DOES ORAL HEALTH AFFECT YOUR BONE LOSS? THE LINK BETWEEN PERIODONTITIS DISEASE AND OSTEOPOROSIS - AN EPIDEMIOLOGICAL APPROACH TO LUMBAR DISC HERNIATION IN A NEUROSURGERY HOSPITAL IN THE NORTHEASTERN REGION OF ROMANIA

Mădălina Duceac (Covrig)[1†], Lucian Eva[2†], Marius Gabriel Dabija[3†], George Stoica[4], Daniela Druguș[3], Letiția-Doina Duceac[1]*, Doina-Carina Voinescu[1†]

1. „Dunărea de Jos" University of Galați, Faculty of Medicine and Pharmacy, Galați, 47 Domnească Street, RO-800008, Galați, România
2. *Apollonia* University, Faculty of Dental Medicine, Iasi, România
3. University of Medicine and Pharmacy "Grigre T.Popa", Iași
4. Department of Dental Prosthetics, Dunarea de Jos University of Medicine and Pharmacy Galati, Domneasca Street 47, 800008 Galati, Romania;

*Corresponding Author: Letiția-Doina Duceac email: letimedr@yahoo.com

George Stoica email: geostoica2003@gmail.com

†- all author have the same contribution

Abstract: Lumbar disc herniation is a population and socio-economic health problem affecting patients worldwide. More than half of adults worldwide suffer from low back pain at some point in their lives, with varying degrees of severity, frequently associated with sciatic symptoms. The multifactorial mechanism of low back pain has not yet been fully elucidated and is aggravated by mechanical, traumatic, inflammatory factors and osteoporosis. Low back pain leads over time to disability and decreases quality of life. **Material and method**: Our research was carried out as a retrospective epidemiological study including a group of 944 patients with lumbar disc herniation admitted in the 3 Neurosurgery Departments of the Emergency Clinical Hospital "Prof. N.Oblu" in Iași during the period 1 January-31 December 2022. **Results**: The study reveals a somewhat equal distribution in both sexes: male (466- 49.36%) and female 478 (50.64%) and higher in urban areas (60%). According to the age histogram, the group 41-60 years predominates - 428 cases (45.43%), followed by the group 61-80 years - 309 (32.72%), the group 21-40 years - 193 (20.43%), and 8 patients (0.85%) were over 80 years and 6 (0.63%) under 20 years. The most affected professions were: drivers, civil servants, dentists, commercial workers. The most common comorbidities in females were: neuro-psychiatric diseases (68%); hypertension (31%), obesity (15%), diabetes mellitus (12%), osteo-articular diseases (4%). 3 patients although presenting with SARS CoV-2 virus infection, were operated with favourable outcome. Obesity and intense physical exertion were the main risk factors in both sexes. Regarding the type of therapeutic manoeuvres in the studied group, 715 patients (75.7%) underwent surgical interventions such as: discectomies - 640 (89.5%); spondylolisthesis - 36 (5%); decompression - 17 (2.4%) and other reparative manoeuvres - 22 (3.1%). Conservative medical treatment required 10.5% - 229 patients. Referral for functional recuperative treatment was followed by 664 patients (70.3%), at the Recovery Hospital or state or private specialist outpatient clinics. At the 6-month reassessment, 56% showed complete remission and 44% partial remission of symptoms. **Conclusions:** The study highlights some clinico-epidemiological features of lumbar disc herniation, which influence the evolutionary profile of the condition in the group of patients. Comorbidities are also triggering factors with an unfavourable influence on the quality of life of these patients. Proper health care management must approach the patient with degenerative pathology holistically.

Keywords: lumbar disc herniation, epidemiological study, neurosurgery, oral pathology, periodontitis, osteoporosis, treatment, rehabilitation, health management.

INTRODUCTION

Modern society is generally characterized by sedentary lifestyles and lack of physical

activity of individuals, which has led to an overall increase in the cases of low back pain. The intensity of low back pain has increased by more than 50% in the last 50 years. Low back pain leads to disability and decreases quality of life. Lumbar disc herniation, as a degenerative neurological condition, is aggravated by the traumatic factor, along with other risk factors, and is a consequence of the fissuring of the annulus fibrosus with partial migration of the nucleus pulposus into the spinal canal. Vertebral disc damage is even more intense, either irritative or compressive, if a radicular syndrome is associated as a complication. It is a condition that mainly affects patients of active age (25-60 years), with an increased referral to neurosurgical services [1,2,3,4,5].

MATERIAL AND METHOD

The authors conducted a retrospective, observational, clinico-epidemiological study in the only neurosurgical university hospital in the northeastern region of Romania. It is called "Prof. Dr. Nicolae Oblu" Emergency Clinical Hospital in Iasi and serves through its 3 neurosurgical wards the entire population of the area and beyond. The study included all patients who were admitted and treated for degenerative diseases of the lumbar spine during 2022.

RESULTS

The study group comprised 944 patients with lumbar disc herniation, 60% (567 patients) from urban areas compared to 40% (377) from rural areas (Fig. 1), with an approximately equal distribution in both sexes: 50.64% (481) females and 49.36% (463) males (Fig. 2).

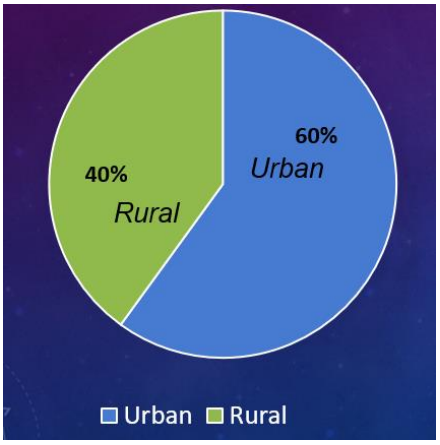

Fig. 1. Distribution of patients with lumbar disc herniation by living environment

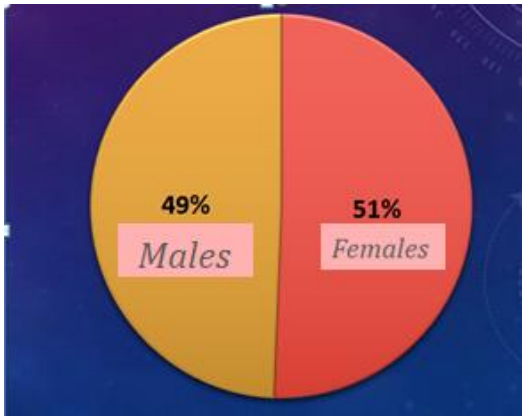

Fig. 2. Gender distribution of patients with lumbar disc herniation

The age histogram reveals the predominance of the condition at active ages: the 41-60 age group with 428 patients (45.43%) and even at younger ages, the 21-40 age group, followed by the 61-80 age group, less active but prone to household accidents - 309 (32.72%). 6 patients (0.63%) were under 20 years of age, being victims of spinal injuries. 8 patients (0.85%) were over 80 years of age, showing a greater degree of bone demineralisation visible not only at vertebral level (osteoporosis) but also in the oral cavity,

through tooth loss (eviction) and inflammatory (gingivitis) or degenerative (periodontitis) conditions (Fig.3).

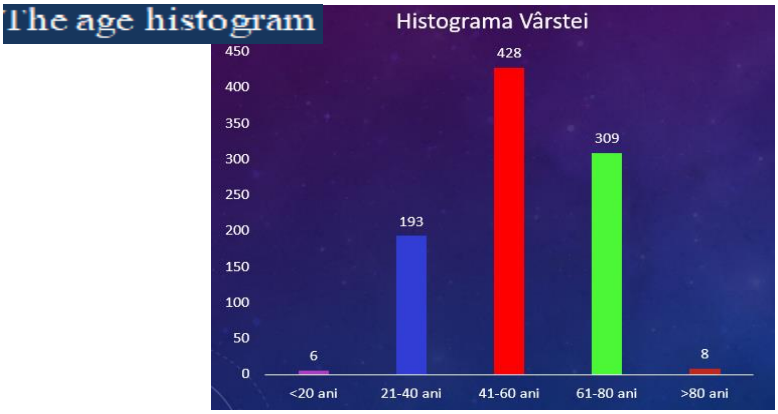

Fig. 3. Distribution of patients with lumbar disc herniation by age group

Some professional categories are more prone to vertebral discopathy due to over-strain of the intervertebral disc through microtraumatism, prolonged static positions or great efforts. Thus, our study highlights that the most affected were pensioners (20%), farmers (15%), civil servants (10%), drivers (8%), commercial workers (7%), dentists (5%) and athletes (4%). There were also situations where the profession could not be specified (31%). (Fig. 4).

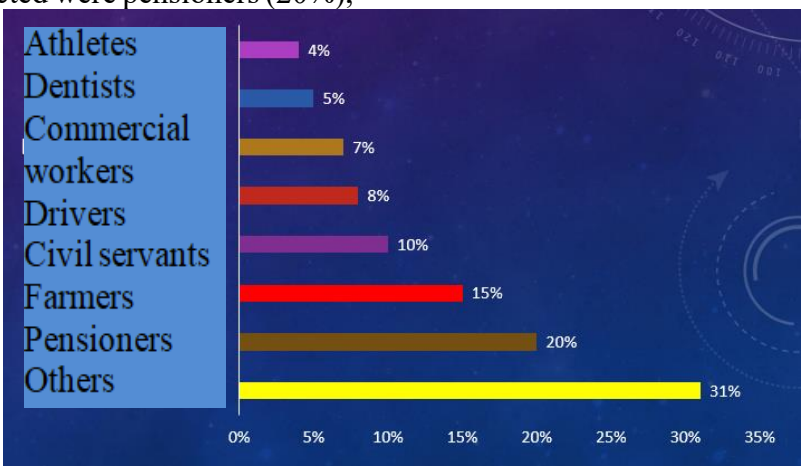

Fig. 4. Professions affected by lumbar disc herniation

All patients in the study group, and especially women, presented comorbidities or associated diseases, some chronic, others inflammatory or degenerative. Neuro-psychiatric diseases prevailed (insomnia, depression, dementia)-70%; arterial hypertension-34%; other cardiovascular diseases-17%; obesity and diabetes (18% and 15%), osteo-articular disorders (13%) some degenerative - osteoporosis, others traumatic - fractures, dislocations, etc. Three patients, although they had SARS-CoV-2 virus infection, were operated on with favorable results. Obesity and intense physical exertion

were the main risk factors in both sexes. (Fig. 5).

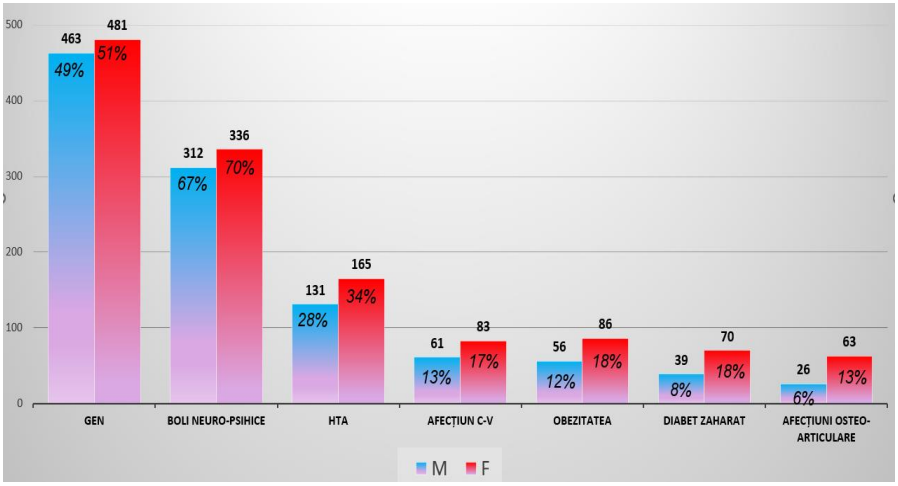

Fig. 5. Distribution of comorbidities in patients with lumbar disc herniation

From the total of 944 patients with disc herniation who addressed the three departments of neurosurgery, the majority underwent surgical interventions - 76% (715 patients), and 24% (229) received only conservative medical treatment (Fig. 6).

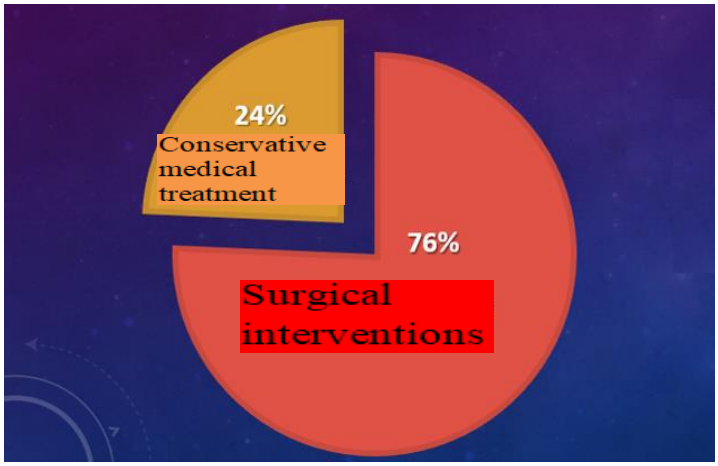

Fig. 6. Methods of treatment in patients with lumbar disc herniation

Most of the patients who had surgical indications benefited from discectomies (surgical removal of the herniated disc pressing on a spinal root) - 640 patients (89.5%). Much fewer -36 (%%) benefited from spondylosyndesis (surgical maneuver involving the union of two or more vertebrae), 17 patients (2.4%) underwent spinal cord decompression, and 22 patients (3.1%) had benefited from other procedures: rhizolysis (neurosurgical procedure that selectively destroys problematic nerve roots in the spinal cord), anesthetic agent injections, postoperative reopenings, removal of intradural lesions, segmental internal fixation of the spine, correction of

spinal procedures, biopsies and other reparative interventions.

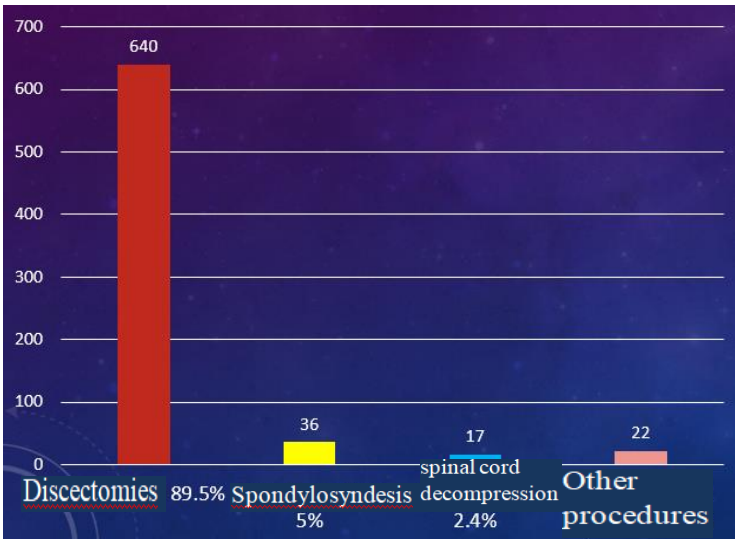

Fig. 7. Types of surgical interventions in operated patients

The recommendation to follow a functional recuperative therapy was followed by 664 patients (70.3%), either at the local Recovery Hospital or at state or private specialized outpatient clinics. At the 6-month re-evaluation, our study revealed a complete remission of symptoms in 44% of those who underwent recovery treatment and a partial recovery in 56% of cases. (Fig. 8).

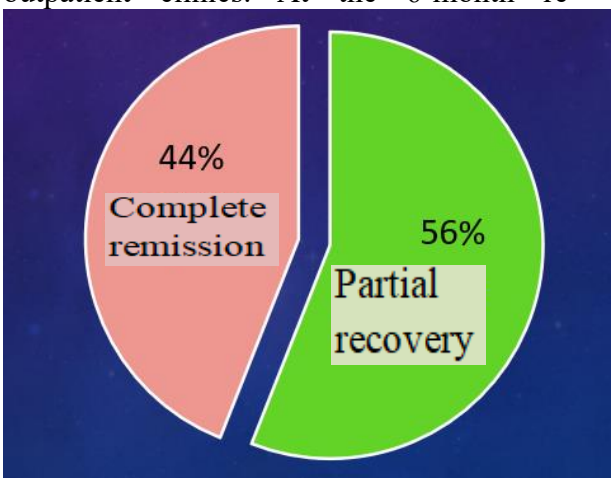

Fig. 8. Evolution of recovery treatment in patients with lumbar disc herniation

DISCUSSIONS

In the last 20-25 years, the diagnosis and treatment of degenerative lesions of the lumbar spine has changed considerably. New exploratory and interventional technologies have brought consistent benefits to all patients with this degenerative pathology [6,7,8,9,10].

According to a meta-analysis [11], Shriver et al (2015) found that the mean reoperation rate

for lumbar disc herniation after open discectomy is approximately 7.1% (4.8% - 10.1%) in while for minimally invasive endoscopic discectomy (MED), the average reoperation rate is approximately 3.7% (2.1% - 6.2%). [11, 12,13]

Several studies with a large number of patients have been carried out worldwide. For example, Keskimaki et al. (2000) [14] examined 25,359 patients in the Finnish Hospital Register for reoperation rates after lumbar discectomy. They found a reoperation (reoperation) rate of 12.3% at 4.1 years and an 18.9% Kaplan-Meier probability of reoperation at nine years. Another retrospective level III study [14,15, 16].

Heindel et al (2017) (United States), analyzed a national health insurance database with 13,654 patient records and found a reoperation rate of 3.95% at three months after single-level discectomy [17]. In the longer-term follow-up of 6,274 patients from the same database, a reoperation rate of 12.2% was observed at four years. In the same study, it was found that 38.4% of patients who underwent a re-exploratory discectomy within two years of the initial procedure eventually required a lumbar fusion. [14, 17, 18]

In another study, Kim et al. (2013) [19] analyzed the Korean national medical insurance database for 47,316 patients who underwent surgery for lumbar disc herniation. They included all treatment modalities including microdiscectomy, MED (endoscopic intervention), nucleolysis, laminectomy and fusion. An overall reoperation rate of 13.9% was observed. Microdiscectomy had a reoperation rate of 13.8%, while MED had a reoperation rate of 12.4% at five years. [19, 20, 21, 22].

Regarding the appropriateness of surgical treatment, Esfahani et al (2018), United States of America, [23] conducted a study whose objective was to investigate the influence of the specialty of the neurosurgeon on the rates of postoperative complications at 30 days for lumbar discectomies in a single level. For this, information on all patients who underwent single-level lumbar discectomy between 2005 and 2014 from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was reviewed. Using propensity score correlation and univariate binary regression, we aimed to determine the impact of neurosurgeon specialty on 30-day postoperative complications. Of the 28,863 patients who underwent single-level lumbar discectomies between 2005 and 2014, 12,659 patients met the study inclusion criteria. Of these, orthopedic surgeons performed 3733 operations (29.4%), while neurosurgeons performed 8926 operations (70.6%). To assess the effect of neurosurgical specialty on 30-day outcomes, a sample of 7464 propensity score-matched cases (3732 orthopedic surgeons and 3732 neurosurgeons) was analyzed. [23,24,25].

After propensity score matching/correlation, orthopedic surgeons and neurosurgeons were found to have similar outcomes for postoperative complications, except for a slightly higher frequency of blood transfusions among orthopedic surgery patients (0.3%, n = 11) compared with those with neurosurgery (0.1%, n = 3; P = 0.032). However, this difference did not remain significant after Bonferroni adjustment. Neurosurgeons were also noted to have a slightly longer mean operative time compared with orthopedic surgeons (83.7 minutes vs. 72.5 minutes; $P < 0.001$). In terms of mortality, readmission rate or reoperation rate, no significant differences were revealed

between the two surgical specialties [23, 26,27, 28, 29].

Thus, the results of this study indicate that the specialty of the surgeon (orthopedic or neurosurgeon) does not seem to significantly influence the rate of postoperative complications at 30 days in the case of single-level lumbar discectomies. However, there was a slight difference in the frequency of blood transfusions, but this was not statistically significant after proper adjustment. It is important to note that the results of this study are limited to the investigated population and that other factors, such as the experience and skill of the surgeon, could have an impact on the postoperative results [23, 30, 31, 32, 33].

Rajasekaran et al (2023) [34] analyzed metabolites in intervertebral discs. 1.6% of metabolites in human lumbar discs were found to be of microbial origin. The presence of bacterial metabolites in healthy discs confirms previous reports that even healthy discs have a biotope, and dysbiosis can be the cause of disc degeneration. In addition, they revealed an overexpression of bacterial metabolites in degenerated discs [34, 35, 36].

Wang et al (2021) studied how immune infiltration influences intervertebral disc (IVD) degeneration by contributing to disease progression by enhancing inflammation, angiogenesis, and nociceptive nerve fiber formation [35, 37].

The studies carried out thus support the results of the study conducted by Chen et al. (2023) [38] on 141 patients with lumbar degenerative diseases found that the severity of periodontitis is associated with an increased incidence of intervertebral disc degeneration (IVD) and changes in the vertebral plateaus. Patients with periodontitis showed higher rates of disc degeneration and plateau changes in specific lumbar segments. A definite association was also observed between periodontal parameters and low back and lower limb pain. These findings suggest a possible link between oral cavity diseases (periodontitis, periodontosis) and lumbar degenerative diseases. [35,38, 39].

The degenerative described phenomena are more evident at women in menopause, who reach a high degree of bone demineralization and develop osteoporosis at various lumbar levels and also processes of demineralization of maxillary, mandibular and teeth bones [39,40,41,42,43]

CONCLUSIONS:

Our study highlights several clinico-epidemiological features of lumbar disc herniation that influence the evolutionary profile of the condition in the group of patients.

Comorbidities are also triggering factors with unfavourable influence on the quality of life of these patients.

There is a causal relationship between degenerative osteo-articular pathological processes in the oral cavity (periodontitis, eviction) and the same degenerative processes in the spine (osteoporosis, herniated discs).

Our research is a plea for the importance of the rehabilitation team in the socio-professional and family reintegration of the patient with lumbar disc herniation and the improvement of his/her quality of life. Proper health care management must approach the patient with degenerative pathology holistically.

REFERENCES

1. Wang Y, Dai G, Jiang L, Liao S. The incidence of regression after the non-surgical treatment of symptomatic lumbar disc herniation: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2020 Aug 10;21(1):530. doi: 10.1186/s12891-020-03548-z.
2. Mariscal G, Torres E, Barrios C. Incidence of recurrent lumbar disc herniation: A narrative review. J Craniovertebr Junction Spine. 2022 Apr-Jun;13(2):110-113. doi: 10.4103/jcvjs.jcvjs_38_22.
3. Siccoli A, Schröder ML, Staartjes VE. Association of age with incidence and timing of recurrence after microdiscectomy for lumbar disc herniation. Eur Spine J. 2021 Apr;30(4):893-898. doi: 10.1007/s00586-020-06692-1.
4. Jung JM, Lee SU, Hyun SJ, Kim KJ, Jahng TA, Oh CW, Kim HJ. Trends in Incidence and Treatment of Herniated Lumbar Disc in Republic of Korea : A Nationwide Database Study. J Korean Neurosurg Soc. 2020 Jan;63(1):108-118. doi: 10.3340/jkns.2019.0075.
5. Wong T, Patel A, Golub D, Kirnaz S, Goldberg JL, Sommer F, Schmidt FA, Nangunoori R, Hussain I, Härtl R. Prevalence of Long-Term Low Back Pain After Symptomatic Lumbar Disc Herniation. World Neurosurg. 2023 Feb;170:163-173.e1. doi: 10.1016/j.wneu.2022.11.029.
6. Martin BI, Mirza SK, Spina N, Spiker WR, Lawrence B, Brodke DS. Trends in Lumbar Fusion Procedure Rates and Associated Hospital Costs for Degenerative Spinal Diseases in the United States, 2004 to 2015. Spine (Phila Pa 1976). 2019 Mar 1;44(5):369-376. doi: 10.1097/BRS.0000000000002822.
7. Xiong GX, Goh BC, Agaronnik N, Crawford AM, Smith JT, Hershman SH, Schoenfeld AJ, Simpson AK. Impact of insurance type on patient-reported outcome measures in patients with lumbar disc herniation. Spine J. 2022 Aug;22(8):1309-1317. doi: 10.1016/j.spinee.2022.03.011.
8. Wei FL, Li T, Gao QY, Yang Y, Gao HR, Qian JX, Zhou CP. Eight Surgical Interventions for Lumbar Disc Herniation: A Network Meta-Analysis on Complications. Front Surg. 2021 Jul 20;8:679142. doi: 10.3389/fsurg.2021.679142.
9. Mroz TE, Lubelski D, Williams SK, O'Rourke C, Obuchowski NA, Wang JC, Steinmetz Wei FL, Zhou CP, Zhu KL, Du MR, Liu Y, Heng W, Wang H, Yan XD, Sun LL, Qian JX. Comparison of Different Operative Approaches for Lumbar Disc Herniation: A Network Meta-Analysis and Systematic Review. Pain Physician. 2021 Jul;24(4):E381-E392.
10. Wang D, Xing J, Shao B, Su H, Zhang X, Zhao W, Fang Q, Sun J, Zhang Z, Zhang D, Zhang T. A surgical decompression procedure for effective treatment of calcified lumbar disc herniation. J Int Med Res. 2020 Jul;48(7):300060520938966. doi: 10.1177/0300060520938966.
11. Shriver MF, Xie JJ, Tye EY, Rosenbaum BP, Kshettry VR, Benzel EC, Mroz TE (2015) Lumbar microdiscectomy complication rates: a systematic review and meta-analysis. Neurosurg Focus 39(4):E6. https://doi.org/10.3171/2015.7.FOCUS15281
12. Shen SC, Chen HC, Tsou HK, Lin RH, Shih YT, Huang CW, Tang CL, Chen HT, Chang CC, Tzeng CY. Percutaneous endoscopic lumbar discectomy for L5-S1 disc herniation based on image analysis and clinical findings: A retrospective review of 345 cases. Medicine (Baltimore). 2023 Feb 3;102(5):e32832. doi: 10.1097/MD.0000000000032832.
13. Pan M, Li Q, Li S, Mao H, Meng B, Zhou F, Yang H. Percutaneous Endoscopic Lumbar Discectomy: Indications and Complications. Pain Physician. 2020 Jan;23(1):49-56.
14. Keskimäki I, Seitsalo S, Osterman H, Rissanen P. Reoperations after lumbar disc surgery: a population-based study of regional and interspecialty variations. Spine (Phila Pa 1976). 2000 Jun 15;25(12):1500-8. doi: 10.1097/00007632-200006150-00008.

15. Yuan C, Wen B, Lin H. Clinical Analysis of Minimally Invasive Percutaneous Treatment of Severe Lumbar Disc Herniation with UBE Two-Channel Endoscopy and Foraminal Single-Channel Endoscopy Technique. Oxid Med Cell Longev. 2022 Oct 13;2022:9264852. doi: 10.1155/2022/9264852.
16. Cai H, Liu C, Lin H, Wu Z, Chen X, Zhang H. Full-endoscopic foraminoplasty for highly down-migrated lumbar disc herniation. BMC Musculoskelet Disord. 2022 Mar 29;23(1):303. doi: 10.1186/s12891-022-05254-4.
17. Heindel P, Tuchman A, Hsieh PC, Pham MH, D'Oro A, Patel NN, Jakoi AM, Hah R, Liu JC, Buser Z, Wang JC (2017) Reoperation rates after single-level lumbar discectomy. Spine 42(8):E496–E501. https://doi.org/10.1097/BRS.0000000000001855
18. Rossi V, Maalouly J, Choi JYS. Lumbar arthroplasty for treatment of primary or recurrent lumbar disc herniation. Int Orthop. 2023 Apr;47(4):1071-1077. doi: 10.1007/s00264-023-05708-x.
19. Kim CH, Chung CK, Park CS, Choi B, Kim MJ, Park BJ (2013) Reoperation rate after surgery for lumbar herniated intervertebral disc disease: nationwide cohort study. Spine 38(7):581–590. https://doi.org/10.1097/BRS.0b013e318274f9a7
20. Jiang HW, Chen CD, Zhan BS, Wang YL, Tang P, Jiang XS. Unilateral biportal endoscopic discectomy versus percutaneous endoscopic lumbar discectomy in the treatment of lumbar disc herniation: a retrospective study. J Orthop Surg Res. 2022 Jan 15;17(1):30. doi: 10.1186/s13018-022-02929-5.
21. Wang H, Zhou T, Gu Y, Yan Z. Evaluation of efficacy and safety of percutaneous transforaminal endoscopic surgery (PTES) for surgical treatment of calcified lumbar disc herniation: a retrospective cohort study of 101 patients. BMC Musculoskelet Disord. 2021 Jan 12;22(1):65. doi: 10.1186/s12891-020-03938-3.
22. de Nijs L, Fomekong E, Raftopoulos C. Tubular Microdiscectomy for Recurrent Lumbar Disc Herniation: A Valuable Alternative to Endoscopic Techniques. World Neurosurg. 2023 May;173:e401-e407. doi: 10.1016/j.wneu.2023.02.063.
23. Esfahani, D. R., Shah, H., Arnone, G. D., Scheer, J. K., & Mehta, A. I. (2018). Lumbar Discectomy Outcomes by Specialty: A Propensity-Matched Analysis of 7464 Patients from the ACS-NSQIP Database. World Neurosurgery. doi:10.1016/j.wneu.2018.07.077
24. Lin ET, Hsiao PH, Lin CY, Chang CC, Lo YS, Lai CY, Li LY, Chen MJ, Chen YJ, Chen HT. Computed Tomography-Guided Endoscopic Surgery in Lumbar Disc Herniation With High-grade Migration: A Retrospective, Comparative Study. Pain Physician. 2022 Aug;25(5):E777-E785.
25. Cheng YP, Cheng XK, Wu H. A comparative study of percutaneous endoscopic interlaminar discectomy and transforaminal discectomy for L5-S1 calcified lumbar disc herniation. BMC Musculoskelet Disord. 2022 Mar 12;23(1):244. doi: 10.1186/s12891-022-05186-z.
26. Deng C, Feng H, Ma X, Chen C, Mei J, Sun L. Comparing oblique lumbar interbody fusion with lateral screw fixation and percutaneous endoscopic transforaminal discectomy (OLIF-PETD) and minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) for the treatment of lumbar disc herniation complicated with lumbar instability. BMC Musculoskelet Disord. 2022 Dec 19;23(1):1104. doi: 10.1186/s12891-022-06075-1.
27. Staartjes VE, Joswig H, Corniola MV, Schaller K, Gautschi OP, Stienen MN. Association of Medical Comorbidities With Objective Functional Impairment in Lumbar Degenerative Disc Disease. Global Spine J. 2022 Jul;12(6):1184-1191. doi: 10.1177/2192568220979120.
28. Zhu K, Su Q, Chen T, Zhang J, Yang M, Pan J, Wan W, Zhang A, Tan J. Association between lumbar disc herniation and facet joint osteoarthritis. BMC Musculoskelet Disord. 2020 Jan 29;21(1):56. doi: 10.1186/s12891-020-3070-6.
29. Borja AJ, Connolly J, Kvint S, Detchou DKE, Glauser G, Strouz K, McClintock SD, Marcotte PJ, Malhotra NR. Charlson Comorbidity Index score predicts adverse post-operative outcomes after

far lateral lumbar discectomy. Clin Neurol Neurosurg. 2021 Jul;206:106697. doi: 10.1016/j.clineuro.2021.106697.

30. Kao YC, Chen JY, Chen HH, Liao KW, Huang SS. The association between depression and chronic lower back pain from disc degeneration and herniation of the lumbar spine. Int J Psychiatry Med. 2022 Mar;57(2):165-177. doi: 10.1177/00912174211003760.
31. Ding Y, Lv S, Li G, Dong S, Sun X, Chen Y. Scheuermann's Disease as a Risk Factor for Lumbar Disc Herniation Recurrence. J Coll Physicians Surg Pak. 2020 Jun;30(6):584-589. doi: 10.29271/jcpsp.2020.06.584.
32. Fujii K, Abe T, Koda M, Funayama T, Noguchi H, Miura K, Kumagai H, Nagashima K, Mataki K, Shibao Y, Yamazaki M. Cauda equina schwannoma with concomitant intervertebral disc herniation: A case report and review of literature. J Clin Neurosci. 2019 Apr;62:229-231. doi: 10.1016/j.jocn.2018.12.033.
33. Chen X, Chamoli U, Fogel H, Diwan AD. Clinicians' perceptions around discectomy surgery for lumbar disc herniation: a survey of orthopaedic and neuro-surgeons in Australia and New Zealand. Arch Orthop Trauma Surg. 2023 Jan;143(1):189-201. doi: 10.1007/s00402-021-04019-3.
34. Rajasekaran S, Tangavel C, Vasudevan G, Easwaran M, Muthurajan R, K S SVA,Murugan C, Nayagam SM, Kanna RM, Shetty AP. Bacteria in human lumbar discs -subclinical infection or contamination? Metabolomic evidence for colonization, multiplication, and cell-cell cross-talk of bacteria. Spine J. 2023 Jan;23(1):163-177. doi: 10.1016/j.spinee.2022.05.001.
35. Gadjradj PS, Harhangi BS, van Tulder MW, Peul WC, de Bekker-Grob EW. Surgeons preference for lumbar disk surgery: a discrete choice experiment. Eur Spine J. 2022 Feb;31(2):380-388. doi: 10.1007/s00586-021-06838-9.
36. Son S, Ahn Y, Lee SG, Kim WK, Yoo BR, Jung JM, Cho J. Learning curve of percutaneous endoscopic transforaminal lumbar discectomy by a single surgeon. Medicine (Baltimore). 2021 Jan 29;100(4):e24346. doi: 10.1097/MD.0000000000024346.
37. Wang L, He T, Liu J, Tai J, Wang B, Zhang L, Quan Z. Revealing the Immune Infiltration Landscape and Identifying Diagnostic Biomarkers for Lumbar Disc Herniation. Front Immunol. 2021 May 27;12:666355. doi: 10.3389/fimmu.2021.666355.
38. Chen X, Xue D, Zhao Y, Cui P, Wang P, Wang Y, Lu SB. Association between periodontitis and disc structural failure in older adults with lumbar degenerative disorders: A prospective cohort study. BMC Surg. 2023 Mar 18;23(1):57. doi: 10.1186/s12893-023-01950-7.
39. Moedano DE, Irigoyen ME, Borges-Yáñez A, Flores-Sánchez I, Rotter RC. Osteoporosis, the risk of vertebral fracture, and periodontal disease in an elderly group in Mexico City. Gerodontology. 2011 Mar;28(1):19-27. doi: 10.1111/j.1741-2358.2009.00342.x.
40. Kim JW, Kong KA, Kim HY, Lee HS, Kim SJ, Lee SH, Sim KW, Kim MR, Lee JH. The association between bone mineral density and periodontitis in Korean adults (KNHANES 2008-2010). Oral Dis. 2014 Sep;20(6):609-15. doi: 10.1111/odi.12179.
41. Binte Anwar R, Tanaka M, Kohno S, Ikegame M, Watanabe N, Nowazesh Ali M, Ejiri S. Relationship between porotic changes in alveolar bone and spinal osteoporosis. J Dent Res. 2007 Jan;86(1):52-7. doi: 10.1177/154405910708600108.
42. Naitoh M, Takada ST, Kurosu Y, Inagaki K, Mitani A, Ariji E. Relationship between findings of mandibular cortical bone in inferior border and bone mineral densities of lumbar vertebrae in postmenopausal women. Okajimas Folia Anat Jpn. 2014;91(3):49-55. doi: 10.2535/ofaj.91.49.
43. Takaishi Y, Okamoto Y, Ikeo T, Morii H, Takeda M, Hide K, Arai T, Nonaka K. Correlations between periodontitis and loss of mandibular bone in relation to systemic bone changes in postmenopausal Japanese women. Osteoporos Int. 2005 Dec;16(12):1875-82. doi: 10.1007/s00198-005-1955-8.