal chondrosarcoma.

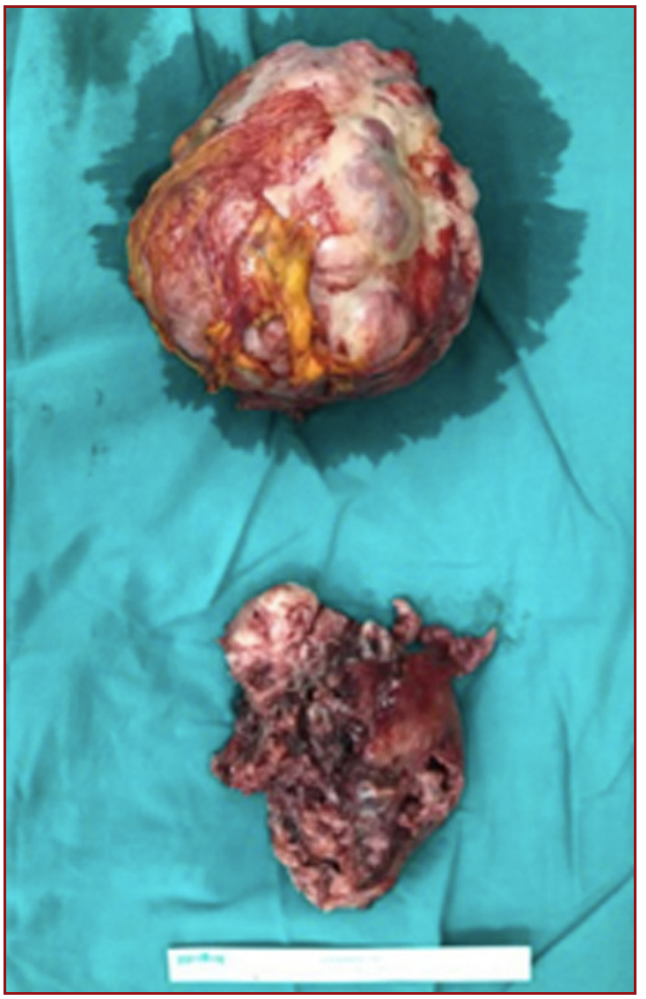

Figure-2. Two giant tumor specimens after the tumor excisions.

DISCUSSION

Chondrosarcomas are cartilaginous matrix synthesizing tumors and most of the chondrosarcomas arises from bones or cartilages. Chondrosarcoma is the third common malignant bone tumor following osteosarcoma and Ewing's sarcoma [(4)].

Chondrosarcomas are commonly located in the thoracic vertebrae and dominant in male gender. Cervical and lumbar vertebrae are second and third frequent locations [(13)]. Extraskeletal localizations are rare. Orbit, meningeal sheets

of central nervous system and lower limbs are frequent Extraskeletal locations [7]. Malignant tumor originated from lumbar spine in our patient. After completing the skeletal maturation, osteochondromas and enchondromas should be suspected of chondrosarcoma transformation if they grow or become painful. Chondrosarcoma of the osteochondromas is thickened by cartilage capillary lesions. Spread of lesion in neighboring vertebral segments taking into the disc is seen in 35 % of patients [12].

Well-differantiated and myxoid types grow slowly but mesencyhmal chondrosarcomas are more aggressive and tend to make distant metastases.

The type that holds the nervous system of extraskeletal mesenchymal chondrosarcomas is more frequent and most often 3rdand 4th decades. Non-skeletal mesenchymal chondrosarcomas involving soft tissues are seen over 40 years of age [1].

Conventional radiography has no impact on the diagnosis of mesenchymal chondrosarcomas but they mostly appear as destructive lesions in the spine or as a highly opaque calcified paraspinal soft tissue mass in computed tomography or magnetic resonance imaging. Peripheral and focal low attenuation areas are seen in contrast-enhanced computed tomography which are possibly present necrosis [14]. In magnetic resonance imaging of mesenchymal chondrosarcomas, intratumoral calcified and non-calcified components demonstrate low and high intensity on T2W1 images. This view of images are named as "salt and papper" sign [6]. Our patient did not have MRI but in CT images two calcified, central necrotic huge masses were found.

As in other malignant spinal tumors, it is difficult to determine the surgical resection boundaries due to the difficulty of local anatomy and the proximity of vital structures in spinal chondrosarcomas [2,12]. Whether vertebra localized or retroperitoneal localized, complete resection of the mesenchymal chondrosarcoma is of critical importance for prolonged survival. When complete resection is performed, 25% cure is obtained. The cases where the marginal resection can not be performed and the relapsed cases result in 74% fatality [2]. Complete resection with disease free wide margins should be accompanied by a histological examination[8]. For en-bloc resection of spinal chondrosarcoma, a multidisciplinary surgical team is needed including orthopedic, neuro and plastic surgeons[15]. Both radiotherapy and chemothrapy are used for adjuvant treatment but positive effect of these therapies on prolonged survival or local recurrence are limited. Better outcome in post operative proton-beam therapy is shown, especially for spinal lesions [5]. Despite all treatment modalities, 5-year survival is 54 %, 10-year survival is 27 % [11]. The case presented in this study was applied to a brain surgery clinic at another center due to pathological fracture and severe pain at T12-L1 vertebral levels, where marginal resection and posterior instrumentation were performed. This situation has increased the recurrence rate as mentioned above. When the patient was operated on because of paravertebral abscess, the recurrence of rapidly growing tumor mass was noticed. A titanium cage filled with internal cement was placed to prevent implant failure in the absence of anterior support.

In primary spine malignant tumors, neurological deficits occur in up to 20 % of tumors due to pressure or malignant invasion or due to arterial compression, occlusion and ischemia [12]. In the presented case, postoperative paraplegia development shows that neural structures are injured during mass excision. If complete resection of the tumor is not possible, partial removal followed by radiotherapy may provide palliation in symptoms such as pain or neurological deficiency [16].

Negative prognostic factors are high histological grade, advanced age and primary surgery out of a referral center [3]. In our patient's history, there were an unsuccessful surgical procedure causing paraplegia and sepsis. After referred to an experienced center in spinal surgery, he had prolonged treatment in intensive care unit for treatment of sepsis and two more operations to correct the complications of the first two operations, and finally the removal of two retroperitoneal masses.

The surgical planning the patient with malign mesenchymal chondrosarcoma is very imported and need wide experience. Instrumentation failure is inevitable result, if the anterior strut grafting or anterior cage or anterior instrumentation would not use. Infection is worst complication after the surgery of spinal tumors [15]. Infection rates are very high for the patient's immune system is reduced with chemotherapeutic drugs and the patient is generally in poor condition. The presenting case was also referred to our hospital because of sepsis. Infection with a broad abscess is linked to the surface infection of the implants. After removal of implants, abscess drainage and debridement, the infection could be controlled and the patient could be discharged from the intensive care unit [9-10].

Malignant lesions on the spine are challenging cases for both orthopedic surgeons and neurosurgeons. After years of experience, these tumors can be successfully treated. These operations, which have catastrophic complications such as paraplegia or tetraplegia, infection and sepsis, need to be performed in experienced centers. Under the light of this work and the literature, the idea was obtained which is it is necessary to make good planning before the first surgery in the primary chondrosarcomas of the spine and to protect the neural structures from being easily sacrificed during mass excision and to preserve the enblock total vertebra excision in order to prevent recurrence, prolong the life expectancy and improve the comfort of life.

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Marmara OMURGA Grubu

2018 MARMARA OMURGA GRUBU TOPLANTILARI

10 Ocak 2018 Çarşamba

Skolyoz cerrahisinde füzyon şart mı?

Moderatör: *Dr. Ünsal DOMANİÇ*

Füzyon şart - *Dr.Fatih DİKİCİ*

Füzyonsuz da olur - *Dr. Mehmet AYDOĞAN*

14 Şubat 2018 Çarşamba

Omurgayı tutan romatizmal rahatsızlıklar.

Moderatör: *Dr. Mehmet TEZER*

Romatolojik Bakış Açısı - *Dr. Yonca ÇAĞATAY*

Cerrahi Bakış Açısı - *Dr. Meriç Enercan*

14 Mart 2018 Çarşamba

Bel ağrısında ayırıcı tanı

Moderatör: *Dr. İrfan ÖZTÜRK*

Omurga ile ilişkili bel ağrısı - *Dr. Hüseyin BOTANLIOĞLU*

Omurga ile ilişkili olmayan bel ağrısı - *Dr. Erden ERTÜRER*

11 Nisan 2018 Çarşamba

Sagital plan analizi

Moderatör: *Dr. Erden ERTÜRER*

Konuşmacı: *Dr. Ahmet ALANAY*

9 Mayıs 2018 Çarşamba

Spinal deformite cerrahisinde hazırlık, kanama kontrolü ve bakım, klinik değerlendirme

Moderatör - *Dr. Teoman BENLİ*

Preoperatif hasta hazırlığı - *Dr. Nurullah ERMİŞ*

İntraoperatif kanama yönetimi ve postoperatif bakım - *Dr. İsmail OLTULU*

Postoperatif klinik sonuçların ve yaşam kalitesinin değerlendirilmesi - *Dr. Yunus ATICI*