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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 in 2019. We are happy to accomplish the forth issue of 2018.

There are 9 clinical research articles in this issue. One of them is biomechanical study. Three studies are about the epidemiology of chronic neck and low back pain, spinal infections. In fifth study, effecting on lumbosacral alignment with surgical treatment of isthmic spondylolysis about sagittal plane in spinal deformity. In next two article are about the cervical trauma. Ninth study is about sacral stress fractures.

In this issue, one case report about the complex regional pain syndrome following carpal tunnel surgery.

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 ARTICLES

BIOMECHANICS

EPIDEMIOLOGY

SPONDYLOLISTHESIS AND SAGITTAL BALANCE

CERVICAL TRAUMA

STRESS FRACTURE OF SACRUM

CASE REPORTS

Volume: 29, Issue: 4, October 2018 pp: 197-202 ORIGINAL ARTICLE

DOES THE SAGITTAL ORIENTATION OF THE PEDICLE SCREW AFFECT BIOMECHANICAL STABILITY? A FINITE ELEMENT STUDY

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ABSTRACT

Background: One of the most important steps in obtaining a successful outcome in spine surgery is appropriate placement of the pedicle screw. To test the hypothesis that sagittal angle of pedicle screw affects the biomechanical stiffness of the construct used in the spinal surgery, we evaluated the biomechanical results of different directions of pedicle screw on sagittal plane by performing a finite element (FE) analysis both in a single vertebral body and in a dual vertebral model.
Material/Method: Three-dimensional FE models of thoracic vertebrae (T10-T11) were used. The vertebral body was divided into three areas (upper, mid, lower one-third) in the sagittal plane. The entry points of the pedicle screw were same. The stiffness of different sagittal orientated screws in single vertebral body were evaluated in pull-out strength and in dual vertebral model strength of the screws were analyzed in flexion, extension and lateral bending movements.
Results: The screw at the upper one third of the vertebral body had the strongest pull-out load of 13.200N in single vertebral body model. The screw at the mid one-third of the vertebral body and lower-third of the vertebral body had 12.500N and 10.500N retrospectively. Flexion, extension and lateral bending tests had strongest loadings at upper one-third, mid one-third and lower one-third of vertebral body retrospectively.
Conclusion: The pedicle screw at the upper one-third of vertebral body in the sagittal was found to be more biomechanically stronger. This finding may be useful in clinical practice to prevent late complications of pedicle screw.
Keywords: Pedicle screw; sagittal plan; finite element; vertebral body
Level of Evidence: Biomechanical study, Level F.

INTRODUCTION

The use of pedicle screw is based on 1950s [(2)]. Pedicle screw is a surgical equipment, which has brought a new perspective to the spinal surgery after the use of Harrington rod and Luque's instrumentations. Especially in scoliosis surgery, the screw has enabled correction of more deformities with three-dimensional correction. Since it provides a more rigid stabilization compared to the other method, lower rates of pseudoarthrosis have been reported [(6,9,20,21)]. Pedicle screw has a wide area of usage regarding all fields of the spinal surgery such as spinal trauma, degenerative diseases, spinal tumor and infections of spinal region. Although this technique has such a wide area of use, probability of complications due to improper fixation of the screw is high because of its proximity to the neurovascular structures. Therefore, fixation of an appropriate and safe pedicle screw is the most important first step in the spinal surgery. Although it is predicted that being an experienced surgeon would decrease the complications due to pedicle screw, the rate of complications may reach up to 30 % even at experienced hands [(1,8,10,14,22)]. Complications due to improper fixation of the pedicle screw would lead to destructive results in early periods, although failures may also be seen in the chronic period due to the biomechanical structure of the implant in the screws considered of proper fixation [(5,16,19)].

We believe that, sagittal orientation of a pedicle screw fixed with free-hand

method in the thoracic region affects biomechanical durability of the structure that is used in the spinal surgery. In order to test this hypothesis, we assessed biomechanical results of the orientation of the screw in sagittal plane in the vertebral body by performing the finite element analysis both in a single vertebral body, and in a dual vertebral model.

MATERIAL AND METHODS

T10 and T11 vertebral images of a healthy adult person aged 30 years were obtained on the computed tomography of the thoracal region. 3D image was transferred to the system. Finite element analysis model was produced for both vertebrae using Solidworks 2018 simulation program (Solidworks 2018, Dassault Systemes SE, France). Since the analysis was performed in both single and dual vertebra models, a disc model was created manually using Solidworks 2018 simulation program, because CT scan could not define the intermediate disk structure when the dual vertebra model was produced (Solidworks 2018, Dassault Systemes SE, France). The disc type was solid mesh, and so a curvature-based mesh model was used. Maximum element size was determined as 9.5229 mm and minimum element size as 1.90458 mm. "FEE plus iterative solver" was used for the finite element analysis. As the materials, High Density Polyethylene (HDPE) was chosen for the cortical bone, Low Density Polyethylene (LDPE) for the spongiosa bone, and Ti6A14V-ELI for the Screw-rod system.

The model type of High Density Polyethylene was defined as Linear Elastic Isotropic. Tensile strength was calculated as 2.21e+07 N/m^2, elastic modulus as 1.07e+09 N/m^2, Poisson's rate as 0.4101, Bulk density as 952 kg/m^3, and Shear modulus as 3.772e+08 N/m^2. The model type of Low Density Polyethylene was defined as linear elastic isotropic; tensile strength was calculated 1.327e+07 N/m^2, Elastic modulus as 1.72e+08 N/m^2, Poisson's ratio as 0.439, Mass density as 917 kg/m^3, and Shear modulus as 5.94e+07 N/m^2. The model type of Ti-6Al-4V-ELI was defined as linear elastic isotropic. Default failure criteria was defined as maximum von Mises Stress, yield strength as 8.27371e+08 N/m^2, Tensile strength as 1.05e+09 N/m2, Elastic modulus as 1.048e+11 N/m^2, Poisson's ratio as 0.31, Mass density as 4428.78 kg/m^3, Shear modulus as 4.10238e+10 N/m^2, and Thermal expansion coefficient as 9e-06 /Kelvin.

Same screw type and length, and same rod system were used for each analysis. The screws were of 6 mm diameter, 55 mm length, and polyaxial. The entry point of the pedicle screw was 2 mm caudal and 2 mm lateral to the junction of the lateral border of the superior facet joint and transverse process. Insertion point of each screw was defined as the same for each different region. The vertebral body was divided into 3 equal areas on the sagittal plane. The screws were inserted as to fit into 3 areas (1st, 2nd, and 3rd) on the sagittal plane. The first area was defined as the one third upper portion of the vertebral body, the second area as the one third medium portion of the vertebral body, and the third area as the one third lower portion of the vertebral body (Figure-1).

Each screw was subjected to pull-out load as to be parallel with the screw axis in the area of insertion in single vertebrae model (Figure-2.a-c).

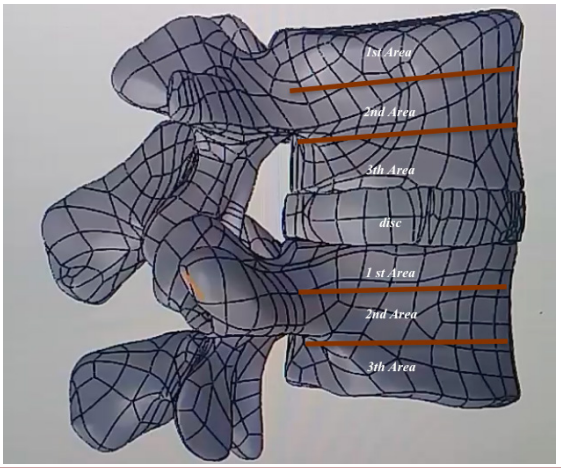

Figure-1. Illustration of areas 1, 2, 3 described in the study.

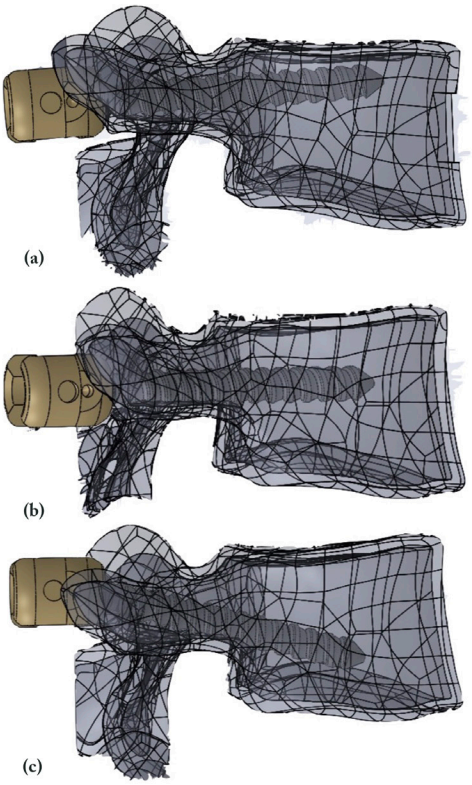

Figure-2.a-c. Description of pedicle screws in a single vertebral body model. **a)** Screw at first area, **b)** Screw at 2nd area, **c)** Screw at 3th area

In the dual vertebrae model, the screws inserted in the 1st, 2nd, and 3rd areas of each vertebra were combined with rod system, and three model of 4 screws inserted model was obtained (Figure-3.a-c).

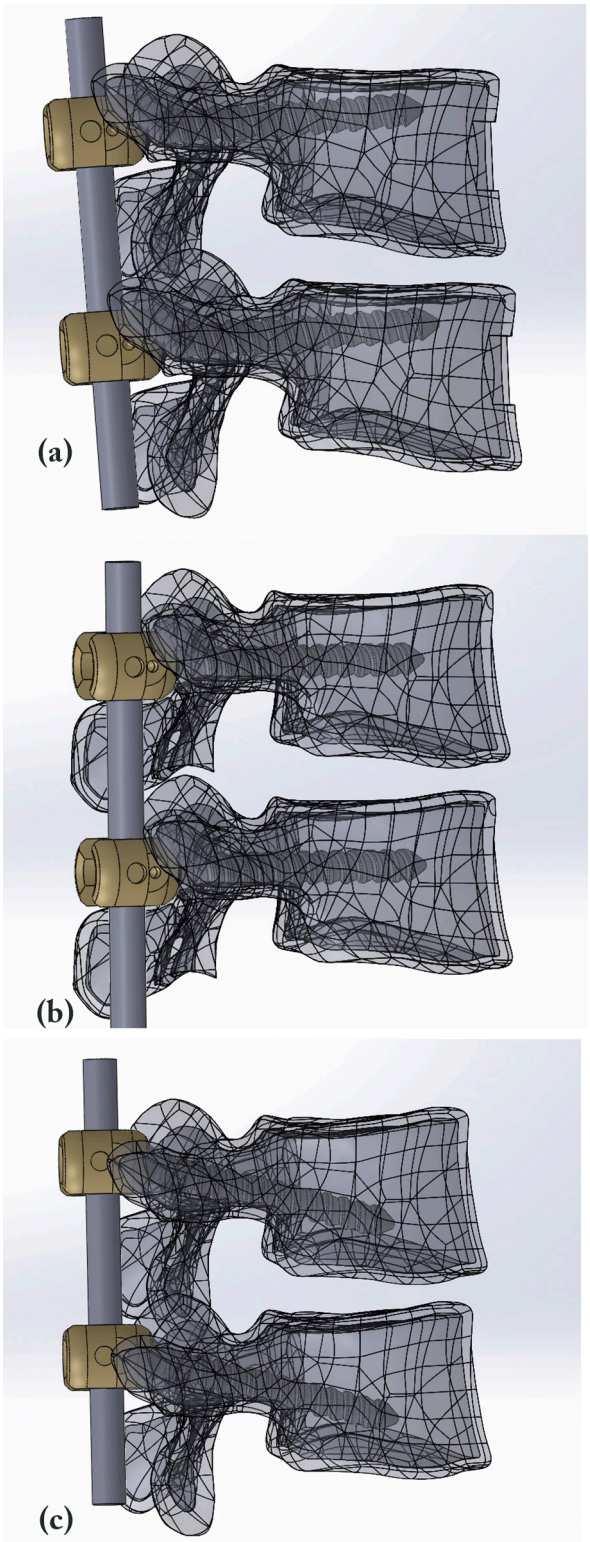

Figure-3. a-c. Description of pedicle screws in a dual vertebral body model, a) Screw at 1st area, **b)** Screw at 2nd area, **c)** Screw at 3th area

In these model, the lower vertebra was fixed with "surface boundary condition definition", and the upper vertebra was subjected to the forces that will provide vertebra to make flexion, extension, and lateral bending movements (Figure-4.a-c).

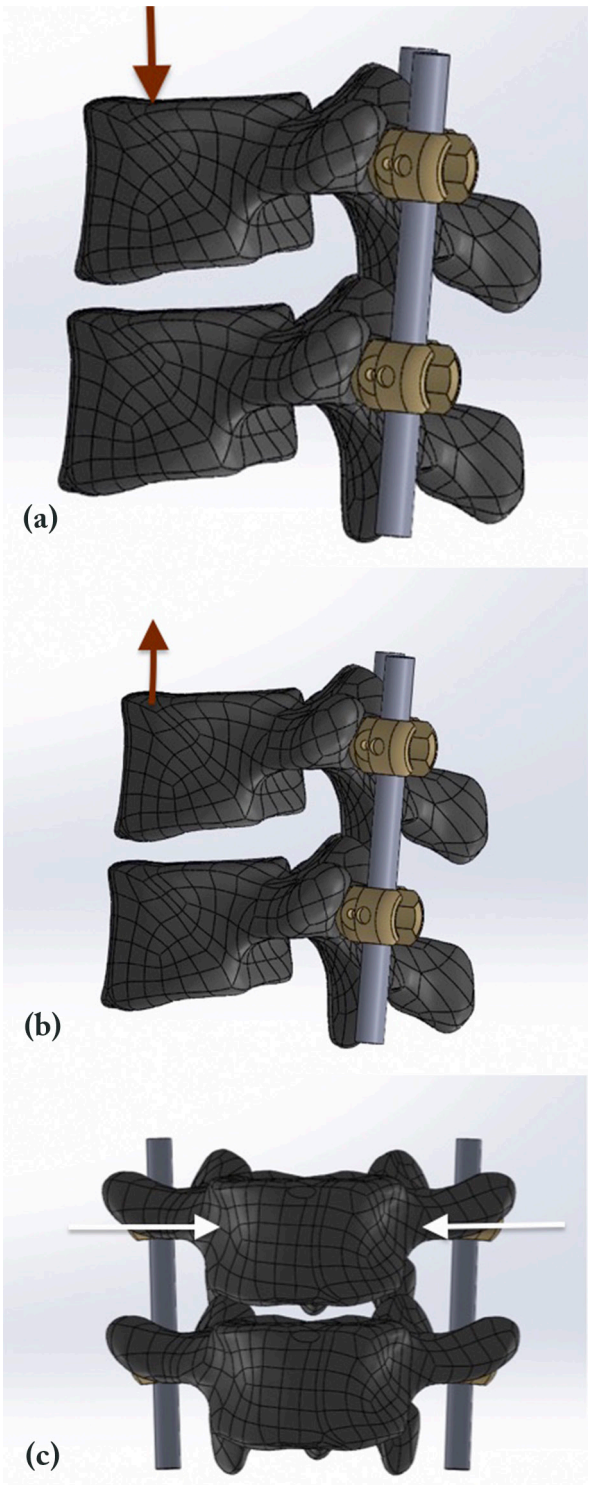

Figure-4.a-c. Illustration of forces providing; **a)** flexion, **b)** extension, **c)** lateral bending movements.

Loadings were started with 0 N, and the loads where the implants begin to deform were recorded. Each force was applied from the same point in each model, and durability of the screws against the forces applied were studied in the dual vertebra model.

RESULTS

"Pull-out" tests of screws in the single vertebral body model were performed with a static load applied at the screw axis for all three conditions. According to the results obtained, the screw which was delivered to the upper one third area (1st Area) led to deformation in the vertebra model at a pull out load of 13,200 N. Whereas the screw inserted in the middle one third area (2nd Area) caused deformation in the vertebra model at a pull out load of 12,500 N. On the other hand, the screw inserted in the lower one-third area (3rd Area) led to deformation in the vertebra model at a pull out load of 10,500 N. Accordingly the strongest attachment area of the screw is the upper one-third area of the vertebral body. Less strong areas are the middle and lower one third of the vertebral body, respectively (Table-1).

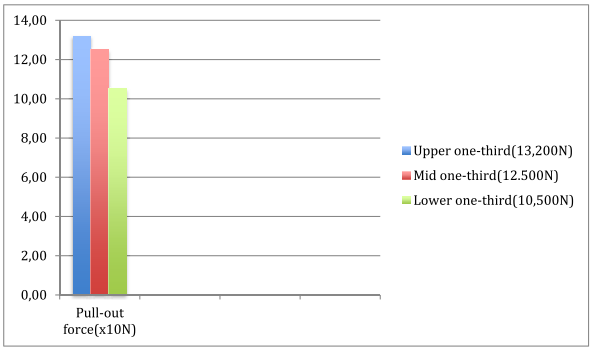

Table-1. Values of static load led to deformation in the single vertebra model for all three-pedicle screw conditions

Flexion tests in the dual vertebra model were performed with a flexion load created on the vertebra for all three conditions Test assembly consisted of 2 vertebra model, 4 screws and 2 rods. The system assembled with the screws delivered to the upper one third area (1st Area) was deformed at a flexion load of about 520 N. The deformation began in the screw neck. The system assembled with the screws delivered to the middle one third area (2nd Area) was deformed at a flexion load of about 500 N. In this case also the deformation began in the screw neck. The rate of deformation in the rods and screw necks was higher compared to the vertebra model with the screws in the first area. The system assembled with the screws delivered to the lower one third area (3rd Area) was deformed at a flexion load of about 400 N (Table-2).

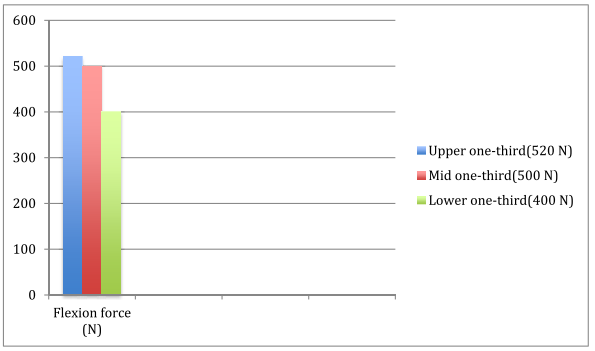

Table-2. Values of Flexion load lead to deformation in the dual vertebra model for all three pedicle screw conditions.

The deformation began in the rods. The rate of deformation in the screw necks and rods was significantly higher compared to the other two areas.

The extension tests applied in the dual vertebra model were performed with an extension load produced on the vertebral for all three conditions. Test assembly consisted of 2 vertebra model, 4 screws and 2 rods. The system assembled with the screws delivered to the upper one third area (1st Area) was deformed at an extension load of about 520 N. The deformation began in the screw neck. The system assembled with the screws delivered to the middle one third area (2nd Area) was deformed at an extension load of about 500 N. In this case also the deformation began in the screw neck. The rate of deformation in the rods and screw necks was higher compared to the vertebra model with the screws in the first area. The system assembled with the screws delivered to the lower one third area (3rd Area) was deformed at an extension load of about 400 N (Table-3).

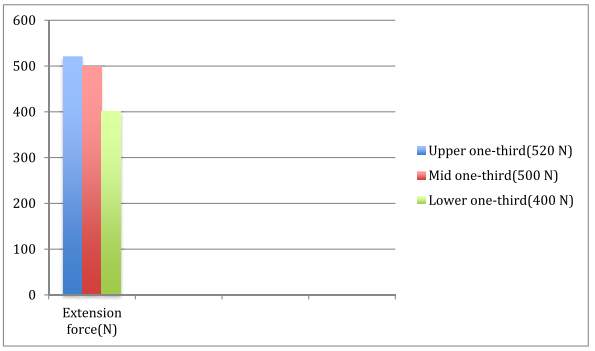

Table-3. Values of Extension load lead to deformation in the dual vertebra model for all three pedicle screw conditions.

The deformation began in the rods. The rate of deformation in the screw necks and rods was significantly higher compared to the other two areas.

Bending tests were performed with the lateral load created on the dual vertebra model for all three conditions. Test assembly consisted of 2 vertebra model, 4 screws and 2 rods. The system assembled with the screws delivered to the upper one-third area (1st Area) was deformed at a bending load of about 540 N. The deformation began in the screw neck. The system assembled with the screws delivered to the middle one-third area (2nd Area) was deformed at a bending load of about 440 N. In this case, the deformation began in the rods and screw necks. The rate of deformation in the rods and screw necks was higher compared to the vertebra model with the screws in the first area. The system assembled with the screws delivered to the lower one-third area (3rd Area) was deformed at a bending load of about 360 N (Table-4).

The deformation began in the rods. The rate of deformation in the screw necks and rods was significantly higher compared to the other two areas.

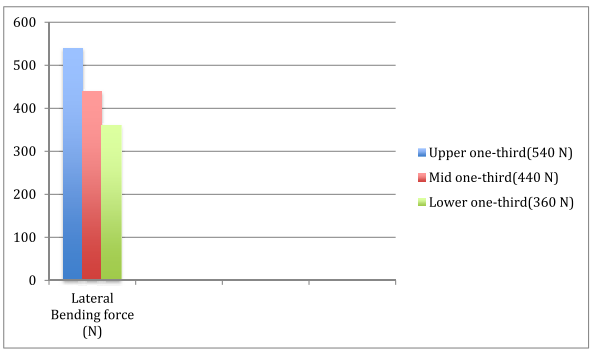

Table-4. Values of Lateral bending load created in the dual vertebra model for all three pedicle screw conditions.

DISCUSSION

There are a lot of accessory equipment to use for increasing the correctness and conformity of pedicle screws. Among the examples are C-arm fluoroscopy and computer aided navigation. The leading surgical techniques used especially by experienced spinal surgeons is insertion of pedicle screws with free hands. There are different entry points for pedicle screws in the free hand technique that have been described by authors [15,18,23]. Each technique define medialization of the pedicle screw according to the entry axis and orientation of the screw on the sagittal plane, but to apply this in the practice requires experience. Indeed, one of the main starting point of our study was to evaluate our pedicle screw insertion technique which we used in the operations [11]. We have previously stated that being perpendicular to the lamina in front of the pedicle with screw inserted would be helpful for adjustment of the sagittal orientation because in the free hand pedicle screw insertion defined in the literature, it may not always possible to adjust the sagittal orientation.

Especially, mistakes in the medialization may give rise to highly catastrophic outcomes for patients, differences in the orientation of the screw on the sagittal plane may cause outcomes that are not recognized in the early period, but may lead to implant failure in the advanced periods, such as loss of correction in the deformity and failed knitting in the fusion area [5,12,19,24].

Pull-out power of the pedicle screw has been evaluated in many studies in the literature, and the proper location of the screw in the vertebral corpus on the sagittal plane has been subjected to debate [3-4,16,19]. In this study, we evaluated 3 different orientation of the pedicle screw in the vertebral corpus on the sagittal plane. The finite element models that we created for this purpose revealed that attachment of the screw inserted in the upper one third area was stronger than the other areas in the evaluations made both at a pull-out power of the pedicle screw, and of two pedicle screws together. Our results show similarity with those of the literature. Newcomb et al. reported that superior screw angulation may be advantageous in reduction of the loosening and breaking of the screw [17]. Matsukawa et al. stated that lateral-cranial screw orientation a has higher pull-out strength compared to other orientations [16].

In a study from the literature comparing anatomic trajectory and straight-forward trajectory, it was emphasized that caudal orientation of the screw which was inserted in the anatomic trajectory on 22 degree sagittal plane provided the pedicle screw more bone channel contact [7]. In a biomechanical study by Lehman et al. comparing the two technique, straight-forward technique was reported to be superior over anatomic technique in terms of maximum insertion torque and pull-out strength [13].

Limitation of our study may be that bone mineral density was not included in the evaluation criteria. However, we studied vertebra model obtained from CT imaging of a 30-year-old healthy young adult patient. If we would studied in vertebra models obtained from more then one person we had to take into account bone mineral density since it would affect screw fixation strength (comparison of pedicle). In addition, as our study not an in vitro experimental trial, material properties defined in the modelling could cause us to obtain different results because of nonhomogenous structure of the spine. Therefore, we taken the material properties used in the modelling on a single vertebra identical and produced our own homogeneity.

CONCLUSION

The finite element analysis we performed revealed that insertion of the pedicle screw end in the upper one-third area of the vertebral body is better for the attachment.

Taking care to fit the screw in the upper one-third area would reduce complications such as late period fusion failure and loss in the correction of deformity.

Conflict of interest: None
Role of the funding source: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Belmont PJ, Klemme WR, Dhawan A, Polly DW. In vivo accuracy of thoracic pedicle screws. *Spine* 2001; 26: 2340-2346.
2. Boucher HH. A method of spinal fusion. *J Bone Joint Surg* 1959; 41-B: 248-259.
3. Chao CK, Hsu CC, Wang JL, Lin J. Increasing bending strength and pullout strength in conical pedicle screws: biomechanical tests and finite element analyses. *J Spinal Disord Tech* 2008; 21: 130-138.
4. Chatzistergos PE, Sapkas G, Kourkoulis SK. The influence of the insertion technique on the pullout force of pedicle screws: an experimental study. *Spine* 2010; 35: 332-337.
5. Cho W, Cho SK, Wu C. The biomechanics of pedicle screw-based instrumentation. *J Bone Joint Surg* 2010; 92: 1061-1065.
6. Delorme S, Labelle H, Aubin CE, de Guise JA, Rivard CH, Poitras B, Dansereau J. A three dimensional radiograpfhic comparison of Cotrel-Dubousset and Colorado instrumentation for the correction of idiopathic scoliosis. *Spine* 2000; 25: 205-210.
7. Dhawan A, Klemme WR, Polly DW Jr. Thoracic pedicle screws: comparison of start points and trajectories. *Spine* 2008;15; 33(24): 2675-2681.
8. Di Silvestre M, Parisini P, Lolli F, Bakaloudis G. Complications of thoracic pedicle screws in scoliosis treatment. *Spine* 2007; 32: 1655-1661.
9. Dobbs MB, Lenke LG, Kim YJ, Kamath G, Peelle MW, Bridwell KH. Selective posterior thoracic fusion for adolescent idiopathic scoliosis: comparison of hooks versus pedicle screws. *Spine* 2006; 31: 2400-2404.
10. Gertzbein SD, S.E. Robbins, Accuracy of pedicular screw placement in vivo. *Spine* 1990; 15: 11-14.
11. Gokcen HB, Erdogan S, Ozturk S, Gumussuyu G, Bayram I, Ozturk C. Sagittal orientation and uniform entry for thoracic pedicle screw placement with free-hand technique: A retrospective study on 382 pedicle screws. *Int J Surg* 2018; 51: 83-88.
12. Inceoğlu S, Montgomery WH, Clair SS, McLain RF. Pedicle screw insertion angle and pull-out strength: Comparison of 2 proposed strategies. *J Neurosurg Spine* 2011; 14: 670-676.
13. Lehmen RA, Polly DW, Kuklo TR, Cunningham B, Kirk KL, Belmont PJ Jr. Straight-forward versus anatomic trajectory technique of thoracic pedicle screw fixation: a biomechanical analysis. *Spine* 2003; 28: 2058-2065.
14. Liljenqvist UR, Halm HF, Link TM. Pedicle screw instrumentation of the thoracic spine in idiopathic scoliosis. *Spine* 1997; 22: 2239-2245.
15. Magerl FB. Stabilization of the lower thoracic and lumbar spine with external skeletal fixation. *Clin Orthop* 1984; 125-141.
16. Matsukawa K, Yato Y, Hynes RA, Imabayashi H, Hosogane N, Yoshihara Y, Asazuma T, Nemoto K. Comparison of pedicle screw fixation strength among different transpedicular trajectories: A finite element study. *Clin Spine Surg*. 2017; 30(7): 301-307.
17. Newcomb AG, Baek S, Kelly BP, Crawford NR. Effect of screw position on load transfer in lumbar pedicle screws: a non-idealized finite element analysis. *Comput Methods Biomech Biomed Engin* 2017; 20(2): 182-192.
18. Roy-Camille R, Saillant G, Mazel C. Plating of thoracic, thoracolumbar and lumbar injuries with pedicle screw plates. *Orthop Clin North Am* 1986; 17: 147-159.
19. Sterba W, Kim D-G, Fhrie DP, Yeni YN, Vaidya R. Biomechanical analysis of differing pedicle screw insertion angles. *Clin Biomech.* 2007; 22: 385-391.
20. Suk SI, Lee CK, Min HJ, Cho KH, Oh JH. Comparison of Cotrel-Dubousset pedicle screws and hooks in the treatment of idiopathic scoliosis. *Int Orthop* 1994; 18: 341-346.
21. Suk SI, Lee CK, Ghung Y-J, Chung YJ, Park YB. Segmental pedicle screw fixation in the treatment of thoracic idiopathic scoliosis. *Spine* 1995; 20: 1399-1405.
22. Suk SI, Kim WJ, Lee SM, Kim JH, Chung ER. Thoracic pedicle screw fixation in spinal deformities: are they really safe? *Spine* 2001; 26: 2049-2057.
23. Vaccaro A, Rizzolo S, Allardyce T, Ramsey M, Salvo J, Balderston RA, Cotler JM. Placement of pedicle screws in the thoracic spine. Part I: Morphometric analysis of the thoracic vertebrae. *J Bone Joint Surg* 1995; 77-A: 1193-1199.
24. Wu SS, Edwards WT, Yuan HA. Stiffness between different directions of transpedicular screws and vertebra. *Clin Biomech* 1998; 13: 1-8.

Volume: 29, Issue: 4, October 2018 pp: 203-207 ORIGINAL ARTICLE

EVALUATION OF CHRONIC NECK PAIN IN ORTHOPEDICS AND TRAUMATOLOGY CLINIC

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ABSTRACT

Objective: Evaluating the management in patients with chronic and non-spesific neck pain.

Materials and method: Questionnaire based retrospective clinical study

Results: In the previous year forty-six percent visited the general practice (GP) for neck pain. These patients , 28% did not receive a diagnostic modality, 36% did not receive therapy and 36% were not referred. The most diagnostic and therapeutic modalities were physical examination (54%) and pain medication (64%), respectively. The GPs most frequently referred to a physiotheraphy and rehabilitation (52%).

Conclusion: Administration to hospital to chronic neck pain is % 46. This percentage is a minor group among chronic neck pain. Fifty-four percent of these patients can be diagnosed, if appropriate evaluations are made.

Key Words: Chronic neck pain, evaluation, questionnaire.

Level of evidence: Retrospective clinical study, Level III.

INTRODUCTION

Musculoskeletal disorders are common cause of administration to hospital. Neck pain is one of the most common region of pain. Prevelance of neck pain is reported as 9.5 % – 35 % [5,13]. In postmenopausal women who are 50-59 years, prevalence is %10-15 [12]. According to Lamberts H., the prevalence of neck pain has been estimated as 18 per 1000 registered patients per year [11].

Neck pain is not a medical emergency, but complaints of pain and stiffness affect patients daily-routine. It causes absence for work. In some industries it even accounts for as many absences as low-back pain [14]. Pain may arise from different structures of neck. These include the intervertebral discs and annuli, ligaments, muscles, facet joints, dura and nerve roots [3]. The cause of pain may also be too variable. Neck pain may cause from infections, congenital disorders, trauma (especially motor vehicle accidents) tumours, and inflammation. Despite all clinical evaluations, no underlying pathology can be established and considered as 'non-specific neck pain' in many patients. In these cases, radiologic abnormalities are usually absent or occur in lower frequency as among subjects without complaints [2].

For neck pain, studies on efficacy of therapeutic interventions are largely lacking [1,18]. Due to lack of consensus among practitioners, the management of neck pain is greatly divergent [17]. In general, there is a broad spectrum of diagnostic procedures available for neck pain patients: plane radiographs, tomography, computed tomography (CT) scans, magnetic resonance imaging (MRI), electromyogram (EMG), etc [18].

In chronic patients who cannot be diagnosed and suffer from neck pain during few weeks, there is not a convention on which diagnostic procedures and therapeutic interventions should be applied. In the literature pain is often classified as acute (0 – 6 weeks), sub-acute (6 weeks– 3 months)

and chronic (>3 months) [13]. The aim of this study is to evaluate the diagnostic procedures in chronic and non-specific neck pain.

MATERIALS AND METHODS

Patients:

A sample of 542 patients were taken from the University Hospital. Patients were included in our study based on the following criteria:

1) Neck symptoms/complaints (excluding headache) or syndromes of cervical spine, 2) age 18-70 years, 3) symptoms had to be present for at least 6 months before administration. Exclusion criterias were specified following pathologies: fractures, infection, tumours, inflammatory disorders and osteoporosis.

Procedure

A questionnaire applied to selected patients.

Questionnaires

The questionnaire contained diagnosis, frequency of visits, diagnostic techniques, therapeutic interventions. The patients' questionnaire contained regarding patient characteristics, pain intensity, sickness related to work and visits to medical specialists/paramedical therapists. The severity of the neck pain was measured on an 11-point ordinal scale, ranging from 0 (no pain) to 10 (unbearable pain).

Statistics

Statistics were used to present the frequencies of diagnostic and therapeutic interventions and referrals. All patient characteristics were described by median and quartiles since most of the variables were asymmetrically distributed. Differences characteristics between responders and non-responders were assessed by a Mann–Whitney U test. The difference in mean age was assessed by a t-test. Comparison of sex in both groups was made by means of a chi-square test.

RESULTS

Initially a sample of 763 patients was taken from the University database. Thirty-six patients were excluded because they had symptoms for less than 6 months and 185 patients were under 18 or over 70 years of age. Due to a lack of time, two GPs filled out questionnaires for only a random sample of patients. Of these 542 patients, 286 (52.7 %) returned the questionnaire.

GPs were asked to fill out questionnaires for all 542 included patients. The GPs returned 486 (89,6 %), questionnaires (regarding 254 responders and 232 non-responders).

Patient characteristics

The responders and non-responders were compared for demographic and descriptive characteristics (Table-1).

The mean age for the responders was 50 years (median 51). The mean severity of pain was 4.8 (SD 2.6). Sixty-four percent of the responders appeared to be women. Twenty-six percent had private insurance and 74% had public insurance. Seventy-six per cent of the responders reported neck pain radiating towards other parts of the body. In 70 % the pain radiated towards the head. In 36% the pain radiated below the elbow, which could indicate neurologic abnormalities. According to 20% of the responders, the cause of their symptoms was unknown. The most frequently reported causes were ascribed to working conditions (32 %), tension: stress (26 %) and a poor posture (21 %).

Table-1. Comparison of demographic and descriptive characteristics for responding and non-responding patients

	Responders (n_254)	Non-responders (n_232)	p-value2
Age	52 (41–60)	56 (44–62)	0.006
First onset of pain ever (years ago)	6 (2–8)	7 (3–9)	0.012
GP visits previous year (all diagnosis)	5 (2–8)	5 (2–8)	0.486
GP visits previous year (neck)	0 (0–1)	0 (0–1)	0.015
Male (%)	42	44	
Female (%)	60	58	0.442

Diagnosis, therapy and referrals

During the previous year, 52% of our cohort did not visit their GP for neck pain. 24 % visited their GP for neck pain once and 24% visited their GP two or more times. The frequencies of the different modalities and referrals are reported for the total cohort and for the number of patients who visited their GP at least once for neck pain in the previous year (Tables-2,3 and 4).

The frequencies of the different diagnostic modalities used by the GPs are reported in Table II. Of the patients who did visit their GP in the previous year, 30 % did not receive a diagnostic modality. 68 % of all diagnostic modalities consisted of physical examination. The therapeutic modalities advised or applied by the GPs are reported in Table 3. Of the patients who did visit their GP in the previous year, 33 % did not receive therapy. 60 % of all advised or applied therapeutic modalities consisted of pain medication, including NSAIDs. The GPs most frequently referred to a physiotherapy and rehabilitation (52 %).

Table-2. Diagnostic modalities used in patients with chronic non-specific neck pain in general practice during the previous year.

	Patients with GP consultation (n_210)		Total population (n_486)	
	n1	%2	n1	%2
No diagnostic modalities	60	28.5	324	66.6
Physical examination	132	62,8	134	27,5
Laboratory examinations	14	6,6	16	3
X-ray	28	13,3	28	5,7
Other imaging techniques: CT, MRI, myelography, discography	4	1,94	0,8	

Table-3. Therapeutic modalities advised or applied by the GPs in patients with chronic non-specific neck pain in general practice during the previous year

	Patients with GP consultation (n_210)		Total population (n_486)	
	n1	%2	n1	%2
No therapy	65	30,9	300	61,7
Heat application	36	17	36	7,4
Rest	22	11,8	22	5
Paracetamol, aspirin: NSAIDs	180	85,7	180	37
Benzodiazepines	22	10,4	22	4,5
Antidepressants	7	3,3	7	1,4
Postural advice	36	17	36	7,4
Collar	11	5	11	2,2
Other: ointment, injection, orthopedic pillow	6	3	6	1,2

Table-4. Visits: referrals to medical specialists and paramedical therapists in patients with chronic non-specific neck pain in general practice during the previous year

Patients General practitioners		
	Total population (n_486)	Patients with GP consultation (n_210)
	%4	%4
No referral	62	38
Physiotherapy and rehabilitation	24	52
Orthopedic surgeon	11	7
Neurologist: neurologic surgeon	18	8
Rheumatologist	1	1

DISCUSSION

The results should be evaluated in two parts. First is the information on diagnostic procedures and therapy. This information was obtained from the questionnaires Second is the information of the complaints. Since these informations are based on questionnaires, there might be bias in responses and may not be objective.

Datas were not enough to study on acute phase because patients were administrated in chronic phase. Since the onset of pain started more than 5 years, the evaluation of pain would not be accurate. Compared to the study of Van Tulder et al. [16] some differences in the number of visits between patients with neck pain (46 %) and low-back pain (82 %) appeared. Since the patients evaluate their neck pain less sufferable than low-back pain, it is accountable for patient to administer less than low back pain. There are some differences between managing the neck pain versus low-back pain.

One example is the contradiction between neck and low-back patients in plain radiography. The frequency of using diagnostic imaging in patients with neck pain compared to low-back pain is lower because the incidence of herniated cervical discs (5.5 / 100000 / year) is much lower than the incidence of herniated lumbar discs (5 / 1000 / year) [7-9]. Compared with other major reasons of disability and pain, there are relatively few randomized controlled trials to guide treatment of neck pain and the guidelines for neck pain are often extrapolated from those for other conditions.

Clinical trials planned to define comparative effectiveness and efficacy are needed for all types of treatments but especially adjuvants for neuropathic pain and surgery for mechanical pain. Biological agents such as stem cell therapy, nerve growth factor and cytokine inhibitors have been studied to use in chronic low back pain, but such a study has not been conducted for neck pain. The focus should be on assessing the efficacy of these agents in neck pain in future studies. The continuity of neck pain after spinal injury and other types of injuries poses significant psychological, physical and economic results for patient and the community. There is a weak correlation between symptoms and imaging abnormalities in injured patients with chronic neck pain [6]. Finding ways to determine the risk factors leading to the development of chronic neck pain and preventing it, represents a significant challenge to the medical community.

It is understood that, only % 46 of the patients administer to physician for chronic neck pain. 54 % of the patients can be diagnosed who have chronic neck pain. 44 % percent of the patients did not receive a therapeutic modality. Compared to the study of Kuijper et al.[10] randomized study of patients with acute cervical radiculopathy, both use of hard collar and physical therapy accompanied by home exercises produced greater reduction in neck pain and disability than wait and see approach. In a randomized study comparing physical therapy, hard cervical collar immobilization and anterior decompression and fusion with cervical radiculopathy, Persson et al.[15] found greater reductions in pain the surgical group than in the others. One year fallow-up favoring surgery differences were for a lot of part no longer statistically significant. Physical examination and history can provide important clues as to whether the pain is mechanical or neuropathic and are specifying who benefit from advanced further diagnostic might develop or advanced imaging [6]. Our results are consisted with literature [4].

In this study, obtaining information on acute neck pain was not possible. Future studies should be made to evaluate acute cases to prevent patients to be chronic.

REFERENCES

1. Aker PD, Gross AR, Goldsmith CH, Peloso P. Conservative management of mechanical neck disorders: systematic overview and meta-analysis. BMJ 1996; 313: 1291–1296.
2. Bogduk N. Neck pain. *Aust Fam Physician* 1984; 13: 26–30.
3. Bogduk N. Neck pain: an update. *Aust Fam Physician* 1988; 17: 75–80.
4. Borghouts J, Janssen H, Koes B, Muris J, Metsemakers J, Bouter L. The management of chronic neck pain in general practice: a retrospective study. *Scand J Primary Health Care* 1999; 17(4): 215-220.
5. Brattberg G, Thorslund M, Wikman A. The prevalence of pain in a general population. The results of a postal survey in a county of Sweden. *Pain* 1989; 37: 215–222.
6. Cohen SP. Epidemiology, diagnosis, and treatment of neck pain. *Mayo Clin Proc* 2015; 90(2): 284-299.
7. Frymoyer JW. Back pain and sciatica. *N Engl J Med* 1988; 318: 291–300.
8. Frymoyer JW, Ducker TB, Hadler NM, Kostuik JP, Weinstein JN, Whitecloud III TS. *The Adult Spine, Principles and Practice.* 2nd Ed. Lippincott-Raven, Philadelphia 1997; pp: 130–134.
9. Kuijper B, Tans JT, Beelen A, Nollet F, de Visser M. Cervical collar or physiotherapy versus wait and see policy for recent onset cervical radiculopathy: randomised trial. *BMJ* 2009; 339: b3883.
10. Lamberts H. Inhethuisvan De Huisarts (The General Practitioner In Practice), Verslagvanhettransitie project (Report Of Thetransition project). Mediatekst, Lelystad 1991.
11. Lau EMC, Sham A, Wong KC. The prevalence and risk factors for neck pain in Hong Kong Chinese. *J Public Health Med* 1996;18:396–399.
12. Makela M, Heliovaara M, Sievers K, Impivaara O, Knekt P, Aromaa A. Prevalence, determinantsandconsequences of chronicneckpain in Finland. *Am J Epidemiol* 1991; 134: 1356–1367.

13. Matsumoto M, Okada E, Ichihara D, Chiba K, Toyama Y, Fujiwara H, Momoshima S, Nishiwaki Y, Hashimoto T, Inoue T, Watanabe M, Takahata T. Prospective ten-year follow-up study comparing patients with whiplash associated disorders and asymptomatic subjects using magnetic resonance imaging. *Spine* 2010; 35(18): 1684-1690.

14. Persson LC, Moritz U, Brandt L, Carlsson CA. Cervical radiculopathy: pain, muscle weakness and sensory loss in patients with cervical radiculopathy treated with surgery, physiotherapy or cervical collar: a prospective, controlled study. *Eur Spine J* 1997; 6: 256–266.

15. Spitzer WO, Leblanc FE, Dupuis E. Scientific approach to the assessment and management of activity-related spinal disorders. *Spine* 1987; 7(Suppl.): 1–59.

16. Van Tulder MW, Koes BW, Bouter LM, Metsemakers JFM. Management of chronic nonspecific low back pain in primary care: a descriptive study. *Spine* 1997; 22: 76–82.

17. Weel Van C. Rugklachten in de huisartspraktijk (Back complaints in general practice). *Huisarts Wet* 1983; 26 (Suppl. H&P); 5–7.

18. Wilson PR. Chronic neck pain and cervicogenic headache. *Clin J Pain* 1991; 7: 5–11.

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PATIENTS WITH LOW BACK PAIN APPLYING TO THE EMERGENCY DEPARTMENT

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ABSTRACT

Aim: Low back pain is a great loss of work force, on the other hand increases the workload in emergency services. The aim of this study was to determine the spinal degenerative pathologies in the patients with low back pain and to evaluate the effects of these pathologies on the emergency department.

Methods: Patients who applied to the emergency department with the complaint of low back pain and who were referred to the neurosurgery outpatient clinic were included in the study. Spinal degenerative pathologies was evaluated retrospectively in lumbar MRI examinations due to radiculopathy in the neurosurgery outpatient clinic or long-term low back pain in 3 months.

Results: 2220 patients 46.8% (n = 1039) women and 53.2% (n = 1181) men were treated with diagnosis code ICD (M54.4). The mean age was 40.12 ± 14.24. Lumbar MRI was performed in 31.2% (n = 693) patients. 43.7% (n = 301) 306 PDH 44.7% (n = 309) EDH, 38.6% (n = 267) LLF, 17.6% (n = 122) LSS was detected. LLF, PDH (RR 1,430, 95% IC, 1.190 to1.730) and EDH (RR 1,410, 95% IC, 1.170 to 1,700) are seen 1.4 times more than those without LLF. LSS was observed in 1.7 fold (RR 1.786, 95% CI 1,285 to 2,480) more in patients with EDH.

Conclusion: It should be kept in mind that non-specific low back pain causes in patients admitted to the emergency department with acute low back pain are significant in terms of disc herniation, lumbar lordosis flattening and MC in MRI.

Keywords: Low back pain, emergency department, spinal degeneration, Modic changes, Lumbar lordosis flattening

Level of Evidence: Retrospective clinical study, Level III.

INTRODUCTION

Almost every individual is considered to have suffered from a back pain at least once in his life. Low back pain could be the result of mechanical causes as a result of spinal degenerative changes. Although there are socio-economic and cultural differences in many epidemiological studies, it is reported that the prevalence of low back pain (LBP) is 60-90 % / year [4,6,8,13].

Ilhan et al. lifelong low back pain (LLBP) was determined as 79.4 % [4]. Waterman et al. reported that in the United States, back pain was 3.15 % of all emergency visits the emergency department with incidence and risk factors, and home injuries (65 %) accounted for the majority of patients presenting with LBP [14]. Gilgil et al. LLBP frequency in their study in Turkey was determined to be 46.6 % [5]. Risk factors for low back pain are a wide range of people, including physical characteristics, socio-economic status, general medical health and psychological status, and professional environmental factors [6,8,10]. Among the causes of LBP, the most common causes are the mechanical, muscle spasm and spinal degenerative pathologies. There are differences in socio-economic and cultural reasons among patient behaviors that are faced with low back pain. We can list roughly the pain in the population of our hospital, those who expect pain to pass spontaneously, those who use analgesic drug without a doctor's advice, and those who apply to our hospital at the onset of pain.

The aim of this study is to determine the spinal degenerative pathologies which are the cause of emergency service in patients with LBP without neurological deficits presenting with LBP.

MATERIAL AND METHOD

Patients who applied to the emergency department of Gaziosmanpaşa Taksim Training and Research Hospital with the complaint of low back pain between 01.01.2018 and 30.06.2018 and who were referred to the neurosurgery outpatient clinic were included in the study. In the neurosurgery outpatient clinic, due to the complaint of radiculopathy or long-term LBP at least 3 months, lumbar MRI examinations were performed retrospectively in the presence of spinal pathology, disc herniation (DH), flattening in lumbar lordosis (LLF), lumbar spinal stenosis (LSS) and Modic changes (MC). Patients with trauma, under 18 years of age, oncology patients, patients with non-spinal pain (such as kidney stones), patients admitted to the neurosurgery clinic due to acute neurological deficits, and those who had previously undergone surgery for lumbar region were excluded. In addition, in our hospital PACS system, patients with more than one MRI and neurosurgery clinic were evaluated previously and excluded from the study. Thus, acute and subacute back pain were tried to be selected.

In this study,1.5 T MR Unit (Signa HDxt; GE, USA) and body surface coil was used. Sagittal T1-W FSE, T2-W FSE and axial T2-W FSE (320x256 matrix, 4-mm section thickness, NEX 3) were imaged. We used the Miyazaki Rating System for evaluation of disc degeneration and Modic classification for evaluation of final endplate degeneration in MRI.

Statistical Analyses

Normality control was done by plotting one sample Kolmogorov Smirnov test, histogram, Q-Q plot and box plot graphics. The data were presented as median, IQR (25.per.-75.per.), Frequency and percentage. Nominal variables were evaluated by chi-square test. RR (Risk Ratio) values of the variables were calculated. The significance limit was taken as $p < 0.05$ and bidirectional. The analyses were performed using the NCSS 10 software (2015. Kaysville, Utah, USA).

RESULTS

Among the determined dates, 2220 patients 46.8 % (n = 1039) women and 53.2 % (n = 1181) men were treated with ICD (M54.4). The mean age was 40.12 ± 14.24. Lumbar MRI was performed in 31.2 % (n = 693) patients in the neurosurgery outpatient clinic. Of the patients undergoing MRI, 46.8 % (n = 323) were female and 53.4 % (n = 370) were male.

While 82.1 % (n = 569) of the patients had lumbar MRI, 17.9 % (n = 124) had no pathology. There were 31.2 % female and 31.1 % male in the group of patients with pathology and there was no significant difference between them. 43.7 % (n = 301) 306 protrudes disc herniations (PDH), 44.7 % (n = 309) extruded disc herniations (EDH), 38.6 % (n = 267) lordosis flattening, 17.6 % (n = 122) lumbar spinal stenosis was detected (Table-1).

17.5 (n = 100) patients had protrused and extruded disc herniation. 2.7 % (n = 19) Type-1 MC, 12.8 % (n = 89) Type-2 MC, 1.9 % (n = 13) Type-3 MC, 17.4% (n = 121) patients were MC (Table-2).

MC is associated with extruded DH (p = 0,000). There was no statistically significant difference between the two genders in all the parameters investigated. In patients with LLF, protruded DH (RR 1,430, 95 % IC,1.190 to 1.730) and extruded DH (RR 1,410, 95 % IC, 1.170 to 1,700) are seen 1.4 times more than those without LLF. SS was observed in 1.7 fold (RR 1.786, 95 % CI 1,285 to 2,480) more in patients with extruded DH (Table-3).

Table-1. The distribution of pathological findings in both sexes in MRI.

	Pathology (+)	PDH	EDH	LLF	LSS	MC
Female	81,2 %	43,0 %	44,0 %	36,2 %	17,6 %	18,8 %
Male	82,9 %	44,3 %	45,3 %	40,7 %	17,6 %	16,1 %

Table-2. The distribution of pathological findings in both sexes.

	MC Type1	MC Type 2	MC Type 3
Female	2,2 %	11,4 %	2,5 %
Male	3,3 %	14,1 %	1,4 %

Table-3. The significance of protrusion and extruded disc hernia with other parameters.

	LLF	LSS	MC
PDH	p< ,000	p< ,004	p< ,001
EDH	p< ,000	p< ,000	p< ,000

DISCUSSION

Disc degeneration and herniation, lumbar spinal stenosis, paravertebral muscle atrophy, lumbar lordosis changes, vertebral corpus endplate changes (MC), facet joint degeneration, scoliosis, spondylolisthesis, spinal masses are the etiologic factors of low back pain. Among these reasons, disc hernia and lumbar spinal stenosis are the most common surgical procedures.

Waterman et al. reported that age, gender and race are important risk factors for the development of low back pain requiring treatment in the emergency department [14]. In Ilhan et all., LLBP risk of their research in Turkey, body mass index higher, economic hardship living, elderly, short ones and uneducated people are also at high rates they published that it is LLBP [4]. Occupational factors, heavy lifting, frequent bending moment and long-standing survivors, workers and housewives increase the risk of LLPB. There are epidemiological studies in the literature. We have the same opinion that the difference of our study is to investigate the significance of the association of spinal pathologies with acute and subacute pain and spinal degenerative changes in emergency department applications. In our study, 2220 patients 47.2 % women (n = 1039) and 53.68 % men (n = 1181) were treated in the emergency department. Among these patients, 31,03 % (n = 689) patients underwent MRI by the neurosurgery outpatient clinic. Lumbar MRI 46,8 % (n=324) female and 53,2 % (n=369) male patients were evaluated. Watermen et al. reported no significant difference in rates of emergency department admissions for male and female low back pain [14].

Our results were similar in both genders. In the evaluation of MRI revealed degenerative changes in 53.8 % men, 46.2 % women. There was no statistically significant difference between the two groups.

Low back pain risk factors are very versatile. anatomical features, socioeconomic status, any existing chronic disease, psychological status and occupational factors can be listed. [6,8,10]. Acute non-specific back pain is usually caused by severe physical activity and paraspinal muscle spasm after uncontrolled physical activity. In our study, there were 50.8 % (n = 63) male and 49.2 % (n = 61) female patients with MRI without pathological findings. In these patients, it was found that working conditions and socioeconomic conditions were effective in their anamnesis, and most of these patients were housewives, textile and construction workers. Our results in this group are consistent with the literature, especially in Ilhan et al. for lifelong lumbar pain, prevalence and social - occupational risk research [4].

Most of the low back pain is non-specific low back pain and mechanical back pain. This group of patients is the main part of the emergency department applications. Degenerative pathologies are usually caused by subacute and chronic low back pain. This group of patients are admitted to emergency department for acute low back pain attacks. In our study, we investigated spinal degenerative pathologies and coexistence of these pathologies in patients without neurological deficit.

Temizturk et al. reported that the MRI of the patients with low back pain was associated with extruded, sequestered and posterolateral herniation and the findings of the examination, but not with other degenerative findings [11]. Dora et al. have found a strong relationship between pain and disk extrusion in a study they have done [2]. However, Rankine et al. reported that a weak correlation was found between the pain level and the root compression in MRI [7]. Our results showed high extrusion and protrusion disc herniation. It is clear that these pathologies increase the patient's low back pain during the acute attack. In addition, the lumbar lordosis flattening, spinal stenosis, and Modic changes were significantly associated with extruded and protruding disc herniation (Table-3).

Boden et al. MRI of healthy people with low back pain revealed high levels of disc degeneration, but early MRI showed that degenerative changes were not clinically relevant at all times [1]. At this point, patients with positive clinical findings may not always have degenerative changes in the MRI. In our study, there were 17.9 % (n = 124) patients without any pathology in the MRI.

The most important limitation of the study was a retrospective study and the fact that factors affecting non-specific low back pain could not be evaluated. But they applied to the emergency department with only back pain. And it was found that they benefited from non-steriod anti-inflammatory and muscle relaxant treatment applied in neurosurgery outpatient records.

Yıldız et al. reported that the flattening of lumbar lordosis increased after 40 years of age [15]. Dreischarf et al. Reported that the lower lumbar spine was flattened in the middle and became less mobile with aging [3]. In our study 38.6 % of the lumbar lordosis was flattened and protruded from DH (RR 1,430, 95 % IC, 1.190 to1.730) and extruded to DH (RR 1,410, 95 % IC, 1.170 to 1,700) were seen 1.4 times.

In the MC prevalence study, Type-2 MCs were the most common in the whole spine, Type-3 MCs were the least common, and MC was 21.0 % in patients with low back pain [9]. In the same study, the prevalence of MC was higher in with spinal pain group. We were detected Type-2 MC (12,8 %, n=89) the most common and Type-3 MC (1,9 %, n=13) the least. MC is associated with extruded DH (p = 0,000). There are many articles investigating the development and prevalence of MC, and Thompson et al. reported that MCs had a strong relationship with pain and that Type 1 MC was more associated with other types [12]. In our study, Type-2 MCs were frequently seen.

In our results, Type-2 MCs were strongly associated with extruded disc herniation. However, it can be said that these patients are frequently associated with pain in Type-2 MCs due to pain and not being able to say this because of the lack of pain.

CONCLUSION

The limitation of this study, the retrospective nature of the study, and the pain scale could not be evaluated, The patients who applied to the emergency department but did not apply to the neurosurgery outpatient clinic did not reflect the general population.

In spite of their limitations, etiological factors are very wide range in patients who applied to emergency department in acute low back pain or low back pain attack. In our results, MRI was normal in 17.9. In 82.1 % of the patients, there was degenerative finding in MRI. There was a statistically significant relationship between acute low back pain attack and disc herniation, lumbar lordosis, flattening and Modic changes. Patients with acute low back pain who apply to emergency department should be referred to neurosurgery outpatient clinics.

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REFERENCES

1. Boden SD, Davis DO, Dina TS, Patronas NJ, Wiesel SW. Abnormal magnetic resonance scans of the lumbar spine in asymptomatic subjects: aprospective investigation. *J Bone Joint Surg* 1990; 72-A (3): 403-408.
2. Dora C, Schmid MR, Elfering A, Zanetti M, Hodler J, Boos N. Lumbar disc herniation: Do MR imaging findings predict recurrence after surgical discectomy? *Radiology* 2005; 235(2): 562-567.
3. Dreischarf M, Albiol L, Rohlmann A, Pries E, Bashkuev M, Zander T, Duda G, Druschel C, Strube P, Putzier M, Schmidt H. Age-related loss of lumbar spinal lordosis and mobility – a study of 323 asymptomatic volunteers. *PLoS One* 2014; 9(12): e116186.
4. Ilhan MN, Aksakal N, Kaptan H, Ceyhan MN, Ilhan F, Maral I, Bolukbası N, Bumin MA. Birinci basamakta yaşam boyu bel ağrısı sıklığı ve ilişkili sosyal ve mesleksel risk etmenleri, Gazi Med J 2010; 21(3): 107-110.
5. Gilgil E, Kacar C, Butun B. Prevalence of low back pain in a developing urban setting. *Spine* 2005; 30: 1093-1098.
6. Melikoglu MA, Kocabas H, İlhan S, Bilgilisoy M, Tuncer T. Validity of the Turkish version of the Quebec Back Pain Disability Scale for patients with low back pain. *Spine* 2009; 34 (6): 219-224.
7. Rankine JJ, Fortune DG, Hutchinson CE, Hughes DG, Main CJ. Pain drawings in the assessment of nevre root compression: a comparative study with lumbar spine lumbar magnetic resonance imaging. *Spine* 1998; 23(15): 1668-1676.
8. Raspe H, Matthis C, Croft P, O'Neil T. Variation in back pain between countries: the example of Britain and Germany. *Spine* 2004; **?:** 1017-1021.
9. Sheng-yun L, Letu S, Jian C, Mamuti M, Jun-hui L, Zhi S, Chong-yan W, Shunwu F, Zhao F. Comparison of modic changes in the lumbar and cervical spine, in 3167 patients with and without spinal pain. *PLoS One* 2014; 9(12): e114993.
10. Stranjalis G, Tsamandouraki K, Sakas DE, Alamanos Y. Low back pain in a representative sample of Greek population: analysis according to personal and socioeconomic characteristics. *Spine* 2004; 29: 1355-1360.
11. Temizturk F, Temizturk S, Ozkan Y, Ozguzel MH. Bel ağrılı hastalarda klinik muayene bulguları ve manyetik rezonans görüntüleme bulguları arasındaki ilişkinin araştırılması. *Kocatepe Med J* 2015; 16: 110-115.
12. Thompson KJ, Dagher AP, Eckel TS, Clark M, Reinig JW. Modic changes on MR images as studied with provocative discography: clinical relevance - a retrospective study of 2457 discs. *Radiology* 2009; 250(3): 849-855
13. Tucer B, Yalcın BM, Ozturk A, Mazıcıoğlu MM, Yılmaz Y, Kaya M. Risk factors for low back pain and its relation with pain related disability and depression in a Turkish sample. *Turk Neurosurg* 2009; 19(4): 327-332.
14. Waterman BR, Belmont PJ, Schoenfeld AJ. Low back pain in the United States: incidence and risk factors for presentation in the emergency setting. *Spine J* 2012; 12: 63–70.
15. Yıldız HK, Ekin EE. Normal aging of the lumbar spine in women. *J Back Musculoskelet Rehabil* 2017; 30(5): 1061-1067.

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SPINAL INFECTIONS

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ABSTRACT

Objective: The aim of the study is to reveal the etiological and epidemiological characteristics of frequently observed spinal infections.

Material and Method: The patients who applied and diagnosed with spinal infection to Neurosurgery Polyclinics between 2013 and 2018 were investigated. The age, sex, radiological examinations, neurological consultations, medical treatments and comorbidities of the patients were evaluated. The cases were divided into 3 groups as tuberculosis, brucella and other pyogenic factors. The vertebra segment involved and the surrounding bone, neural and soft tissue dispersion of infection were analyzed.

Results: The study was made with 75 cases, in total, and consisted of 26 (34.7 %) females and 49 (65.3 %) males. The ages of the cases varied between 19 and 85 and the average was 59.32 ± 16.14 years. The abscess rate of the cases was observed to be 70.7 % (n=53), and was found in paraspinal, epidural and psoas areas of 52.8 % (n=28), 32.1 % (n=17) and 15.1 % (n=8) of the patients, respectively. In consequence of the analysis, we observed the factor to be 57.3 % (n=43) pyogenic, 28.0 % (n=21) tuberculosis, and 14.7 % (n=11) brucella.

Conclusion: Spinal infections are highly morbid, prevalent and destructive infections. Early diagnosis and treatment are necessary in order to preserve spinal stability and neurological function. Spinal infections are generally medically treated with antibiotics. However, debridement and intervertebral fusion are generally practiced in order to support healing, restrict neurological deterioration and ensure spinal stability in case surgical intervention is indicated.

Key words: Spinal infections, brucella, vertebra abscess

Level of evidence: Retrospective clinical study, Level III.

INTRODUCTION

Spinal infections can involve one or more than one of vertebra, neural tissues and the surrounding soft tissues. It is hard to diagnose this group early due to its insidious onset and asymptomatic clinic course [4]. 10-50 % of the patients develop neurological deficit. Though rarely, severe neurological deficits can also be seen such as paraplegia [4,11,15]. This is a disease group that is expensive to treat and which takes a morbid course as a consequence. Therefore, early diagnosis and treatment are necessary.

Spinal infections demand great effort to diagnose due to their insidious onset. These infections are encountered in males more frequently compared to females. They are generally adult diseases and appear after 50 [12,15]. This research attempts to reveal the etiological and epidemiological characteristics of frequently observed spinal infections.

MATERIAL AND METHOD

In this study, the files were retrospectively analyzed for the patients who applied to Neurosurgery Polyclinics between 2013 and 2018 and who were diagnosed with spinal infection. The age, sex, radiological examinations, neurological consultations, medical treatments and comorbidities of the patients were evaluated.

The cases were divided into 3 groups as tuberculosis, brucella and other pyogenic factors. The vertebra segment involved and the surrounding bone, neural and soft tissue dispersion of infection were analyzed.

Statistical Analyse

NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program was used for the statistical analyses. Descriptive statistical methods (average, standard deviation, median, and frequency, rate, minimum and maximum) were used while evaluating the data of the study. Kruskal Wallis test was availed of for the comparison of three or more groups that did not show normal distribution. Fisher-Freeman-Halton test and Fisher's Exact Test were used for the comparison of qualitative data. The significance level was determined to be p<0,05 (Table-1).

RESULTS

The study was carried out in Neurosurgery Clinics of Istanbul Training and Research Hospital with 75 cases, in total, and consisted of 26 (34.7 %) females and 49 (65.3 %) males. The ages of the cases varied between 19 and 85 and the average was 59.32 ± 16.14 years.

The incidence rate of diabetes was found out to be 20.0 % (n=15). The analysis on the involved areas produced the following rates: lumbar 52.0 % (n=39), thoracic 20.0 % (n=15), thoracolumbar 9.3 % (n=7), lumbosacral 14.7 % (n=11) and cervical 4.0 % (n=3) (Figure-1).

The abscess rate of the cases was observed to be 70.7 % (n=53), and was found in paraspinal, epidural and psoas areas of 52.8 % (n=28), 32.1 % (n=17) and 15.1 % (n=8) of the patients, respectively (Figure-1).

In consequence of the analysis, we observed the factor to be 57.3 % (n=43) pyogenic, 28.0 % (n=21) tuberculosis, and 14.7 % (n=11) brucella (figure-3, Table-1).

The type of development of the cases is 68.0 % (n=51) spontaneous and 32.0 % (n=24) postop. The follow-up periods varied from 2 to 45 months and the average follow-up period was 10.09 ± 6.85 years (Figure-4).

The factor showed statistically significant difference according to the presence of diabetes (p=0,005; p<0,01). The pyogenic rate of the diabetes group was found to be significantly higher than the non-diabetes group. The tuberculosis and brucella rates of the non-diabetes group were found to be significantly higher than the diabetes group (Table-2, Figure-5).

Type of development does not indicate statistically significant difference according to diabetes presence (p>0,05) (Table-3).

No statistically significant difference was obtained between the age distributions according to the involved area (p>0,05).

The abscess condition demonstrates statistically significant difference according to the involved area (p=0,014; p<0,05). The abscess incidence rate of lumbosacral group was found to be significantly lower compared to the lumbar, thoracolumbar and cervical groups. The abscess incidence rate of thoracic group was found to be significantly lower compared to the thoracolumbar and cervical groups. The rate of paraspinal abscess in thoracolumbar group was determined to be significantly higher than thoracic group.

The epidural abscess rate of cervical group was found to be significantly higher compared to the lumbar, thoracic and lumbosacral groups.

The factor does not demonstrate statistically significant difference according to the involved area (p>0,05).

Table-1. The Distribution of Descriptive Characteristics

		n (%)
Age (years)	*Min-Max (Median)*	19-85 (62)
	Ave±Sd	59.32±16.14
Sex:	**Female**	26 (34,7)
	Male	49 (65,3)
Diabetes	**N/A**	60 (80,0)
	Yes	15 (20,0)
Involved area	**Lumbar**	39 (52,0)
	Thoracic	15 (20,0)
	Thoracolumbar	7 (9,3)
	Lumbosacral	11 (14,7)
	Cervical	3 (4,0)
Abscess	**N/A**	22 (29,3)
	Yes	53 (70,7)
	Paraspinal	28 (52,8)
	Epidural	17 (32,1)
	Psoas	8 (15,1)
Factor	**Pyogenic**	43 (57,3)
	Tuberculosis	21 (28,0)
	Brucella	11 (14,7)
Type of development	**Spontaneous**	51 (68,0)
	Postop	24 (32,0)
Follow-up period (months)	*Min-Max (Median)*	2-45 (9)
	Ave±Sd	10.09±6.85

The factor showed statistically significant difference according to the presence of abscess (p=0,042; p<0,05). The pyogenic factor rate of epidural abscess cases was higher compared to the psoas abscess cases. The rate of tuberculosis in psoas abscess cases was higher than the cases without abscess but with paraspinal and epidural abscesses (Figure-6).

The type of development showed statistically significant difference according to the presence of abscess (p=0,032; p<0,05). The rate of spontaneous development in psoas abscess cases was higher compared to the paraspinal abscess cases. The rate of postop development in paraspinal abscess cases was higher compared to the psoas abscess cases (Table-4).

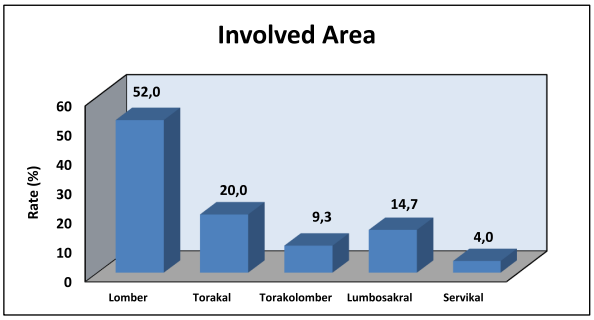

Figure-1. Involved area distributions

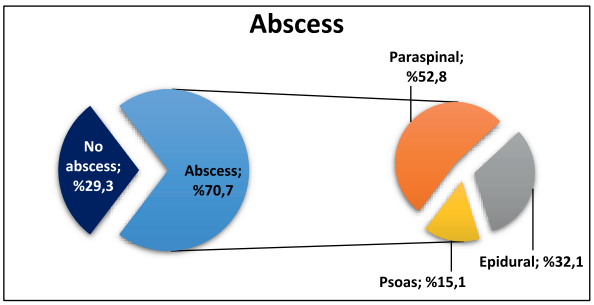

Figure-2. The distribution for abscess cases

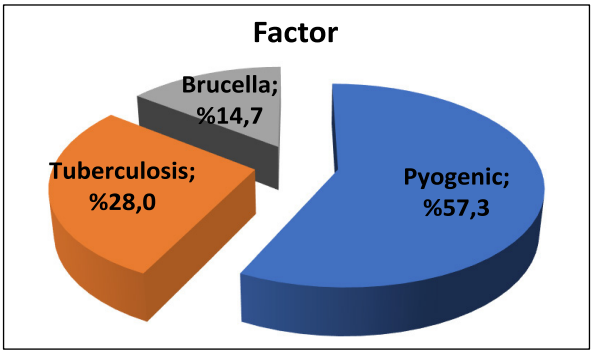

Figure-3. Factor distributions

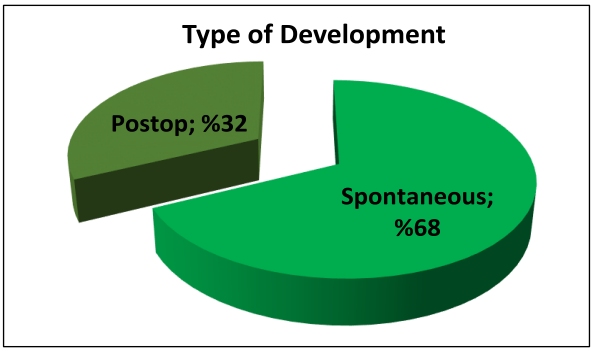

Figure-4. Type of development distributions

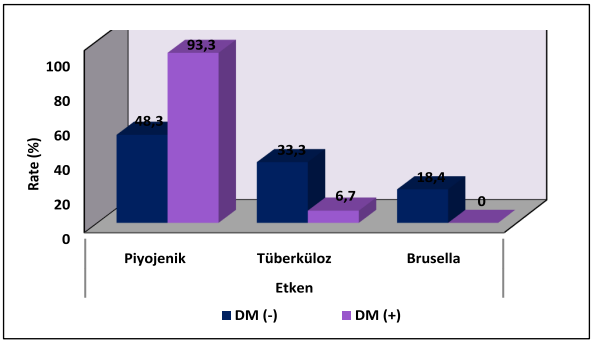

Figure-5. Factor distributions according to diabetes presence

Table-2. Evaluations for the Presence of Diabetes

		DM (-) (n=60)	DM (+) (n=15)	*p*
Factor; *n (%)*	**Pyogenic**	29 (48,3)	14 (93,3)	*[a]0,005***
	Tuberculosis	20 (33,3)	1 (6,7)	
	Brucella	11 (18,4)	0 (0)	
Type of development; *n (%)*	**Spontaneous**	42 (70,0)	9 (60,0)	*[b]0,540*
	Postop	18 (30,0)	6 (40,0)	

[a]Fisher Freeman Halton Test *[b]Fisher's Exact Test* ***p<0,01*

Table-3. Evaluations for the Involved Area

		Involved area					
		Lumbar (n=39)	**Thoracic (n=15)**	**Thoracolumbar (n=7)**	**Lumbosacral (n=11)**	**Cervical (n=3)**	***p***
Age (years)	*Min-Max (Median)*	26-85 (66)	19-81 (60)	23-69 (62)	44-80 (60)	26-70 (62)	***[c]0,860***
	Ave±Sd	60.56±16.64	58.40±17.99	55.57±16.34	60.36±11.02	52.67±23.44	
Abscess; *n (%)*	**N/A**	9 (23,1)	7 (46,6)	0 (0)	6 (54,5)	0 (0)	***[a]0,014****
	Paraspinal	16 (41,0)	4 (26,7)	5 (71,4)	3 (27,3)	0 (0)	
	Epidural	6 (15,4)	4 (26,7)	2 (28,6)	2 (18,2)	3 (100)	
	Psoas	8 (20,5)	0 (0)	0 (0)	0 (0)	0 (0)	
Factor; *n (%)*	**Pyogenic**	24 (61,5)	5 (33,3)	3 (42,8)	9 (81,8)	2 (66,7)	***[a]0,127***
	Tuberculosis	12 (30,8)	6 (40,0)	2 (28,6)	1 (9,1)	0 (0)	
	Brucella	3 (7,7)	4 (26,7)	2 (28,6)	1 (9,1)	1 (33,3)	

*[a]Fisher Freeman Halton Test [c]Kruskall Wallis Test *p<0,05*

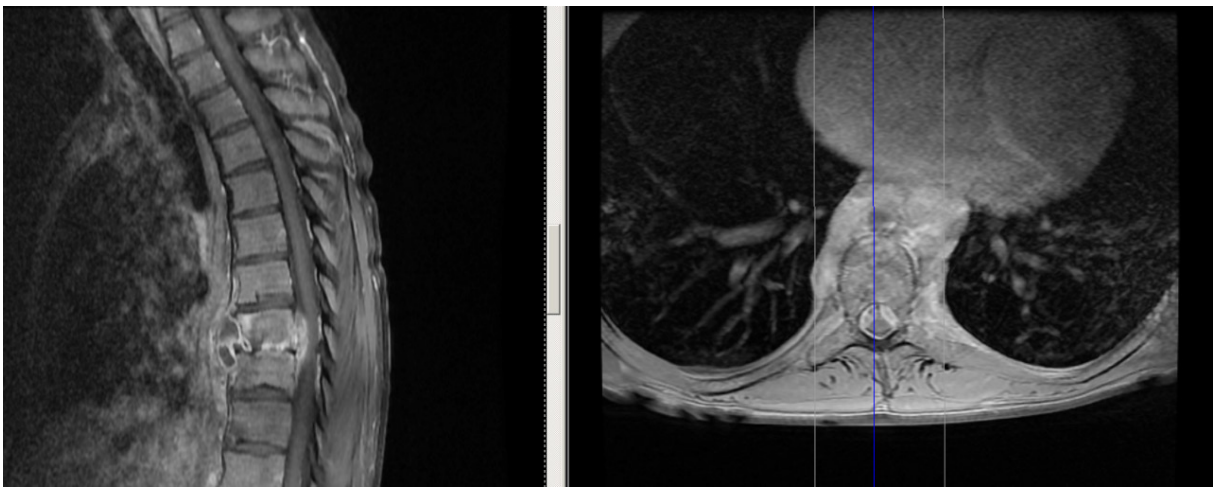

Figure 6. Axial and sagittal MR imaging of the patient with tuberculosis spondylitis.

Table-4. The Evaluations for Abscess Cases

		Abscess				
		N/A (n=22)	**Paraspinal (n=28)**	**Epidural (n=17)**	**Psoas (n=8)**	***[a]p***
Factor; *n (%)*	**Pyogenic**	14 (63,6)	15 (53,6)	12 (70,6)	2 (25,0)	***0,042****
	Tuberculosis	6 (27,3)	7 (25,0)	2 (11,8)	6 (75,0)	
	Brucella	2 (9,1)	6 (21,4)	3 (17,6)	0 (0)	
Type of development; *n (%)*	**Spontaneous**	16 (72,7)	14 (50,0)	13 (76,5)	8 (100)	***0,032****
	Postop	6 (27,3)	14 (50,0)	4 (23,5)	0 (0)	

*[a]Fisher Freeman Halton Test *p<0,05*

DISCUSSION

The clinical characteristics of cases are determined by the virulence of an active microorganism and the resistance of host. Cases generally apply for medical consultancy due to backache, fever, night sweat and extremity distress [15]. In this study, the most frequent complaint for application was backache. Many studies pointed out diabetes mellitus (DM), immune suppression, kidney failure, liver failure, malignity and alcoholism as significant risk factors [5,10,12-13,20,24]. In this study, diabetes mellitus was the most frequent accompanying disease by 20 %. In particular, pyogenic infection risk is statistically significant higher for the patients with DM (p<001).

There are three forms of spinal infections that vary according to etiological characteristics: tuberculosis, brucella and other pyogenic infections [2]. It is reported that mostly thoracic vertebra is affected in tuberculosis cases [1,4-5,9-10,15,17,22-23]. This study observed that lumbar vertebra involvement was more prevalent. Cervical area demonstrated the least prevalent involvement. Brucella generally indicates lumbar area involvement [2,23,27]. This study accomplished the same results with the literature. Soft tissue changes in tuberculosis form are encountered more frequently compared to the other infection cases [4-5,7,21]. In contrast with the literature, this study revealed that soft tissue changes were observed more frequently in brucella. This is followed by tuberculosis and pyogenic factors, respectively. The study conducted by Hamidi et al. revealed that thoracic area involvement was more frequent in tuberculosis cases while lumbar area involvement was higher for brucella cases [15]. On the contrary, this study encountered brucella in thoracic area and pyogenic and tuberculosis in lumbar area more frequently. The prevalence of abscess in thoracolumbar area is higher than the other areas (p<0,05).

Vertebral osteomyelitis is a morbid disease which is expensive to treat. The infection at upper spinal area increases morbidity. Infection at upper spinal area is associated with neurological deficit [8,14]. The serious deficit rate obtained in this study supports such data.

MRI is the gold standard imaging modality while biopsy and culture accompanied by CT is the gold standard for diagnosis. If a patient is hemodynamically and neurologically stable, biopsy should always be performed previous to treatment [26]. It may not be possible to reproduce factor for every patient. Treatment should commence according to clinical and other lab characteristics [15,18-19]. Regardless whether it is a defined organism, patients generally are obliged to be subject to intravenous antibiotics for more than 1 month [3]. Aggressive antibiotic treatment, early immobilization, close observance of inflammatory markers and clinical condition constitute the basis for the first conservative treatment of discitis. Furthermore, all the attempts must focus on the determination of causative pathogen before initiating any treatment in case the patient is hemodynamically and neurologically stable [25]. Surgical treatment should be considered in cases of neurological deterioration, wide vertebral destruction with instability and big epidural abscess [6,26]. Debridement should be the main purpose; however, decompression and fusion are also required if neural compression or spinal cord instability are present [16]. Instrumentation and combined debridement for stabilization are associated with faster postoperative mobilization, decreased postoperative morbidity and decreased risk for pseudoarthrosis and kyphosis [28].

CONCLUSION

Spinal infections are highly morbid, prevalent and destructive infections. Early diagnosis and treatment are necessary in order to preserve spinal stability and neurological function. Spinal infections are generally medically treated with antibiotics. However, debridement and intervertebral fusion are generally practiced in order to support healing, restrict neurological deterioration and ensure spinal stability in case surgical intervention is indicated.

REFERENCES

1. Akman S, Sirvanci M, Talu U, Gogus A, Hamzaoglu A. Magnetic resonance imaging of tuberculous spondylitis. *Orthopedics* 2003; 26: 69-73.
2. Bodur H, Erbay A, Çolpan A, Akıncı E. Brucellar spondylitis. *Rheumatol Int* 2004; 24(4): 221-226.
3. Chong BSW, Brereton CJ, Gordon A, Davis JS. Epidemiology, Microbiological Diagnosis, and Clinical Outcomes in Pyogenic Vertebral Osteomyelitis: A 10-year Retrospective Cohort Study. *Open Forum Infect Dis* 2018; 5(3): ofy037.
4. Colmenero JD, Jiménez-Mejías ME, Sánchez-Lora FJ, Reguera JM, Palomino-Nicás J, Martos F, García de las Heras J, Pachón J. Pyogenic, tuberculous, and brucellar vertebral osteomyelitis: a descriptive and comparative study of 219 cases. Ann Rheum Dis 1997; 56(12): 709-715.
5. Currier BL, Kim CW, Eismont FJ. Infections of the spine. *Rothman-Simeone The Spine*. 2006; pp: 1265-1309.
6. Di Martino A, Papapietro N, Lanotte A, Russo F, Vadala` G, Denaro V. Spondylodiscitis: standards of current treatment. *Curr Med Res Opin* 2012; 28(5): 689-699.
7. Doğan H. Vertebranın granülomatöz infeksiyonları. *J Turk Spinal Surg* 2006; 17(2): 33-51.
8. Eismont FJ, Bohlman HH, Soni PL, Goldberg VM, Freehafer AA. Pyogenic and fungal vertebral osteomyelitis with paralysis. *J Bone Joint Surg* 1983; 65-A: 19–29.
9. Farah K, Graillon T, Dufour H, Fuentes S. Adjacent level spondylodiscitis in a patient with thoracic spondylodiscitis: A case report and review of the literature. *Neurochirurgie*. 2018; 64(1): 53-56.

10. Gasbarrini AL, Bertoldi E, Mazzetti M, Fini L, Terzi S, Gonella F, Mirabile L, Barbanti Bròdano G, Furno A, Gasbarrini A, Boriani S. Clinical features, diagnostic and therapeutic approaches to haematogenous vertebral osteomyelitis. *Eur Rev Med Pharmacol Sci* 2005; 9(1): 53-66.
11. Govender S. Spinal infections. *J Bone Joint Surg* 2005; 87-B(11): 1454-1458.
12. Gupta A, Kowalski TJ, Osmon DR, Enzler M, Steckelberg JM, Huddleston PM, Nassr A, Mandrekar JM, Berbari EF. Long-term outcome of pyogenic vertebral osteomyelitis: a cohort study of 260 patients. *Open Forum Infect Dis* 2014; 1: 107.
13. Güven O, Bezer M, Aydın N, Ketenci İE. Tüberküloz spondilitinde tedavi stratejisi: 55 hastanın uzun dönem takip sonuçları. *Acta Orthop Traumatol Turc.* 2008; 42(5): 334-343.
14. Hadjipavlou AG, Mader JT, Necessary JT, Muffoletto AJ. Hematogenous pyogenic spinal infections and their surgical management. *Spine* 2000; 25: 1668–1677.
15. Hamidi AA, Ozsut H, Basaran S, Cagatay A, Eraksoy H. Tuberculous, pyogenic and brucellar spondylodiscitis: clinical and laboratory features of 103 cases. *Clin J* 2015; *28*(2): 80-86.
16. Hsieh PC, Wienecke RJ, O'Shaughnessy BA, Koski TR, Ondra SL. Surgical strategies for vertebral osteomyelitis and epidural abscess. *Neurosurg Focus* 2004; 17(6): E4.
17. Kandemir Ö, Milcan A, Uğuz M. Spinal infeksiyonlu olguların etyolojik, klinik ve laboratuvar olarak karşılaştırılması: ön çalışma. *J Turk Spinal Surg* 2008; 19(4): 427-434.
18. Kim J, Kim YS, Peck KR, Kim ES, Cho SY, Ha YE, Kang CI, Chung DR, Song JH. Outcome of culture-negative pyogenic vertebral osteomyelitis: comparison with microbiologically confirmed pyogenic vertebral osteomyelitis. *Semin Arthritis Rheum* 2014; 44: 246–252.
19. Lora-Tamayo J, Euba G, Narváez JA, Murillo O, Verdaguer R, Sobrino B, Narváez J, Nolla JM, Ariza J. Changing trends in the epidemiology of pyogenic vertebral osteomyelitis: the impact of cases with no microbiologic diagnosis. *Semin Arthritis Rheum* 2011; 41: 247–255.
20. Luzzati R, Giacomazzi D, Danzi MC, Tacconi L, Concia E, Vento S. Diagnosis, management and outcome of clinically-suspected spinal infection. *J Infect* 2009; 58(4): 259-265.
21. Panta OB, Pathak YR, Karki DB. Magnetic resonance imaging findings in spondylodiscitis. *J Nepal Health Res Counc* 2018; 15(3): 217-221.
22. Talı ET, Gültekin S. Spinal infeksiyonların tanı ve tedavisinde görüntüleme yöntemlerinin algoritmik kullanımı. *Ankem Derg* 2005; 19(2): 174-177.
23. Turgut M, Turgut AT, Koşar U. Spinal brucellosis: Turkish experience based on 452 cases published during the last century. *Acta Neurochir (Wien)* 2006; 148(10): 1033-1044.
24. Turunç T, Demiroğlu YZ, Uncu H, Çolakoğlu S, Arslan H. A comparative analysis of tuberculous, brucellar and pyogenic spontaneous spondylodiscitis patients. *J Infect* 2007; 55(2): 158-163.
25. Sharan AD, Tang SY, Vaccaro AR. *Basic Science of Spinal Diseases*. Jaypee Brothers Medical Publishers, Philadelphia 2013.
26. Shenoy K, Singla A, Krystal JD, Razi AE, Kim YH, Sharan AD. Discitis in adults. *JBJS Rev* 2018; 6(6): e6.
27. Solera J, Lozano E, Martínez-Alfaro E, Espinosa A, Castillejos ML, Abad L. Brucellar spondylitis: review of 35 cases and literature survey. *Clin Infect Dis* 1999; 29(6): 1440-1449.
28. Zarghooni K, Rollinghoff M, Sobottke R, Eysel P. Treatment of spondylodiscitis. *Int Orthop* 2012; 36(2): 405-411.

Volume: 29, Issue: 4, October 2018 pp: 219-221 ORIGINAL ARTICLE

FACET CYSTS

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ABSTRACT

Objective: The aim of the study is to investigate the facet cysts from MRI of patients from Neurosurgery outpatient clinic even if they are symptomatic or not, levels, numbers and side.

Materials and Method: Two-hundred and fifty adult patients who underwent a dedicated lumbar spine MRI with or without contrast between 2015 and 2018 at Neurosurgery outpatient clinic are included to our study and investigated from patient's files and radiological PACS achieve retrospectively.

Results: Two-hundred and fifty adult patients with a mean of age 62 ± 13 had a ratio of 130 (52 %) female and 120 (48 %) male. The indications of patients to make radio diagnostic MRI were radiculopathy 178 (71.2 %), back pain 197 (78.8 %), trauma 47 (18.8 %) and non-specific pain 23 (9.2 %). We found a total of 362 cysts from 250 patients. There are some patients that have more than one facet cyst. There are more cysts on the left side and the highest percentage for the level was L4-L5. We found only 6 patients (2.4 %) that have symptomatic facet cyst.

Conclusions: Lumbar facet joint synovial cysts are synovial lined outpouchings that arise from the facet joint capsule. While these cysts may occur at any lumbar level, they most commonly occur at the L4–L5 facets in degenerative facet arthropathy. Considering all spine conditions that can cause radiculopathy, facet cysts are regarded as an uncommon cause of radiculopathy.

Key Words: Facet cyst, lumbar synovial cyst, facet joint

Level of evidence: Retrospective clinical study, Level III

INTRODUCTION

Facet cysts are most common in the lumbar spine that are round, fluid-containing lesions and could arise around the facet joint in the foraminal, epidural or paravertebral area [3]. Von Gruker is known to be the first to describe an intraspinal ganglion cyst during an autopsy in 1880 [7]. Since then, many studies reported the prevalence of facet cysts: during surgery, on CT scan, and on MRI and it is between 0.1 % and 22 % in the literature mostly [5-6,12].

Facet cysts can also be asymptomatic and found incidentally and they could lead to radiculopathy because of the nerve root compression [11]. Facet cysts are known as an uncommon cause of leg pain and radiculopathy when compared with all spine conditions with radiculopathy. There are researches that point out an association of facet cysts with degenerative spine disease and spinal instability [1]. Diagnosis of the facet cyst increased because of the magnetic resonance imaging (MRI) is being used often (Khan).

The aim of the study is to investigate the facet cysts from MRI of patients from neurosurgery outpatient clinic according to they are symptomatic or not, levels, numbers and side.

MATERIALS AND METHOD

Two-hundred and fifty adult patients who underwent a dedicated lumbar spine MRI with or without contrast between 2015 and 2018 at Neurosurgery outpatient clinic are included to our

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study and investigated from patient's files and radiological PACS archives retrospectively.

Our outcome measure was the presence of a synovial facet cyst but perineural, Tarlov, intraosseous or subchondral cysts were not included to study as synovial facet cysts. We investigated also whether the facet cyst was symptomatic or asymptomatic with the presence of radiculopathy or not in patient's history and neurological examination notes.

Statistical Analyses

The categorical variable gender was presented as frequency and percent. The comparisons between independent two groups were conducted by Mann-Whitney U test. The changes during the follow-ups were compared by using Friedman test, and when a statistically significant difference was observed, post-hoc analyses were performed by Wilcoxon test with Bonferroni correction. SPSS software version 21 (IBM Inc., USA) was used for the statistical analyses.

Table-1. Patients demographic data

All Patients	**n (%)**
Age (mean±SD)	62±13
Gender	
Male	120 (48)
Female	130 (52)

Table-2. Percentage of patients according to indication for MRI

Indication for MRI	**n (%)**
Radiculopathy	178 (71.2)
Back pain	197 (78.8)
Nonspecific pain	23 (9.2)
Trauma	47 (18.8)

RESULTS

Two-hundred and fifty adult patients with a mean of age 62 ± 13 had a ratio of 130 (52 %) female and 120 (48 %) male (Table-1).

The indications of patients to make radio diagnostic MRI were radiculopathy 178 (71.2 %), back pain 197 (78.8 %), trauma 47(18.8 %) and non specific pain 23 (9.2 %). There could be more than one indication for requesting MRI (Table-2).

We found a total of 362 cysts from 250 patients. There are some patients that have more than one facet cyst. There are more cysts on the left side and the highest percentage for the level was L4-L5. (Table-3).

We found only 6 patients (2.4 %) that have symptomatic facet cyst.

DISCUSSION

These cysts can be histopathological classified into synovial, ganglion, and ligamentum flavum cysts; however, this distinction is of no clinical relevance and therefore often ignored [4]. NeuroSpine Surgery Research Group (NSURG) made a grading system for facet cysts according to level of comprimising spinal canal and degree of listhesis from grade 1 to 5 [2].

Campbell et al reported the classification of lumbar facet joint cysts using the NSURG Grading Score and Correlation with Recurrence and Clinical Outcomes and they concluded with that the proposed NeuroSpine Surgery Research Group Classification System for lumbar facet joint cysts is effective in identifying patients most likely to endure a recurrent cyst after decompressive surgery adn patients with grades 4 and 5 cysts should be considered for decompressive surgery with concomitant stabilization of the involved segments on initial presentation [2].

Table-3. Evaluation of facet cysts

Number of cysts per patient	**n (%)**
1 cyst	269 (74.3)
2 cysts	112 (30.9)
3 cysts	13 (3.5)
4 cysts	5 (1.3)
Side per cyst	**n (%)**
Left	197 (54.4)
Right	165 (45.5)
Level per cyst	**n (%)**
T12-L1	9 (2.4)
L1-L2	41 (11.3)
L2-L3	40 (11)
L3-L4	86 (23.7)
L4-L5	96 (26.5)
L5-S1	90 (24.8)
Patients With Facet Cyst	250 patients/ 362 cysts

Shah et al reported direct Computed Tomography guided lumbar facet synovial cyst puncture was technically successful in 98 % of procedures and at first postprocedural follow-up, 86 % of patients had a complete or partial symptomatic response [9].

Park et al demonstrated that younger patients had a higher prevalence of facet cysts, whereas sex distribution was comparable [6]. Varghese et al demonstrated no association of facet cyst prevalence with age or sex [10]. Doyle and Merrilees reported that their study was demonstrating an association of older age with having a facet cyst [3].

Janssen et al reported that 1 in 15 patients have at least 1 synovial facet cyst and about half of them are symptomatic and half are asymptomatic [5]. Thus having a facet cyst that symptomatic or asymptomatic is strongly associated with increased age, supporting the theory that degenerative spine disease underlies development of facet cysts. Also they found that large cyst size and anterior location of the cyst are associated with an increased likelihood of having neurological symptoms [5].

CONCLUSION

Lumbar facet joint synovial cysts are synovial lined outpouchings that arise from the facet joint capsule. While these cysts may occur at any lumbar level, they most commonly occur at the L4–L5 facets in degenerative facet arthropathy. Considering all spine conditions that can cause radiculopathy, facet cysts are regarded as an uncommon cause of radiculopathy.

REFERENCES

1. Boviatsis EJ, Stavrinou LC, Kouyialis AT. Spinal synovial cysts: pathogenesis, diagnosis and surgical treatment in a series of seven cases and literature review. *Eur Spine J* 2008; 17: 831–837.
2. Campbell R, Phan K, Mobbs R. Classification of Lumbar Facet Joint Cysts Using the NeuroSpine Surgery Research Group (NSURG) Grading Score and Correlation with Recurrence and Clinical Outcomes. *World Neurosurg* 2018 Aug 1.
3. Doyle AJ, Merrilees M. Synovial cysts of the lumbar facet joints in a symptomatic population: prevalence on magnetic resonance imaging. *Spine* 2004; 29: 874–878.
4. Ening G, Kowoll A, Stricker I. Lumbar juxta-facet joint cysts in association with facet joint orientation, -tropism and -arthritis: a case-control study. *Clin Neurol Neurosurg* 2015; 139: 278–281.
5. Janssen SJ, Ogink PT, Schwab JH. The prevalence of incidental and symptomatic lumbar synovial facet cysts. *Clin Spine Surg* 2018; 31(5): E296-E301.
6. Park HJ, Jeon YH, Rho MH. Incidental findings of the lumbar spine at MRI during herniated intervertebral disk disease evaluation. *Am J Roentgenol* 2011; 196: 1151–1155.
7. Pendleton B, Carl B, Pollay M. Spinal extradural benign synovial or ganglion cyst: case report and review of the literature. *Neurosurgery* 1983; 13: 322–326.
8. Sachdev VP, Savitz MH, Hindi AI. Synovial cysts of the lumbar facet joint. *Mt Sinai J Med* 1991; 58: 125–128.
9. Shah VN, von Fischer ND, Chin CT, Yuh EL, Amans MR, Dillon WP, Hess CP. Long-Term Effectiveness of Direct CT-Guided Aspiration and Fenestration of Symptomatic Lumbar Facet Synovial Cysts. *AJNR Am J Neuroradiol* 2018; 39(1): 193-198.
10. Varghese B, Babu A, Kumar A. Cross-sectional study on incidental spinal findings in magnetic resonance imaging lumbar spine of patients with low back pain. *West Afr J Radiol* 2017; 38–44.
11. Yarde WL, Arnold PM, Kepes JJ. Synovial cysts of the lumbar spine: diagnosis, surgical management, and pathogenesis. Report of eight cases. *Surg Neurol* 1995; 43: 459–464.
12. Zoch K. Vertebral ganglion with the symptoms of an intraspinal space-occupying lesion. *Schweiz Arch Neurol Neurochir Psychiatr* 1969; 105: 323–327.

Volume: 29, Issue: 4, October 2018 pp: 223-226 ORIGINAL ARTICLE

HOW MUCH CAN I CHANGE THE LUMBOSACRAL ALIGNMENT WITH SURGERY IN ISTHMIC SPONDYLOLISTHESIS?

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ABSTRACT

Objectives: The incidence of spondylolisthesis varies between 4-6 % in adult population. However, the incidence of isthmic spondylolisthesis is 2.6–4.4 %. It occurs in the sagittal plane by subluxation of a vertebral body through the other vertebral body. The aim of this study is to determine the changes in sagittal lumbosacral balance, which is a spinal instability parameter, after the surgical treatment in the isthmic spondylolisthesis and to demonstrate the effectiveness of the surgery in restoration of spinal stability

Materials and Methods: Twenty-six patients who underwent surgical treatment for lumbosacral isthmic spondylolisthesis in our study between January 2011 and June 2016 were studied retrospectively. They were classified according to Wiltse's criteria. Preoperative and postoperative Meyerding Slip Ratio (Grade), Slip Angle (SA), Lumbar Lordosis (LL), Lumbosacral Kyphosis Angle (LSK) and Sacral Slope (SS) measurements were performed and compared.

Results: A total of 26 patients with isthmic lumbosacral spondylolisthesis were enrolled in this study. The patient population included 13.1 % (n = 6) male and 76.9 % (n = 20) female. The mean age was 54.08 ± 12.74 years. 61.5 % (n = 16) of the cases were subtype A, 30.8 % (n = 8) were subtype B and 7 % (n = 2) were subtype C. The difference between preoperative and postoperative slip displacement and slip angle was statistically significant (p = 0.001; p <0.01).

Conclusion: Isthmic spondylolisthesis is a clinically occurring condition in middle age group, especially in women. The surgery is effective in recovery of the clinical features of these patients and restoration of the lumbosacral alignment. The most obvious improvement in the balance between the spine and the pelvis is the slip displacement and slip angle.

Key words: spondylolisthesis; isthmic; subtype; surgical; lumbosacral; alignment.

Level of evidence: Retrospective clinical study, Level III.

INTRODUCTION

The incidence of spondylolisthesis varies between 4 % and 6 % [11]. The incidence of isthmic spondylolisthesis is 2.6 - 4.4 % [10]. Spondylolisthesis is a condition that affects all age groups with a percentage of 2 – 8 % of the general population. This percentage is up to 20% in patients with complaints of low back pain. In the sagittal plane, the subluxation of a vertebral body over the other vertebral body occurs. Relatively the common mechanisms of the spinal instability are; ligamentous weakness and laxity, pars interarticularis defect, previous surgical intervention or trauma [5,12]. Various types of classification have been made as long as the causes of the spondylolisthesis are determined. The universally accepted classification is proposed by Wiltse, Newman and Mac-Nab. According to this classification isthmic type; lytic, prolonged, and acutely separated by subtypes [16].

Isthmic spondylolisthesis often happens after start to walk, rarely before 5 year-old. It is most commonly seen in the 2nd - 3rd decade of life. It may be inherited. The incidence of spondylosis or spondylolisthesis of the family members has been reported as 28 - 69 % and a strong genetic factor has been described

[5,10]. It is believed that spondylolisthesis is almost always acquired [11].

According to White and Panjabi, the clinical stability of the vertebra is the ability of the spine to limit the translocation pattern when physiological load is applied and the ability of the spinal cord nerve roots to avoid injury or irritation, as well as to prevent decapacitating deformity and pain due to structural changes [14]. Slow progressive instability is caused by; spondylosis, trauma, tumor, infection and congenital defects. One of the most common types of stability of this type is the isthmic type lumbar spondylolisthesis [1].

Sagittal sacropelvic morphology and orientation determine the lumbar spine geometry and at the same time the mechanical stress in the lumbosacral junction. In order to better understand the process of spondylolisthesis, many parameters that define the relationship between the lumbosacral junction and the pelvis have been described [6-7]. Among these parameters there are: pelvic incidence, pelvic tilt and sacral slope. In many studies, the association between pelvic and spinal parameters has been shown to be important, based on measurements of standardized health-related quality of life (health-related quality of life - HRQOL) [8].

The aim of this study is to determine the changes in sagittal lumbosacral balance, which is a spinal instability parameter, after the surgical treatment in the isthmic spondylolisthesis and to demonstrate the effectiveness of the surgery in restoration of spinal stability.

MATERIAL AND METHODS

Twenty-six patients who underwent surgical treatment for lumbosacral isthmic spondylolisthesis in our study between January 2011 and June 2016 were studied retrospectively. The age, sex, grade and type of spondylolisthesis were evaluated. Wiltse classification was used to determine the type of spondylolisthesis and the isthmic subtype [16] (Figure-1).

Direct lumbosacral anteroposterior, lateral, flexion-extension functional graphs, computed tomography (CT) and magnetic resonance imaging (MRI) examinations were performed for all preoperative cases. In these tests; preoperative and postoperative Meyerding slip displacement (Grade), slip angle (SA), Lumbar Lordosis Angle (LL), Lumbosacral Kyphosis angle (LSK), Sacral slope (SS) measurements were compared and compared to investigate the morphological changes causing instability and postoperative morphologic changes.

Statistical Analysis

NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program was used for statistical analysis. Descriptive statistical methods (Mean, Standard Deviation, Median, Frequency, Odds, Minimum, and Maximum) were used when study data were evaluated. Paired sample t-test was used for intra-group comparison of normal distribution parameters and Wilcoxon Signed Ranks test was used for intra-group comparison of parameters without normal distribution. Significance was evaluated at $p < 0.05$ levels.

RESULTS

The study consisted of 26 cases, as 13.1 % (n = 6) were male and 76.9 % (n = 20) were female. The ages of the cases ranged from 26 to 76 years with a mean of 54.08 ± 12.74 years. 61.5 % (n = 16) were subtype-A, 30.8 % (n = 8) were subtype-B and 7 % (n = 2) were subtype-C isthmic spondylolisthesis. When we analyzed the distributions according to the levels of isthmic spondylolisthesis: 11.5 % (n = 3) were in L3-4, 46.2 % (n = 12) in L4-5 and 43.2 % (n = 11) in L5-S1 levels (Table-1).

Preoperative Meyerding Grades; 30.8 % (n: 8) of the cases were grade-I, 65.4 % (n: 17) were grade-II and 3.8 % (n = 1) were grade-III. Postoperative Meyerding Grades; 88.5 % (n = 23) of the cases were grade I and 11.5 % (n = 3) were grade II.

When compared with the isthmic spondylolisthesis subtypes, the change of slip angle and slip displacement were statistically significant ($p = 0.001$; $p < 0.01$).

The preoperative slip displacement was found to be 30.11° ± 8.36° and the postoperative was 18.61° ± 9.44°. The mean 11.50° ± 5.10° changes in the postoperative slip displacement were statistically significant ($p = 0.001$; $p < 0.01$) (Table-2).

The preoperative slip angle was found to be 11.26 ± 5.18 and the postoperative slip angle was found to be 7.39° ± 4.44°. This change was 3.87° ± 3.40° postoperatively ($p = 0.001$, $p < 0.01$) (Table-2).

The mean difference between preoperative and postoperative was 0.66° ± 7.80° in Lumbar Lordosis, 0.9°4 ± 6.14° in Lumbosacral Kyphosis and 0.46° ± 5.34° in sacral slope. This change was not statistically significant ($p > 0.05$) (Table-2).

Table-1. Summarizes the demographic characteristics of 26 cases of isthmic spondylolisthesis occurring in our study.

		Min.-Max.	Mean±SD
Age (yrs)		26-76	54.08±12.74
Slip Rate (mm)		20-55	30.11±8.39
Slip Angle (°)		3-23.4	11.26±5.18
Lumbar Lordosis (°)		36.3-68.4	53.11±9.11
Lumbosacral Kyphosis (°)		13.6-52.7	29.82±9.98
Sacral Slope (°)		26.3-57.1	38.65±8.36
		n	%
Sex	Female	20	76.9
	Male	6	23.1
Level	L3/4	3	11.5
	L4/5	12	46.2
	L5/S1	11	42.3
İsthmic spondylolisthesis	Subtype A	16	61.5
	Subtype B	8	30.8
	Subtype C	2	7.7
Meyerding Grade	1 (0-25%)	8	30.8
	2 (25-50%)	17	65.4
	3 (50-75%)	1	3.8

Table-2. The results of the statistical analysis of the measurements performed before and after the surgery in the lumbosacral alignment are presented in

	Comparing Differences		
	Mean	Std. Deviation	Sig. (2-tailed)
Preop - Postop Slip Rate	11,50000	5,10882	0,00
Preop - Postop Sacral Slope	,46154	5,34386	0,66
Preop - Postop Lumbosacral Kyphosis	,94615	6,14747	0,44
Preop - Postop Slip Nagle	3,87615	3,40539	0,00
Peop - Postop Lumbar Lordosis	,66923	7,80850	0,67
Preop - Postop Meyerding grade	,61538	,49614	0,00

Paired t-testi, *p<0,05, **p<0,01

DISCUSSION

Isthmic spondylolisthesis is almost always considered to be acquired. Wiltse's study with 700 fetuses and Fredrickson's study with 500 newborns did not reveal any vertebra defect [3,15]. In women, the ratio of pars defect is less than half, in some studies and it is 1/3 of that in males but in females it is 4 times more in high-grade and the female patients are more symptomatic [5,10]. Similar to the literature, 13.1 % (n = 6) of cases were male and 76.9 % (n = 20) of female so the female / male ratio was 5.8. The most frequent level of isthmic spondylolisthesis is L5-S1 [5,10,13]. In our study, 46.2 % (n = 12) was found in L4-5 level and 43.2 % (n = 11) in L5-S1 level.

In the study by Vinig et al., 25 % of patients with isthmic spondylolisthesis were classified as grade-II, of which 17 % were in L5-S1 and 8 % in L4-5 [13]. He et al. reported that, grade-I was 19.1 % in male group and 25 % in female group. In males, 11.3 % were grade-II and above; 13.8 % of the women were grade-II and above [4]. When we look at the preoperative Meyerding grades in our study: 61.9 % (n = 39) were grade-II, 36.5 % were grade-I and only 1.6 % (n = 1) were grade-III. So, 98 % (n = 62) of our cases were low grade spondylolisthesis. According to Labelle, the most important measures in evaluating spondylolisthesis are: slip displacement, slip angle, LSK and SS [6].

There are a few studies in the literature evaluating preoperative and postoperative spinopelvic alignment. Faldini C et al. performed the study of 41 cases of high grade isthmic spondylolisthesis which they evaluated the lumbar lordosis and sacral slope. According to this,

a significant change of 2˚ was detected in sacral slope. No significant change was observed in lomber lordosis[2]. Maciejczake et al showed that, 60 cases of isthmic spondylolisthesis: lumbar lordosis, lumbosacral kyphosis angle and sacral slope evaluation were performed as preoperatively and postoperatively.

The cases were grouped as high and low grade. There was a significant increase in sacral slope both between groups and within the group. There was no significant change in LL and LSK. Similar results were obtained when grouped as balanced and unbalanced [9]. Zhang LL et al. In the study of 18 high grade L5-S1 isthmic spondylolisthesis, slip displacement, slip angle, sacral slope and lomber lordosis were evaluated. No significant change in any parameters was found. Even if the statistical significance is not obtained, it has been reported that surgery can improve spinopelvic balance [17].

In our study, although the amount of slip displacement and slip angle could be corrected with surgery, we could see that LL, LSK and SS could be improved, but this was not significant. It is certain that the surgeon benefits from a balanced distribution of load between the spine and the pelvis. This seems to be effective in preventing the development of the clinical features of the patient and the development of postoperative complications.

In conclusion, isthmic spondylolisthesis is a clinically manifestation in the middle age group, especially in women. The surgery is effective recovery of the clinical features of these patients and improving the lumbosacral alignment. The most obvious improvement in the balance between spine and pelvis is the slip displacement and slip angle.

Conflict of Interest

The authors declare that they have no conflicts of interest concerning this article.

REFERENCES

1. Benzel EC. *Biomechanics of Spine Stabilization*. Thieme, 2011.
2. Faldini C, Di Martino A, Perna F, Martikos K, Greggi T, Giannini S. Changes in spino-pelvic alignment after surgical treatment of high-grade isthmic spondylolisthesis by a posterior approach: a report of 41 cases. *Eur Spine J* 2014; 23: 714-719.
3. Fredrickson BE, Baker D, McHolick WJ, Yuan HA, Lubicky JP. The natural history of spondylolysis and spondylolisthesis. *J Bone Joint Surg* 1984; 66: 699-707.
4. He L-C, Wang Y-XJ, Gong J-S, Griffith JF, Zeng X-J, Kwok AW. Prevalence and risk factors of lumbar spondylolisthesis in elderly Chinese men and women. *Eur Rad* 2014; 24: 441-448.
5. Kalichman L, Kim DH, Li L, Guermazi A, Berkin V, Hunter DJ. Spondylolysis and spondylolisthesis: prevalence and association with low back pain in the adult community-based population. *Spine* 2009; 34: 199.
6. Labelle H, Roussouly P, Berthonnaud É, Dimnet J, O'Brien M. The importance of spino-pelvic balance in L5–S1 developmental spondylolisthesis: a review of pertinent radiologic measurements. *Spine* 2005; 30: S27-S34.
7. Labelle H, Roussouly P, Chopin D, Berthonnaud E, Hresko T, O'Brien M. Spino-pelvic alignment after surgical correction for developmental spondylolisthesis. Euro Spine J 2008; 17: 1170.
8. Lafage V, Schwab F, Skalli W, Hawkinson N, Gagey P-M, Ondra S. Standing balance and sagittal plane spinal deformity: analysis of spinopelvic and gravity line parameters. *Spine* 2008; 33: 1572-1578.
9. Maciejczak A, Jabłońska K, Bączek D, Barnaś P, Czternastek M, Dudziak P, et al: Changes in spino-pelvic alignment after surgical treatment of isthmic spondylolisthesis. *Neurol Neurochir Polska* 2014; 48: 21-29.
10. Ohmori K, Suzuki K, Ishida Y. Translamino-pedicular screw fixation with bone grafting for symptomatic isthmic lumbar spondylolysis. *Neurosurgery* 1992; 30: 379-384.
11. Roy-Camille R, Berteaux D, Saillant G. Unstable fractures of the spine. Surgical methods. Synthesis of the injured dorso-lumbar spine by plates screwed into vertebral pedicles. *Orthop Traumat Surg Res* 2014; 100: 23-25.
12. Simotas AC, Dorey FJ, Hansraj KK, Cammisa Jr F. Nonoperative treatment for lumbar spinal stenosis: clinical and outcome results and a 3-year survivorship analysis. *Spine* 2000; 25: 197.
13. Vining RD, Potocki E, McLean I, Seidman M, Morgenthal AP, Boysen J. Prevalence of radiographic findings in individuals with chronic low back pain screened for a randomized controlled trial: secondary analysis and clinical implications. *J Manip Physiol Ther* 2014; 37: 678-687.
14. White AA, Panjabi MM. *Clinical Biomechanics of the Spine*. Vol.-2, Lippincott, Philadelphia 1990.
15. Wiltse L. The etiology of spondylolisthesis. *J Bone Joint Surg* 1962; 44: 539-560.
16. Wiltse LL, Newman P, Macnab I. Classification of spondyloisis and spondylolisthesis. *Clin Orthop Rel Res* 1976; 117: 23-29.
17. Zhang L, Meng B, Yang H. Effects of pelvic balance after posterior reduction of balanced L5-S1 III-grade isthmic spondylolisthesis in adults. *Zhonghua Yi Xue Za Zhi* 2016; 96: 1811-1814.

Volume: 29, Issue: 4, October 2018 pp: 227-232 ORIGINAL ARTICLE

THE FACTORS AFFECTING FUSION AFTER ANTERIOR ODONTOID SCREW FIXATION FOR TYPE II ODONTOID FRACTURES: A RETROSPECTIVE STUDY OF 12 CONSECUTIVE PATIENTS

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** This retrospective study was approved under decision number: (507/2015) by the medical ethics committee of Bakırköy Research and Training Hospital for Neurology Neurosurgery, and Psychiatry (BRSHH) in Istanbul-Turkey.

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ABSTRACT

Background: The injury mechanism of type II odontoid fractures (TIIOFs) generally occurs as a result of strong flexion or extension that associated to axial overload. This study aimed to find the factors that may affect the surgical outcomes of TIIOF by evaluating the long-term surgical outcomes of 12 consecutive cases.
Material and methods: Medical records were retrospectively reviewed for all TIIOF cases that were diagnosed or/and underwent surgery in our hospitals from 2011 to 2016. All TIIOF patients who were underwent anterior screw fixation constituted the core sample for this study.
Results: This series included three females and nine male patients, with a mean age of 48.8±20.9 (16–85) years. The mean follow-up period was 44.9±22.4 (12–74) months. The mean of duration between the accident and surgery was 9.6±22.0 (0-77) days. Traffic accident (n=6) and falling (n=6) were the causes of the TIIOF in our patients. The most common complaint was neck pain (100%). Preoperative Frankel scale was D (4) in four patients while all patients were discharged with Frankel grade E (5). On 12th month-control visit the rate of fusion was 83.3% (10/12). Two patients were revised for malposition.
Conclusions: Anterior odontoid screw fixation is a minimal invasive approach. Using this approach is safety for the posterior cervical elements. Despite our series is not big enough to generalize, smoking and etiologies did not affect fusion, whereas advanced age (> 79) and history of more than one chronic disease can cause delayed fusion.
Key words: Anterior transodontoid, traction, type II odontoid fractures, minimal invasive approach
Level of Evidence: Retrospective clinical study, Level III

INTRODUCTION

Odontoid process fractures are common cervical spine injuries, accounting for 10 to 20 % of all cervical spine fractures [7]. The most common odontoid process fractures are type II odontoid fractures (TIIOFs) which are occur at the junction of the odontoid process and the body of the second cervical vertebra. These fractures usually result in atlantoaxial instability [1]. The injury mechanism of TIIOFs generally occurs because of strong flexion or extension that associated to axial overload.

TIIOFs are occurring in 65 % to 74 % of the odontoid process fracture cases [14]. These fractures have similar biomechanical properties as transverse ligament injuries, i.e., a loss of the translational restriction of axis (i.e. the first cervical) vertebra on dens (i.e. the second cervical) vertebra, creating the potential for spinal cord injury and severe late craniocervical deformities when healing is not obtained [10,12]. Treatment strategies for odontoid fractures can vary from observation [i.e. nonoperative management with an external immobilization (such as a cervical collar, Minerva, and other cervicothoracic orthoses, and halo orthosis], to operative management with anterior odontoid screw fixation and/or posterior cervical fusion with or without supplemental screw fixation [3-4,10].

The most common etiologies falling in elderly adults, and traffic accidents in

normal population. Only transodontoid anterior screw fixation provides immediate stabilization of the spine and can preserve normal motion between first and second cervical vertebrae. Anterior transodontoid screw fixation that is a minimal invasive method should be the first choice for treating TIIOF. This study aimed to find the prognostic factors that may affect the surgical outcomes of TIIOF by evaluating the long-term surgical outcomes of 12 consecutive cases.

MATERIALS AND METHODS

Patient population

This retrospective study was approved by the medical ethics committee of our hospital. Written informed consent was obtained from the patients for the publication of their cases and accompanying images.

Medical records were retrospectively reviewed to identify all cases of TIIOF diagnosed and surgically treated in the Department of Neurosurgery of our hospitals, between 2011 and 2016. All spinal TIIOF patients (n = 12) who were underwent anterior screw fixation constituted the core sample for this study. The patient characteristics, etiology, the period between diagnosis and surgical intervention, co-morbidity factors, hospital stay length, surgical complications, Frankel classes/grades (Table-1) [6] for pre- and postoperative neurological functional assessments have been evaluated, and the prognostic factors that may affect the fusion and surgical outcomes of TIIOF.

Table-1. Frankel scale (8).

Class	Description	Grade
A	Complete loss of motor and sensory function	1
B	Complete motor and incomplete sensory damage	2
C	Severe, but incomplete motor and partial sensory damage	3
D	Partial motor and sensor damage	4
E	Normal motor and sendory function	5

Statistical analysis

All data are expressed as the mean ± standard deviation with the range shown in parentheses. Differences between groups were assessed by a one-way analysis of variance (ANOVA) using the SPSS 21.0 statistical package. Significance in the multivariate model was determined using a p value of < 0.05, and a trend-level effect was assigned to a p = 0.05–0.10. All p values were presented with an odds ratio (OR). OR are presented with the 95 % confidential interval (CI). When OR could not be calculated, relative risk ratio (RR) was calculated. All tests were two tailed.

Surgery

Under general anesthesia the patients are positioned supine with the head held in fixation device after supporting roll on neck to get extension of head in like 15 degrees. This position may change according to manner that the odontoid fracture is best oriented so as to achieve optimum reduction. If the fracture needs reduction, reduction was performed using Gardner-Wells tongs (2-3 Kg).

A pad is placed between the shoulders. A radiolucent bite block is positioned if the transoral anterioposterior odntoid view will be used radiologically. In our series, reduction used in seven patients. C-armed fluoroscopic images are obtained in the anterioposterior and lateral planes. The patient's neck is prepared and draped, and a unilateral horizontal incision is made at approximately the level fifth cervical vertebra. The platysma is then elevated and divided, and the fascia of the sternocleidomastoid is incised approximately with a 5-cm incision along its medial border. Blunt dissection is used to expose the spinal column by opening natural corridors medial to the carotid artery sheath and lateral to the trachea and esophagus. The fascia of the musculus longus colli is incised in the midline, and the muscle is elevated from the vertebral bodies at the C5-6 level. Caspar retractor is then inserted beneath the musculus longus colli bellies bilaterally and secured with a special lateral self-retaining retractor. This forms a stable base for the rostral retraction. Blunt dissection in the retropharyngeal space is used to open a tunnel in front of the second cervical vertebral body. A K-wire is then inserted through the incision, up to the inferior edge of second cervical vertebra, under fluoroscopic control and impacted into the inferior edge of the second cervical vertebra. A single transodontoid anterior screw was used for all our patient, therefore a midline entry site is chosen for placement. Then, a hollow 8-mm drill is placed over the K-wire and rotated by hand to create a shallow groove in the face of third cervical vertebra and the C2-3 disc and annulus to the inferior border of the second cervical vertebra without removing any of the second cervical vertebra. The drill guide system is then placed over the K-wire. A plastic impactor cover is placed over these, and the spikes of the outer guide tube are firmly set into third cervical vertebra under fluoroscopic guidance. The inner drill guide is then extended to contact the inferior edge of second cervical vertebra. Once the guide tubes are secured, the K-wire is removed and replaced with a drill bit, which engages the starter hole made by the K-wire. The drill is calibrated to allow accurate depth measurement. The drilled hole is then tapped by removing the drill and the inner drill guide, replacing them with

the tap that is manipulated by hand while monitoring its progress fluoroscopically. The screw, selected based on the measured depth, is placed through the outer guide tube and into the body of the second cervical vertebra through the drilled and tapped hole. The screw is placed into the odontoid and tightened firmly, as progress is monitored fluoroscopically (Fig. 1).

At this point, flexion-extension of the patient's neck under fluoroscopy is used to confirm spinal stability. The retractors are then removed. After hemostasis using serum physiologic water, All layers were closed appropriately with their anatomy.

Patients are not required to wear cervical collars postoperatively unless radiographic evidence of osteopenia or the presence of associated cervical fractures were observed.

Figure-1. Perioperatively obtained lateral plain radiographs revealed on correct placement of a single anterior odontoid screw across the odontoid fracture site.

Patient Follow-up

As a part of standard care, the patients undergoing surgical intervention for TIIOFs using single anterior odontoid screw fixation received routine clinical evaluations and serial postoperative early CT, anterioposterior and lateral flexion-extension x-rays films (in first 24 hours after surgery) as well as during their follow-up visits at 6 weeks, 3, 12, 24, 48 months x-rays were performed. To assess the patients' neurological status we used Frankel grades (Table 1). Since Frankel et al. introduced their scale in 1961 [6], this scale (i.e., Frankel scale) which is a 5-point severity scale has commonly been used to determine the severity of the spinal cord injuries. Postoperative CT were obtained at 12, 18 and 24 months to investigate the status of fusion. Anatomical bone fusion was considered successful if there was trabeculation across the fracture site, the absence of movement on lateral flexion-extension films, and anatomical alignment of the fracture fragment. Non-anatomical bone union was considered to have occurred if there was trabeculation across the fracture site, the absence of movement on lateral flexion-extension radiographic studies, and the presence of non-anatomical alignment of the odontoid fracture fragment. The presence of fibrous union was accepted if a visible fracture line was present and movement was absent on flexion-extension x-ray films [1]. The patients who had developed nonunion on his/her 12th months-visit considered as delayed fusion, if he/she had fusion in his/her follow-up visits.

The patients' neurological symptoms before surgical intervention and at all clinical follow-up were recorded. Any clinical symptoms such as hemiparesis, loss of sensation, new neurological deficits, surgical site infection, dysphagia, CSF fistula, worsening deficits or death during the first 30 postoperative day were considered to be surgical-related complications.

RESULTS

Patients Characteristics

This series included three females and nine male patients, with a mean age of 48.8±20.9 (16–85) years. The mean follow-up period was 44.9±22.4 (12–74) months. The mean of duration between the accident and surgery was 9.6±22.0 (0-77) days. Traffic accident (n=6) and falling (n=6) were the causes of the TIIOF in our patients. The most common complaint was neck pain (100%). Co-morbidity factors are shown in Table-2.

Preoperative Frankel grade was D [4] in four patients while all patients were discharged with Frankel grade E [5]. The mean hospital stay length was 5.4±7.4 (1-26) days. On 12th month-control visit the rate of fusion was 83.3% (10/12) (Table-2). The most common associated physical finding was cranial fracture which was detected in a total of six patients; five patients in traffic accident group and in one patient in falling group. Mean operation duration was 77.3±16.1 minutes (range, 52-96 minutes). Mean intraoperative blood loss was 90±42.4 cc (range, 35-130 cc).

Table-2. Baseline clinical and demographic characteristics of the 12 TIIOF patients.

No.	Age/ Sex	Casue	Diagn. Time	Pre Frankel	Co-Morbidity	POD (day)	Follow (mn)	Post Frankel	Complication
1	24,M	Traffic	Same day	5 (E)	Smoking	14	74	5 (E)	Revised
2	16,M	Traffic	After 77 days	5 (E)	-	4	70	5 (E)	-
3	73,F	Falling	After 20 days	5 (E)	HT, DM Hypothyroidism	26	68	5 (E)	SSI, transient dysphagia
4	63,M	Falling	Next day	5 (E)	Smoking, Alcohol	2	64	5 (E)	-
5	49,F	Traffic	After 4 days	4 (D)	HT, Smoking	3	62	5 (E)	-
6	33,M	Falling	Same day	5 (E)	Smoking	4	45	5 (E)	-
7	46,M	Falling	Same day	4 (D)	Smoking	3	41	5 (E)	-
8	36,M	Traffic	Same day	5 (E)	Smoking	4	38	5 (E)	Revised
9	85,M	Falling	After 2 days	4 (D)	HT, DM, Smoking	1	26	5 (E)	-
10	46,M	Traffic	After 3 days	5 (E)	Smoking	1	25	5 (E)	-
11	72,M	Falling	After 6 days	4 (D)	-	2	14	5 (E)	-
12	42,F	Traffic	After 2 days	5 (E)	-	1	12	5 (E)	-

M: Male; F: Female; HT: Hypertension; DM: Diabetes Mellitus; POD: Postoperative day; SSI: Surgical site infection.

Surgical Complications

Two patients were revised for malposition. Delayed fusion was seen in two patients; one female patient who had fusion on her 15th month follow-up and one male patient had fusion on his 18th follow-up. The former patient had transient dysphagia and surgical site infection. She was treated with antibiotics and no pains. Both of them are advanced age (73 and 85) and they have hypertension and diabetes mellitus. No patient had new neurological deficits, CSF fistula, worsening deficits or death. No patient needed posterior C1-2 fusion.

Surgical Outcomes and the Factors Affecting Surgical Outcomes

Despite the fact that our series is not big enough to make generalization, we divided patients into two groups; the first group who had delayed anatomical fusion (i.e., fusion had been occurred after the first postoperative 12 months) (n = 2) and the second group who had normal anatomical fusion (i.e., fusion had been occurred in the first postoperative 12 months) (n = 10). The comparison between both groups is given in Table 3. Because of the sample size is too small comorbidities could not investigate separately. History of one or all of chronic diseases such as hypertension, diabetes mellitus, or hypothyroidism was considered as a comorbidity factor. Advanced age (according to our study > 79) [$p < 0.0001$; $X^2 = 19.45$ (student's T-test)] and history of more than one chronic disease delayed fusion [$p = 0.045$; RR = 10.0 (1.6–64.2)].

Table-3. Factors affecting surgical outcomes in our patients.

	Delayed Fusion Group	Good Fused Group	p	OR/RR and CIs
Number of patients	n = 2	n = 10		
Mean of age (Years)	79±8.5 (73-85)	42.7±16.8 (16-72)	< 0.0001*	$X^2 = 19.45$
Sex (F/M)	1/1	2/8	1.0	OR = 0.25 (0.01 – 6.0)
Etiology (Traf/Fall)	0/2	6/4	0.45	RR = 2.5 (1.1 – 5.3)
Comorbidity (-/+)**	0/2	9/1	0.045*	RR = 10.0 (1.6 – 64.2)
Smoking (-/+)	1/1	3/7	1.0	OR = 0.43 (0.02 – 9.3)
Preoperative deficit (-/+)	1/1	7/3	1.0	OR = 2.3 (0.1 – 51.0)

$p < 0.05$ is significant. F: Female; M: Male; Traf: Traffic accident; Fall: Falling; OR: Odds ratio; RR: Relative risk ratio; OR and RR are presented with the 95% confidential interval. RR: relative risk ratio.
* Statistically significant; ** Presence of one or more chronic diseases such as hypertension, diabetes mellitus, or hyperthyroidism except for smoking or alcohol abusing.

DISCUSSION

Science the beginning of 1980s several spine surgeons [1,3-4,7-8,10-14] have advocated anterior odntoid screw fixation. Thanks of advances in the quality of intraoperative fluoroscopy and improvements in surgical instrumentation were made that this procedure gained wider acceptance in recent years.

Stabilization of TIIOFs requires surgical fixation and/or rigid external immobilization. External immobilization using a rigid orthosis may allow for fusion without the necessity for surgical procedure, but it is limited because of prolonged limitation of the patient's function and higher nonunion rates. In surgical stabilization procedures surgeon has relied primarily on posterior atlantoaxial fusion in which he uses a variety of bone and wire constructs. However, posterior fusion is associated with lower rates of nonunion, it restricts normal rotatory motion between first and second cervical vertebrae, which accounts for more than 50 % of all cervical spine rotatory motion, and reduces cervical spine flexion and extension rotation by 10 % [1,10].

The most common seen problem in TIIOFs is the difficulty in the formation of fusion. In the chronic or late-diagnosed TIIOFs, the difficulty of spontaneous fusion due to sclerosis that occurs on both sides of the fracture line becomes a significant problem [11]. In such cases, a K wire with a narrow diameter is inserted on the surface of the vertebral column towards the sclerotic odontoid surface and passes the sclerotic band four or five times in order to support the development of fusion by damaging the surface on both sides; thus, fusion may achieved in such late-diagnosed patients [15].

If the gap between the fracture and vertebrae is more than 6 mm, this space affects the formation of fusion negatively. Apuzzo et al. found the non-union rates of fractures to be 33 % in the cases with dislocations more than 4 mm in their series of 45 patients [2]. The dislocation gap of the dens is also an important factor for fusion in patients with a brace. In their series of 107 patients, Hadley et al., reported the non-union rates in patients who had a dislocation over 6 mm as 67 % while the rate was 9 % for dislocations below 6 mm [9]. Furthermore, age is another important factor and spontaneous fusion rates decrease after the age of 40 [5,9]. In our results advanced age was a significant factor affected anatomical bone fusion negatively.

Apfelbaum et al. study [1] reported a total of 147 patients who received anterior odntoid screw fixation; 138 patients with TIIOFs and 9 patients with TIIIOFs. They described 129 patients as recent fractures (< 6 months) and 18 patients as remote fractures (≥ 18 months). The study investigated the factors may affect bone fusion in their long series and they found that anatomical bone fusion was significantly affected by only fracture orientation. Patients' sex, age, fracture type, number of screws placed and degree of odntoid displacement had not impact on anatomical bone fusion. According to Apfelbaum et al., fractures oriented in the anterior oblique orientation were significantly more likely to resultin nonanatomical union, fibrous union, or nonunion than posterior oblique and horizontal oriented fractures [1]. In our series 7 patients needed reduction. After reduction all orientations were the same so we could not compare orientations between delayed and normal fused groups. On opposite to Apfelbaum et al. study, we found that advanced age and comorbidity factors are factors can significantly affect anatomical bone fusion. Because of the limited patients number we could not be sure if these factors (advanced age and comorbidities) are independent factors or not.

The high rate limitations associated with either conservative or posterior surgical methods for odontoid fracture stabilization, several spine surgeons have begun to use direct anterior screw fixation to treat TIIOFs. Direct anterior screw fixation is an osteosynthetic technique that can provide immediate spinal stabilization. The results of several clinical studies have shown that anterior screw fixation can preserve normal C1-2 rotatory motion [8,13]. Montesano et al.study has reported that in 83% of their patients seen in follow up, full range of motion was maintained after anterior screw fixation of odontoid fractures [13].

The study has several limitations: first, it's a retrospective study that may suffer from the inherent bias. Second, the sample size of our cohort is small to make generalizations. Third, the reults are a single center results. Further prospective studies with larger sample size are needed to validate our results.

CONCLUSIONS

Anterior odontoid screw fixation is a minimal invasive approach. Using this approach is safety for the posterior cervical elements. Despite our series is not big enough to make generalization, smoking and etiologies did not affect fusion, whereas advanced age (> 79) and history of more than one chronic disease can cause delayed fusion.

Disclosure of Potential Conflicts of Interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Apfelbaum RI, Lonser RR, Veres R, Casey A. Direct anterior screw fixation for recent and remote odontoid fractures. *Neurosurg Focus* 2000; 8(6): Article 2.
2. Apuzzo ML, Heiden JS, Weiss MH, Ackerson TT, Harvey JP, Kurze T. Acute fractures of the odontoid process. An analysis of 45 cases. *J Neurosurg* 1978; 48: 85-91.

3. Dailey AT, Hart D, Finn MA, Schmidt MH, Apfelbaum RI. Anterior fixation of odontoid fractures in an elderly population. *J Neurosurg Spine* 2010; 12: 1-8.
4. Denaro V, Papalia R, Di Martino A, Denaro L, Maffulli N. The best surgical treatment for type II fractures of the dens is still controversial. *Clin Orthop Relat Res* 2011; 469: 742-750.
5. Dunn ME, Seljeskog EL. Experience in the management of odontoid process injuries. An analysis of 128 cases. *Neurosurgery* 1986; 18: 306-310.
6. Frankel HL, Hancock DO, Hyslop G, Melzak J, Michaelis LS, Ungar GH, Vernon JD, Walsh JJ. The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. *Paraplegia* 1969; 7: 179-192.
7. Fujii E, Kobayashi K, Hirabayashi K. Treatment in fractures of the odontoid process. *Spine* 1988; 13: 604-609.
8. Geisler FH, Cheng C, Poka A, Brumback RJ. Anterior screw fixation of posteriorly displaced type II odontoid fractures. *Neurosurgery* 1989; 25: 30-38.
9. Hadley MN, Walters BC, Grabb PA, Oyesiku NM, Przybylski GJ, Resnick DK, Ryken TC. lsolated fractures of the axis in adults. *Neurosurgery* 2002; 50 (Supp.-3): 125-139.
10. Joaquim A, Patel AA. Surgical treatment of Type II odontoid fractures: anterior odontoid screw fixation or posterior cervical instrumented fusion? *Neurosurg Focus* 2015; 38(4): E11.
11. Keskin F, Gomleksiz C, Sasani M, Oktenoglu T, Suzer T, Ozer AF. Clinical Results of Anterior Odontoid Screw Fixation for Type II Odontoid Fractures. *Turk Neurosurg* 2014; 24(5): 750-756.
12. Mashhadinezhad H, Samini F, Mashhadinezhad A, Birjandinejad A. Clinical results of surgical management in type II odontoid fracture: a preliminary report. *Turk Neurosurg* 2012; 22: 583-587.
13. Montesano PX, Anderson PA, Schlehr F, Thalgott JS, Lowrey G. Odontoid fractures treated by odontoid anterior screw fixation. *Spine* 1991; 16 (Suppl.-3): S33-S37.
14. Müller EJ, Schwinnen I, Fischer K, Wick M, Muhr G. Nonrigid immobilisation of odontoid fractures. *Eur Spine J* 2003; 12: 522-525.
15. Ozer AF, Cosar M, Oktenoglu TB, Sasani M, Iplikcioglu AC, Bozkus H, Bavbek C, Sarioglu AC. A new transodontoid fixation technique for delayed type II odontoid fracture: Technical note. *Surg Neurol* 2009; 71(1): 121-125.

Volume: 29, Issue: 4, October 2018 pp: 233-236 ORIGINAL ARTICLE

CERVICAL TRAUMAS

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ABSTRACT

Objective: The aim of our study is to investigate the clinical data of patients with cervical traumas.

Materials and Method: We investigate 65 patients who were hospitalized for cervical traumas in Department of Neurosurgery and this study is planned for Neurosurgery specialty thesis. The patient's files were evaluated from archives retrospectively.

Results: Forty seven man (72 %) and 18 (28 %) woman were included in the study. Mean age of patients were 35.1 (14 months-90 years). 36 patients were treated with surgery and 27 were followed up with conservative treatment with external immobilization. Total mortality was 18 (27.6 %) patients and 12 were exitus before surgery. Forty patients had cervical fracture-dislocation and 4 of them had C1-C2 upper cervical dislocation. Seventeen patients were treated with external immobilization; 2 of them with halo vest, 4 with rigid cervical collar and 11 with brace. Five of operated patients were re-operated because of complications.

Conclusion: The cervical spine is the most vulnerable and hence the most damaged portion of the vertebral column because of the position in relation to the brain, injury can have catastrophic results. The key points in management of cervical spine trauma are to identify the injury to treat and reverse neurological deficits, and to prevent long-term disability by stabilization of the fracture.

Key words: Cervical trauma, cervical spine, cervical injury.

Level of Evidence: Retrospective clinical study, Level III.

INTRODUCTION

The incidence of clinically significant cervical spine injury among blunt trauma patients ranges between 1 % and 3 % [9,15]. The incidence of death from cervical traumas and spinal cord injuries is 21% because of traffic accidents. Cervical cord injuries are serious cause of morbidity with high ratios of mortality. The most important situations are to prevent injuries, take precaution for accidents. Injury severity can range from minor and possibly insignificant, to major and immediately life-threatening. Older patients in particular are vulnerable to the mechanical forces of trauma due to musculoskeletal changes and alterations in cardiovascular and respiratory function, making them more susceptible to injury than their younger counterparts [14].

Management of cervical spine injuries depends on patient factors, mechanism of injury and subsequent effects of the injury on the cord or roots. If there are symptoms of cord compression, decompression may be performed. Fractures or subluxations require reduction and realignment to anatomical position [4].

The critical care and education to prevent additional injuries to cervical vertebra and spinal cord injuries must be given to emergency health team. Early immobilization, reduction and stabilization of the patients is the key points for these kind of injuries. The number of early complications could be decreased by these precautions.

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The aim of our study is to investigate the clinical data of patients with cervical traumas.

MATERIAL AND METHOD

We investigate 65 patients who were hospitalized for cervical traumas in Department of Neurosurgery and this study is planned for Neurosurgery specialty thesis. The patient's files were evaluated from archives retrospectively.

Patients were classified with Frankel Score System:

A- Complete quadriplegia

B- Incomplete quadriplegia-No active motor function.

C- Incomplete quadriplegia-Active motor function.

D- Nerve root functions positive.

E- No neurological deficits.

RESULTS

Forty seven man (72 %) and 18 (28 %) woman were included in the study. Mean age of patients were 35.1 (14 months-90 years) (Table-1). History of patients were presented in Table-2.

36 patients were treated with surgery and 27 were followed up with conservative treatment with external immobilization. Total mortality was 18 (27.6 %) patients and 12 were exitus before surgery.

Forty patients had cervical fracture-dislocation and 4 of them had C1-C2 upper cervical dislocation (Table-3).

Seventeen patients were treated with external immobilization; 2 of them with halo vest, 4 with rigid cervical collar and 11 with brace. Surgical techniques were presented in Table-4.

Five of operated patients were re-operated because of complications.

Patients were scored with Frankel system preoperatively and postoperatively (Table 5).

Tablo-1. Demographic data of patients

	Mean	**Min-max**
Age (years)	35.1	14 month - 90 years
	N	**%**
Sex		
Male	47	72
Female	18	28

Table-2. History of patients with cervical trauma

History	**Number of Patients**
Traffic accident	36(55.5%)
Fall	20(35.5%)
Stroke	5(8%)
Penetrating trauma	2(3%)
Sports injury	2(3%)

Table-3. Type of cervical traumas

Type of Trauma	**Number of Patients**
Fracture-dislocation	40(62%)
Compression	19(29%)
Whiplash injury	2(3%)
SCIWORA	4(6%)

Table-4. Surgery ratios of patients with cervical trauma

Surgery	**Number of Patients**
Anterior fusion	27(75%)
Anterior fusion+anterior plate	5(14%)
Posterior laminectomy	1(2.7%)
Posterior stabilization	3(8.3%)

Table-5. Preoperative and postoperative Frankel Scores of patients

Preoperative Frankel Score	**Number of Patients**	**Exitus**	**A**	**B**	**C**	**D**	**E**	**Total**
A	5	3	2	-	-	-	-	5
B	6	3	1	1	1	-	-	6
C	12	-	-	-	7	3	2	12
D	8	-	-	-	-	5	3	8
E	5	-	-	-	-	-	5	5
Total	36	6	3	1	8	8	10	36

DISCUSSION

The cervical spine is the most mobile, and thus the most vulnerable portion of the spinal construct. Of all traumatic fractures of the spine, 20.8 % occur at the cervical region [5]. Causes of cervical spine fractures include motor vehicle accidents, falls, sports injuries and other modes of trauma. The risk of neurological deficit is highest with cervical spine fractures because of the proximity to the brainstem [4]. Traumatic fractures of the cervical spine cause considerable mortality and morbidity, with a high economic burden to society, and thus early diagnosis and optimal management is necessary in these patients.

The rate of cervical spine injury has been reported to be twice as high in the elderly than in the non-elderly population [7,16]. Owing to the high kinetic forces transmitted in these injuries, 65 % of these fractures have significant associated injuries and thus the cervical spine fracture may initially be overlooked [10].

At present, routine radiographic investigation of the cervical spine following blunt trauma is not indicated, and is associated with risks of radiation exposure in younger patients and over-utilisation of limited healthcare [13].

The most frequent cause of cervical trauma was traffic accident in our study which correlate with literature [1,12,17]. Traffic accident rate was 55.5 %. Second cause of cervical traumas were fall down with the ratio of 30.5 %. The most frequent reason was different in pediatric patients with fall down with 60 %. Sports injury rate was lower than the ratio of stroke.

Thirty six patients were operated and 27 of them gone under anterior fusion surgery. Five of operated patients were re-operated because of graft dislocation. Corpectomy and Cloward techniques were applied for the patients. Five patients had anterior plate with fusion. Anterior cervical procedures were frequently chosen and successful surgery techniques with good planning and correct indications [2-3,6,8].

We followed up patients with Frankel Scores and we saw that patients had A and B scores had 50 % mortality. The 12 patients died before surgeries were also scored as A and B. These results are similar to the researches in the literature [2,11]. Postoperative recovery was seen better in C and D scored patients and we found that 3 patients from C group and 2 patients from D group had recovered and became group E. Recovery rate was 37.5 % in group D. We had not observe any worsening of neurological examination in group E.

CONCLUSION

The cervical spine is the most vulnerable and hence the most damaged portion of the vertebral column because of the position in relation to the brain, injury can have catastrophic results. The key points in management of cervical spine trauma are to identify the injury to treat and reverse neurological deficits, and to prevent long-term disability by stabilization of the fracture.

REFERENCES

1. Bauer RD, Errico TJ. Cervical spine injuries. *Spinal Trauma* 1991; 4: 71-121.
2. Benzel EC, Larson SJ. Functional recovery after decompressive spine operation for cervical spine fractures. *Neurosurgery* 1987, 20(5): 742-746.
3. Cain CM, Langston PG, Wenston PF. Assesment of spinal cord flow and function in sheep after anterolateral cervical interbody fusion in the presence of cord damage. *Spine* 1994; 19(5): 511-519.
4. Copley P, Tilliridou V, Jamjoom A. Traumatic cervical spine fractures in the adult. *Br J Hosp Med (Lond)* 2016; 77(9): 530-535.
5. Devons CA. Comprehensive geriatric assessment: making the most of the aging years. *Curr Opin Clin Nutr Metab Care* 2002; 5: 19–24.
6. Goffin J, Piets D, Van den Berg R. Anterior cervical Fusion and osteosynthetic stabilization according to Caspar; A prospective study of 41 patients with fractures and/or dislocations of cervical spine. *Neurosurgery* 1989, 25: 865-871.
7. Goode T, Young A, Wilson SP, Katzen J, Wolfe LG, Duane TM. Evaluation of cervical spine fracture in the elderly: can we trust our physical examination? *Am Surg* 2014; 80: 182–184.
8. Hamilton A, Webb JK. The role of anterior surgery for vertebral fractures with and without cord compression. *Clin Orthop* 1994, 300: 79-89.
9. Inaba K, Byerly S, Bush LD. Cervical spine clearance: a prospective Western Trauma Associa- tion Multi-institutional Trial. *J Trauma Acute Care Surg* 2016; 81:1122–30.
10. Leucht P, Fischer K, Muhr G, Mueller EJ (2009) Epidemiology of traumatic spine fractures. *Injury* 40(2): 166–72
11. Nielsen CF, Annertz M, Persson LL. Posterior wiring without bony fusion in trauma¬tic distractive flexion injuries of the mid to lower cervical spine. Longterm Fllow-up in 30 patients. *Spine* 1991, 16(4): 467- 472.
12. Oiler DW, Boone S. Blunt cervical spine Brown-Sequard injury. (A report of three cases). *Am Surg* 1991; 57: 361-365.
13. Paykin G, O'Reilly G, Ackland H, Mitra B. Review article: NEXUS criteria to rule out cervical spine injury among older patients: A systematic review. *Emerg Med Australas* 2018; 30(4): 450-455.
14. Pudelek B. Geriatric trauma: special needs for a special population. *AACN Clin Issues* 2002; 13: 61–72.
15. Stiell IG, Wells GA, Vandemheen K. Canadian C-Spine Rule for radiography in alert and stable trauma patients. *JAMA* 2001; 286: 1841–1848.

16. Touger M, Gennis P, Nathanson N. Validity of a decision rule to reduce cervical spine radiography in elderly patients with blunt trauma. *Ann Emerg Med* 2002; 40: 287–293.

17. Wagner FC. Injuries to the cervical spine and spinal cord. In Youmans *Neurological Surg* 1990; 4: 2378-2391.

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SACRAL STRESS FRACTURES: AN IMAGING BASED CROSS-SECTIONAL STUDY*

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***Informed consent was obtained from patients with respect to the retrospective analysis, and the study was approved by the institutional review board.**
Fields of Study: Spine Surgery; Radiology.
Conflict of Interest:The authors of this manuscript have no competing interests that influence the results and discussion of this paper.

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ABSTRACT

Background Data: Having been regarded as a rare cause of low back pain, sacral stress fractures are overestimated because of the lack of specific symptoms. Furthermore, the level of awareness of this pathological condition is quite low amongst the physicians.

Purpose: To present the incidence rate of sacral stress fractures by reviewing imaging modalities, and to compare the results of patient populations-at-risk in accordance with the current literature.

Materials-Methods: This retrospective study was held at a private tertiary care center between April 2013 and December 2017. With the exception of high energy trauma patients, all individuals who had lumbar magnetic resonance imaging (MRI) scans and those who further evaluated with a pelvic MRI scan consisted the study group. The patients' demographics and the radiological features were evaluated and reviewed by using electronic patient records and hospital-based picture archiving and communication system. The frequencies were calculated and compared with the data obtained from the literature.

Results: A total of 1321 individuals (female: 659, male: 662) had a lumbar MRI scan during the study period and 485 of them (female: 238, male: 247) were further analysed with a pelvic MRI scan for differential diagnosis. Fourteen of these patients were diagnosed as sacral stress fracture. The calculated frequencies within a 57 months period for females, males and the whole study population were 1.67 %, 0.45 % and 1.06 %, respectively.

Conclusion: This study has reviewed the MRI studies and found out the incidence rates for sacral stress fractures. These results suggest that physicians should be aware of sacral stress fractures in the setting of clinical suspicion, especially in the certain patient populations.

Key Words: fatigue fracture; insufficiency fracture; sacrum; stress fracture

Level of evidence: Retrospective clinical study, Level III

INTRODUCTION

Commonly misdiagnosed and having been regarded as a rare cause of low back pain, sacral stress fractures are overestimated because of the lack of specific symptoms [7,21]. Moreover, the level of awareness of this pathological condition is quite low amongst the physicians [12,15,21].

The term "stress fracture" is defined as a partial or complete fracture resulting from the inherent inability of bone to lean stress applied in a rhythmic, repeated, sub-threshold manner without intensity. These fractures are further classified by Pentecost et al. as "fatigue" and "insufficiency" based on bone physiology and mechanism of injury [8,11,16,17,28,29]. A fatigue fracture may occur if abnormal stresses are applied to a bone with normal elastic resistance, i.e. the intense training of athletes for prolonged periods [17,28,29]. On the other hand, fractures occurring in the setting of the physiological stresses in bones with deficient elastic resistance, i.e. osteoporosis, named as "insufficiency" [11,17,28,29]. Nowadays, some authors prefer to use the term "fragility fracture" instead of stress, fatigue or insufficiency fractures to describe osteoporosis-associated fractures due to a minor trauma [24].

The reported incidence rate of fatigue fractures may be as high as 20% in runners, and <1% for insufficiency fractures in general population [3]. Because of the high number of undiagnosed cases, the true incidence is unknown for sacral insufficiency fractures, and it has been reported to be between 1% and 5% in at-risk patient populations [14,25-27]. Even though, the prevalence of such situation increases in accordance with the longer life expectancy in the last two decades [1,24], there is a limited evidence in the literature for identifying the frequency rates for stress fractures of the sacrum. So, the purpose of this single-center study is to present the incidence rate of sacral stress fractures by reviewing imaging modalities, and to compare the results of patient populations-at-risk in accordance with the current literature.

MATERIALS AND METHODS

This retrospective study was held at a private tertiary care center, and approved by the institutional review board (ATADEK 2017-13/6). Between April 2013 and December 2017, with the exception of high energy trauma patients, all individuals who had lumbar magnetic resonance imaging (MRI) scans and those who further evaluated with a pelvic MRI scan consisted the study group. A flow chart of the study design is given in Figure-1.

The patients' demographics and the radiological features were evaluated and reviewed by using electronic patient records and hospital based picture archiving and communication system (PACS). The frequencies were calculated, and compared with the data obtained from the literature.

Statistical Analysis

Data were expressed as mean values and standard deviations (SD) for continuous variables and as percentages for categorical variables. The difference between the two rates with its 95% confidence interval and associated p-value was calculated [19]. Type-I error rate was taken as α=0.05 for statistical significance. Statistical analyses were performed using MedCalc for Windows, version 18.9 (MedCalc Software, Ostend, Belgium).

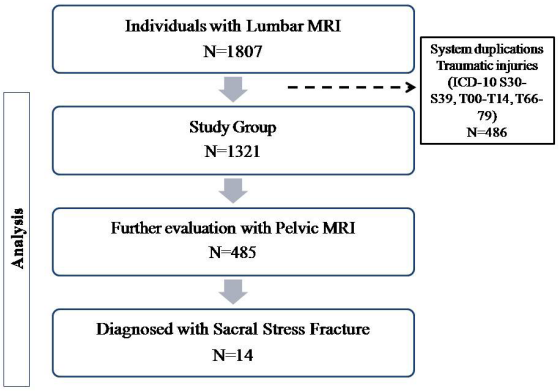

Figure-1. Flowchart of the study.

RESULTS

A total of 1321 individuals (female: 659, male: 662) had a lumbar MRI scan during the study period and 485 of them (female: 238, male: 247) were further analyzed with a pelvic MRI scan for differential diagnosis. Fourteen of these patients were diagnosed as sacral stress fracture, six of them were unilateral and the rest were bilateral. The characteristics of the study population and patient number in the distribution of age groups containing 11 females and 3 males are summarized on Table-1and Figure-2, respectively.

When the fractures further classified according to the recent literature by Bakker et al. [1], the numbers of fractures for Type A, Type B, and Type C were 1, 9 and 4, respectively (Figure-3).

The calculated frequencies within a 57 months period for females, males and the whole study population were 1.67 %, 0.45 % and 1.06 %, respectively. When the incidence rates were compared between the study group and the eligible appropriate literature, no statistically significant difference was found with respect to the whole study population as well as to the patient populations-at-risk in a total person-years analysis (Table-2A-B).

Table-1. Characteristics of the study population.

	Lumbar MRI (+) patients	Further evaluated with Pelvic MRI	Diagnosed with Sacral Stress Fracture
Characteristic	n (%)	n (%)	n (%)
Gender			
Female	659 (49.9)	238 (49.1)	11 (78.6)
Male	662 (50.1)	247 (50.9)	3 (21.4)
Total	1321 (100)	485 (100)	14 (100)
Age years (mean, min-max)	42.8 (1-94)	40.98 (9-82)	54.4 (35-81) F: 53.6 (35-81), M: 61.7 (45-75)

F: female, M: male, min: minimum, max: maximum, MRI: magnetic resonance imaging

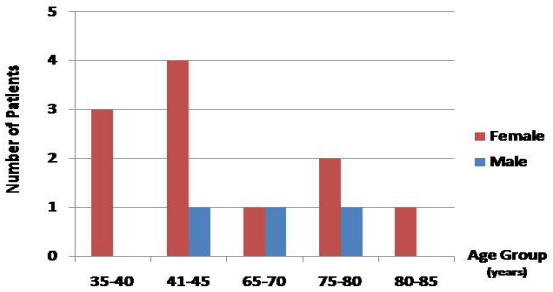

Figure-2. The patient number in the distribution of age groups containing 11 females and 3 males.

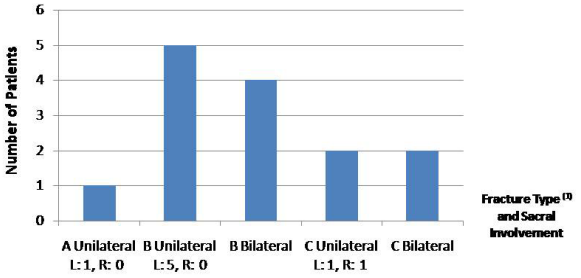

Figure-3. Classification of the sacral stress fractures in accordance with the recent literature by Bakker et al. [1]

Table-2. The comparison between the incidence rates for; **(A)** whole study population, and **(B)** patient populations-at-risk, in a total person-years analysis.

	Incidence Rate	95% CI	p	Incidence Rate Difference, 95% CI	Incidence Rate Ratio, 95% CI
A.					
Present Study	0.002231	0.00122-0.003743	0.06	-0.001995, -0.004093-0.000102	0.5279, 0.2467-1.0989
Weber et al. [26] (1993)	0.004227	0.002582-0.006528			
B.					
Present Study	0.005435	0.001481-0.013915	0.27	-0.004417, -0.012273-0.003438	0.5516, 0.1371-1.6467
Weber et al. [26] (1993)	0.009852	0.006018-0.015216			

CI: Confidence interval

DISCUSSION

This single center study aimed to analyze the incidence rate of sacral stress fractures by reviewing imaging modalities, and to compare the results of patient populations-at-risk in accordance with the literature. The calculated incidence rate was 1.06% for whole study population within a 57 months period. Moreover, no statistically significant difference was found with respect to the whole study population as well as to the patient populations-at-risk in a total person-years analysis (Table-2A-B).

Sacral stress fractures are mainly divided into two categories as "insufficiency" and "fatigue" [17,28]. Both types have different set of risk factors and disease mechanisms. First described by Lourie as spontaneous osteoporotic fracture of the sacrum in 1982 [13], insufficiency fractures occur after normal stress in bone with decreased mineralization and elastic resistance, as caused by postmenopausal osteoporosis [29].

The risk factors for sacral insufficiency fractures are; older age, female gender, osteoporosis, osteopenia, rheumatoid arthritis, corticosteroid use, pelvic radiation therapy, hyperparathyroidism, renal osteodystrophy, osteomalacia, Paget's disease, previous thoracolumbar / lumbosacral fusion surgery, joint arthroplasty, immunosupression, obesity, smoking history, vitamin D insufficiency, and anticoagulant therapy with heparin [12,28,29]. On the other hand, first discovered in 1989 by Volpin et al. [23], sacral fatigue fractures occur when abnormal stresses are applied to normal bone, and are typically seen in long-distance runners and those that engage in regular repetitive weight-bearing exercises for prolonged periods, such as military recruits [29]. The possible risk factors for sacral fatigue fractures are long distance running, a recent increase in training intensity, deficient diet, and to be a military personnel [11,28,29]. Moreover, the female athlete triad (amenorrhea, eating disorder, and osteopenia) is another important factor for the development of sacral fatigue fractures [11,28,29]. Both stress and fatigue type of sacral stress fractures have been reported during the last trimester of pregnancy and the early postpartum period [4,18,20].

Risk factors for the fractures during pregnancy or in the first weeks after delivery include vaginal delivery of a high-birth-weight infant, increased lumbar lordosis, excessive weight gain, rapid vaginal delivery, ligamentous laxity, and transient osteoporosis associated with pregnancy and lactation [12,29]. The authors of the present study have evaluated such type of fractures with imaging studies and the evaluated clinical parameters in the study were only age and gender. There was a female predominance as in line with the literature [11,28,29].

The mean age was 54.4 years that was different from the previous studies [11,28,29]. Here, 21.4 % of the patients were between 35-40 years, 35.7 % of them were between 41-45 years, and the rest (42.9 %) were between 65-85 years. Although the majority of the patients were between 65-85 years, as because of lack of detailed clinical information and bone-mineral density test, the authors were unable to further classify the sacral stress fractures, but they have claimed that all these fractures in the present study could have been classified as insufficiency fractures.

Low clinical suspicion and not to be even aware of such clinical problem, the diagnosis of sacral stress fractures are often delayed or mistaken. Because of the high number of undiagnosed cases, the true incidence is unknown. Weber et al. reported that sacral insufficiency fractures were present in 1.8 % (20/1030) of female patients over age 55 [0.9 % of all 2366 patients (20/2366)] admitted by physicians working in a rheumatology division during a period of 2 years [26]. West et al. reported a rate of 1 % (4/386) of such fractures in a specific group of rheumatoid arthritis patients over 6 years [27]. Here, the calculated incidence rates for sacral stress fractures within a 57 months period for females, males and the whole study population were 1.67 %, 0.45 % and 1.06 %, respectively. When the incidence rates were compared with the study by Weber et al., no statistically significant difference was found with respect to the whole study population as well as to the patient populations-at-risk (female patients over age 55years) in a total person-years analysis. The authors of the current study were not able to compare their results with the study by West et al. [27], because only patients with rheumatoid arthritis were evaluated in aforementioned study [27]. Moreover, data about the "population under risk" is limited in previously published series [1,9,10,22,28], so that's why the present authors have compared their results with only one study in the literature. Of note, as was mentioned before, the authors were unable to further classify the sacral stress fractures, but they have claimed that all these fractures in the present study could have been classified as insufficiency fractures and have made the statistical analysis accordingly.

The diagnosis of sacral stress fractures requires a combination of clinical findings, imaging studies, and laboratory examinations. They are commonly misdiagnosed because of the similar physical presentation findings as other pathological conditions, i.e. low back muscle strain, facet arthropathy, trochanteric bursitis, lumbar disc herniation, degenerative disc disease, vertebral compression fracture, spondylolisthesis, and sacroiliac joint dysfunction [16,28,29]. The most common chief complaints are insidious low-back, buttock or vague pelvic pain [11,28,29].

Furthermore, patients with sacral insufficiency fractures report minimal or no trauma, whereas patients with sacral fatigue fractures report excessive repetitive activity and recent increases in training [11,28,29]. Physical examination shows point tenderness with palpation, and the single leg hop test often reproduces pain [5]. Imaging studies could be performed during the period of differential diagnosis. American College of Radiology appropriateness criteria recommend plain radiographs as the initial imaging study in the suspected cases of sacral stres fractures. However, they can only detect complete fractures [2,12]. Of note, there is a high incidence of concomitant pelvic insufficiency fractures, and radiologists should be aware of this association [14]. When radiography is negative, the next imaging study should be pelvis MRI without intravenous contrast or bone scan, with reported high sensitivities [6,9,21]. In accordance with the systematic review by Yoder et al., an MRI, bone scan, or computed tomography (CT) scan (in descending order) should be utilized to identify the sacral stress fractures [28]. Laboratory studies aid in this diagnosis and are able to evaluate the potential presence of osteoporosis, one of the proposed underlying condition associated with insufficiency fractures [28]. In the present study, the authors have reviewed the MRI scans of the patients focusing on lumbar area as well as the pelvis. None of these patients had bone scan and CT scan. Unlike the recent study by Kim et al. [9], none of the lumbar MRI scans have been able to detect sacral stres fractures in the present study.

This study has several limitations. First, this is a single-center study in a private tertiary care settlement which might affect the study population. Second, because of the lack of detailed clinical information, the authors were unable to further classify the sacral stress fractures. Third, no information was presented about the treatment protocols. This might be because of the lack of detailed clinical data and/or the missing patients after having diagnosed by the MRI scans because of the private setting.

Conclusion

This study has retrospectively reviewed the MRI studies and found out the incidence rates for sacral stress fractures. These rates were 1.67%, 0.45% and 1.06%, for females, males and the whole study population, respectively, during a 57 months study period. Although the rate in the general population is still unknown, the results of this study suggest that physicians should be aware of sacral stress fractures in the setting of clinical suspicion especially in the certain patient populations; and they should evaluate such patients accordingly.

REFERENCES

1. Bakker G, Hattingen J, Stuetzer H, Isenberg J. Sacral Insufficiency Fractures : How to Classify? *J Korean Neurosurg Soc* 2018; 61: 258-266.
2. Blake SP, Connors AM. Sacral insufficiency fracture. *Br J Radiol* 2004; 77: 891-896.

3. Boden BP, Osbahr DC. High-risk stress fractures: evaluation and treatment. *J Am Acad Orthop Surg* 2000; 8: 344-353.

4. Breuil V, Brocq O, Euller-Ziegler L, Grimaud A. Insufficiency fracture of the sacrum revealing a pregnancy associated osteoporosis. First case report. *Ann Rheum Dis* 1997; 56: 278-279.

5. Denay KL. Stress Fractures. *Curr Sports Med Rep* 2017; 16: 7-8.

6. Expert Panel on Musculoskeletal I, Bencardino JT, Stone TJ, Roberts CC, Appel M, Baccei SJ, Cassidy RC, Chang EY, Fox MG, Greenspan BS, Gyftopoulos S, Hochman MG, Jacobson JA, Mintz DN, Mlady GW, Newman JS, Rosenberg ZS, Shah NA, Small KM, Weissman BN. ACR Appropriateness Criteria® Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae. *J Am Coll Radiol* 2017; 14: S293-S306.

7. Harris CE, 3rd, Vincent HK, Vincent KR. Sacral Stress Fractures: They See You, But Are You Seeing Them? *Curr Sports Med Rep* 2016; 15: 73.

8. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, Woolf A, Vos T, Buchbinder R. A systematic review of the global prevalence of low back pain. *Arthritis Rheum* 2012; 64: 2028-2037.

9. Kim YY, Chung BM, Kim WT. Lumbar spine MRI versus non-lumbar imaging modalities in the diagnosis of sacral insufficiency fracture: a retrospective observational study. *BMC Musculoskelet Disord* 2018; 19: 257.

10. Kortman K, Ortiz O, Miller T, Brook A, Tutton S, Mathis J, Georgy B. Multicenter study to assess the efficacy and safety of sacroplasty in patients with osteoporotic sacral insufficiency fractures or pathologic sacral lesions. *J Neurointerv Surg* 2013; 5: 461-466.

11. Lin JT, Lane JM. Sacral stress fractures. *J Womens Health (Larchmt)* 2003; 12: 879-888.

12. Longhino V, Bonora C, Sansone V. The management of sacral stress fractures: current concepts. *Clin Cases Miner Bone Metab* 2011; 8: 19-23.

13. Lourie H. Spontaneous osteoporotic fracture of the sacrum. An unrecognized syndrome of the elderly. *JAMA* 1982; 248: 715-717.

14. Lyders EM, Whitlow CT, Baker MD, Morris PP. Imaging and treatment of sacral insufficiency fractures. *AJNR Am J Neuroradiol* 2010; 31: 201-210.

15. Matcuk GR, Jr., Mahanty SR, Skalski MR, Patel DB, White EA, Gottsegen CJ. Stress fractures: pathophysiology, clinical presentation, imaging features, and treatment options. *Emerg Radiol* 2016; 23: 365-375.

16. Micheli LJ, Curtis C. Stress fractures in the spine and sacrum. *Clin Sports Med* 2006; 25: 75-88, ix.

17. Pentecost RL, Murray RA, Brindley HH. Fatigue, Insufficiency, and Pathologic Fractures. *JAMA* 1964; 187: 1001-1004.

18. Rousiere M, Kahan A, Job-Deslandre C. Postpartal sacral fracture without osteoporosis. *Joint Bone Spine* 2001; 68: 71-73.

19. Sahai H, Khurshid A. Formulas and tables for the determination of sample sizes and power in clinical trials for testing differences in proportions for the matched pair design: a review. *Fundam Clin Pharmacol* 1996; 10: 554-563.

20. Schmid L, Pfirrmann C, Hess T, Schlumpf U. Bilateral fracture of the sacrum associated with pregnancy: a case report. *Osteoporos Int* 1999; 10: 91-93.

21. Turhan S. Sacral stress fracture in geriatrics: A case report. *Turkish Journal of Geriatrics* 2017; 20: 70-72.

22. Vaishya R, Agarwal AK, Banka PK, Vijay V, Vaish A. Insufficiency Fractures at Unusual Sites: A Case Series. *J Orthop Case Rep* 2017; 7: 76-79.

23. Volpin G, Milgrom C, Goldsher D, Stein H. Stress fractures of the sacrum following strenuous activity. *Clin Orthop Relat Res* 1989; 243: 184-188.

24. Wagner D, Ossendorf C, Gruszka D, Hofmann A, Rommens PM. Fragility fractures of the sacrum: how to identify and when to treat surgically? *Eur J Trauma Emerg Surg* 2015; 41: 349-362.

25. Wat SY, Seshadri N, Markose G, Balan K. Clinical and scintigraphic evaluation of insufficiency fractures in the elderly. *Nucl Med Commun* 2007; 28: 179-185.

26. Weber M, Hasler P, Gerber H. Insufficiency fractures of the sacrum. Twenty cases and review of the literature. *Spine (Phila Pa 1976)* 1993; 18: 2507-2512.

27. West SG, Troutner JL, Baker MR, Place HM. Sacral insufficiency fractures in rheumatoid arthritis. *Spine (Phila Pa 1976)* 1994; 19: 2117-2121.

28. Yoder K, Bartsokas J, Averell K, McBride E, Long C, Cook C. Risk factors associated with sacral stress fractures: a systematic review. *J Man Manip Ther* 2015; 23: 84-92.

29. Zaman FM, Frey M, Slipman CW. Sacral stress fractures. *Curr Sports Med Rep* 2006; 5: 37-43.

Volume: 29, Issue: 4, October 2018 pp: 243-245 CASE REPORT

COMPLEX REGIONAL PAIN SYNDROME FOLLOWING CARPAL TUNNEL SURGERY

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ABSTRACT

Complex regional pain syndrome (CRPS) is a chronic neurological condition involving the limbs that is characterized by severe pain along with sensory, autonomic, motor and trophic impairment. This condition may be induced by surgery, trauma or minor injury. This condition can complicate recovery and impair one's functional and psychological well-being.

Here, we presented 2 cases as 66 and 52 years old two female patients. They were suffering for 2 years from hypoesthesia and pain on her right hand at the area of median nerve. On neurological examinations, thenar atrophy, positive on tinnel and phallen tests were detected. On EMG, severe carpal tunnel syndrome is detected. Patients were operated under local anesthesia and median nerve was decompressed. 3 days in first patient and 1 week in second after surgery, patients' hands were swollen and symptoms of pain, hypoesthesia and burning sensation were appeared. We detected prominent edema on their hands starting from the wrist area. They were diagnosed as 'complex regional pain syndrome'. They were treated with steroid, NSAID, antidepressant and physical therapy. There was no rheumathological pathology. There is amelioration at their symptoms 1 month follow-up. In conclusion; given the complex nature of this syndrome, it is unlikely that targeting a specific mechanism will be effective. As with other chronic disorders, the future of CRPS treatment may lie in combination therapy and studies investigating this will be necessary.

Key words: carpal tunnel syndrome; complex regional pain syndrome; surgery; complication; painful; swollen hand.

Level of Evidence: Case report, Level IV.

INTRODUCTION

Carpal tunnel syndrome (CTS) is the commonest entrapment neuropathy and is due to combined compression and traction on the median nerve at the wrist. It was first described by James Paget in 1853. In 1913, Marie and Foix published the first description of a neuroma proximal to the flexor retinaculum (FR). The first surgical release of the FR is attributed to Galloway in 1924 [(1)]. The prevalence of CTS is estimated between 4 and 5 % of the population especially between ages 40 and 60 [(2)].

In most cases, CTS is said to be idiopathic. It occurs most often in women (65 to 80 % of cases) between 40 and 60 years, bilateral in 50 % to 60 % of cases [(11)]. Bilateralism increases with the duration of symptoms. It is related to a fibrous hypertrophy of synovial flexor sheath related to connective tissue degeneration with vascular sclerosis, synovial edema and collagen fragmentation [(12)]. Meta-analyses [(8)] showed that sex, age, genetic and anthropometric factors (size of the carpal tunnel) are the most important predisposing factors. Repetitive manual work, exposure to vibration, and cold exposure are minor predisposing factors. Other minor predisposing factors have been identified such as obesity and tobacco. Secondary CTS may be related to abnormalities of the container or the contents. Dynamic CTS is frequently encountered in occupational pathology. CTS were diagnosed by examination, provocative tests, associated pathology and differential diagnosis. Additional

tests especially electroneuromyography examination (ENMG) is important.

The principle of surgical treatment is to obtain a reduction in intracanalicular pressure by increasing the volume of the carpal tunnel due to the section of the FR. In most cases, the outcome is good with disappearance of pain crises and nocturnal paresthesia's immediately postoperative.

Complex regional pain syndrome (CRPS) is defined as a disorder of the extremities characterized by regional pain that is disproportionate in time or degree to the usual course of any known trauma or other lesion [6]. CRPS can be classified into two types: CRPS types-I and II that are characterized by the absence or presence of identifiable nerve injury. CRPS type-I is a syndrome that usually develops after an initiating noxious event, is not limited to the distribution of a single peripheral nerve, and is disproportionate to the inciting event. It is associated with edema, changes in skin blood flow, abnormal sudomotor activity in the region of the pain, allodynia and hyperalgesia and commonly involves the distal aspect of the affected extremity or with a distal to proximal gradient. CRPS type II can be defined as a burning pain, allodynia and hyperpathia occurring in a region of the limb after partial injury of a nerve or one of its major branches innervating that region.

We present two cases of complex regional pain syndrome following carpal tunnel syndrome surgery without nerve injury.

Case Report

66 and 52 years old two female patients without any history of diseases, operation or trauma were suffering for 2 years from hypoesthesia and pain on her right hand at the area of median nerve. On neurological examinations, thenar atrophy, positive on tinnel and phallen tests were detected. On EMG, severe carpal tunnel syndrome was detected. Patients were operated under local anesthesia and median nerve was decompressed. Median nerve was released both in the proximal and distal areas. Three days in first patient and 1 week in second patient after surgery, patients' hands were swollen and symptoms of pain, hypoesthesia and burning sensation appeared. We detected prominent edema on their hands starting from the wrist area (Figure-1).

They were diagnosed as 'complex regional pain syndrome'. They were treated with prednisolone, NSAID, antidepressant and physical therapy. There was no rheumathological pathology. There is amelioration at her symptoms 1 month follow-up.

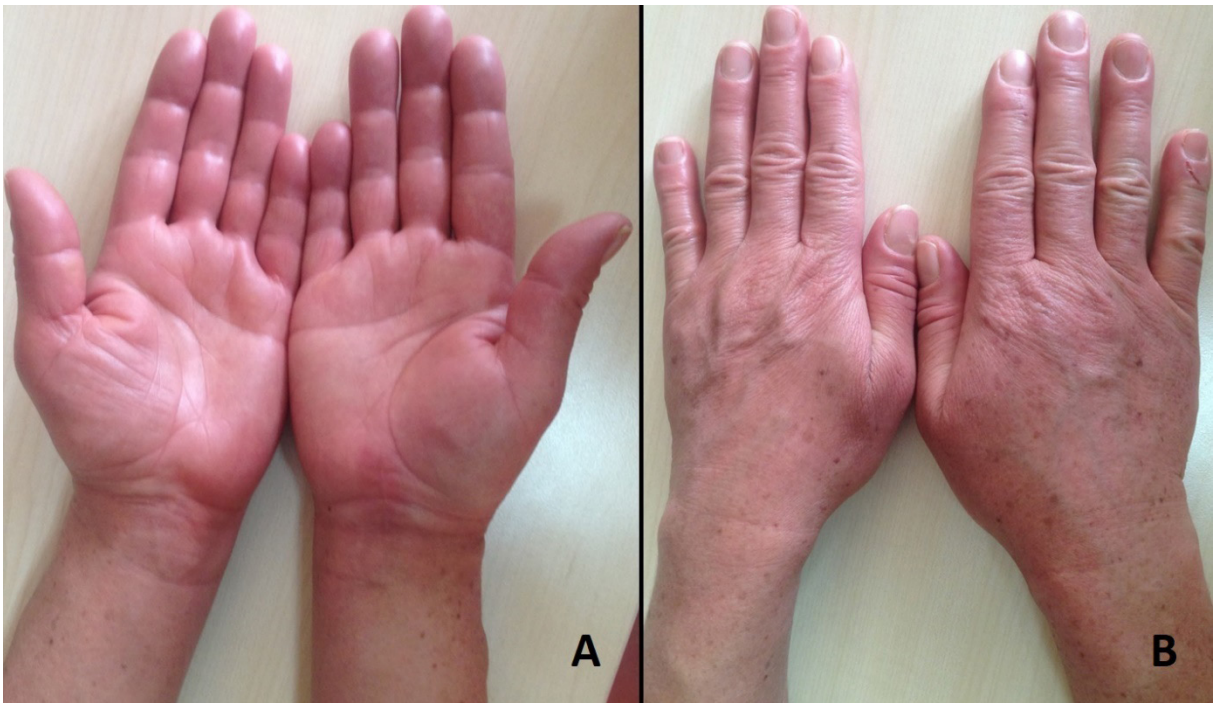

Figure-1. Anterior **(A)** and posterior **(B)** aspect of both hands. We detected prominent edema on operated hand starting from the wrist area according to another hand.

DISCUSSION

Prophylaxis for treatment is essential in occupational pathology and includes the modification of the work-place and tools. Other non-surgical treatment choices are conservative treatment with corticosteroid injection, night splint in neutral wrist position, modification of mechanical and ergonomic measures. The principle of surgical treatment is to obtain a reduction in intracanalicular pressure by increasing the volume of the carpal tunnel due to the section of the FR. The operation is usually unilateral.

Three techniques are currently used: open; techniques known as "mini-open"; and endoscopic techniques. Whatever the technique, the procedure must be atraumatic and care must be taken not to place the median nerve in the extension of the scar incision to minimize postoperative epineural adhesions. In most cases, the outcome is good with disappearance of pain crises and nocturnal paresthesias immediately postoperative. Turner et al. [14] concluded that the worst results were observed in case of: diabetes mellitus including polyneuropathy and impaired general condition; alcohol and tobacco; normal preoperative ENMG; occupational disease; thenar atrophy; multiple nerve compression; length of symptoms. Complication of surgery can be divided into minor and major complications. Minor complications are neuropathic scar pain, pillar pain, complex regional pain syndrome type 1 and instability of ulnar flexor tendons through the cut FR. Major complications are rare but serious. Benson et al. [3] reported 0.49 % serious complications for open surgery and 0.19 % for endoscopic surgery. These are nerve complications, injury to the superficial palmar arch, and section of the flexor tendons of the fingers.

CRPS is a clinical diagnosis made based on the findings during the history and physical examination of the patient, for which diagnostic criteria including the Orlando Criteria for Complex Regional Pain Syndrome and The Budapest Clinical Diagnostic Criteria for Complex Regional Pain Syndrome by the International Association for the Study of Pain (IASP) have been developed [10]. The incidence rate of CRPS type I was 5.46 per 100000 person/years, and the incidence rate of CRPS type-II was 0.82 per 100000 person-years, giving rise to a combined incidence rate for both CRPS types-I and II of 6.28 per 100000 person-years [5]. The incidence of CRPS in carpal tunnel syndrome was ranged between 1.9-5 % [7,9,13].

Management of CRPS-I continues to be a therapeutic challenge. Several treatment protocols using various opioid analgesics, antipsychotics, antidepressants and anti-inflammatory agents have been carried out with the goal of treating CRPS-I [4]. Physical and occupational therapy is a key component of the rehabilitation process in patients with CRPS and is recommended as the first-line treatment. Interventional treatments are used for more serious CRPS. These are sympathetic blocks, medullary stimulation and psychological pain management [4].

Conclusion

Given the complex nature of this syndrome, it is unlikely that targeting a specific mechanism will be effective. As with other chronic disorders, the future of CRPS treatment may lie in combination therapy and studies investigating this will be necessary.

Disclosure of interest:

The authors declare that they have no conflicts of interest concerning this article.

REFERENCES

1. Amadio PC. The first carpal tunnel release? *J Hand Surg (British & European Volume)* 1995; 20: 40-41.
2. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosén I. Prevalence of carpal tunnel syndrome in a general population. *JAMA* 1999; 282: 153-158
3. Benson LS, Bare AA, Nagle DJ, Harder VS, Williams CS, Visotsky JL. Complications of endoscopic and open carpal tunnel release. *Arthroscopy: J Arthroscopic Rel Surg* 2006; 22: 919-924. e912
4. Gay A-M, Béréni N, Legré R. Type I complex regional pain syndrome. *Chirurgie Main* 2013; 32: 269-280.
5. Goh EL, Chidambaram S, Ma D. Complex regional pain syndrome: a recent update. *Burns Trauma* 2017; 5: 2.
6. Harden RN, Bruehl S, Perez RS, Birklein F, Marinus J, Maihofner C, et al. Validation of proposed diagnostic criteria (the "Budapest Criteria") for complex regional pain syndrome. *Pain* 2010; 150: 268-274
7. Lichtman DM, Florio RL, Mack GR. Carpal tunnel release under local anesthesia: evaluation of the outpatient procedure. *J Hand Surg* 1979; 4: 544-546
8. Lozano-Calderón S, Anthony S, Ring D. The quality and strength of evidence for etiology: example of carpal tunnel syndrome. *J Hand Surg* 2008; 33: 525-538.
9. MacDonald RI, Lichtman DM, Hanlon JJ, Wilson JN: Complications of surgical release for carpal tunnel syndrome. *J Hand Surg* 1978; 3: 70-76.
10. Merskey HE. Classification of chronic pain: descriptions of chronic pain syndromes and definitions of pain terms. *Pain,* 1986.
11. Michelsen H, Posner MA. Medical history of carpal tunnel syndrome. *Hand Clin* 2002; 18: 257-268.
12. Schuind F, Ventura M, Pasteels JL. Idiopathic carpal tunnel syndrome: histologic study of flexor tendon synovium. *J Hand Surg* 1990; 15: 497-503.
13. Shinya K, Lanzetta M, Conolly W. Risk and complications in endoscopic carpal tunnel release. *J Hand Surg (British & European Volume)* 1995; 20: 222-227.
14. Turner A, Kimble F, Gulyás K, Ball J. Can the outcome of open carpal tunnel release be predicted? A review of the literature. *ANZ J Surg* 2010; 80: 50-54.