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MRI Evaluation of Degenerative Lumbar Spine Disease in Young Adults: A Quantitative Evaluation of Risk Factors

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ABSTRACT

Background Data: Evidently, there is an alarmingly increasing incidence of degenerative lumbar spine disease in adolescents and young adults. Hence, it is imperative to ascertain and identify the risk factors so that early lifestyle modifications can be done, and early lumbar spine degeneration can be prevented.

Purpose: To study the array of MRI findings of degenerative lumbar spine disease in young adults and quantitatively evaluate the risk factors.

Study Design: A prospective imaging case study.

Patients and Methods: A total of 200 young adult patients between 21 and 30 years old presenting with low back pain were included in this study. MRI findings of 200 young adults were graded and quantitatively evaluated in relation to three risk factors, that is, physical activity, smoking, and BMI. Grading of intervertebral disc degeneration, lumbar facet joint degeneration, and foraminal stenosis was done.

Results: Modic type II endplate changes and reduced T2 bright disc signal were the most common manifestations of spondylosis and intervertebral disc (IVD) degeneration, respectively. A correlation between obesity and increasing grades of disc degeneration was found to be most significant at a 95% confidence interval. A significant correlation was found between each of the risk factors (obesity, sedentary lifestyle, and smoking) and increasing grades of IVD degeneration and facet arthropathy with a p value of <0.05. Foraminal stenosis manifested a positive association with BMI at a 95 % confidence interval.

Conclusion: This study could recognize a statistically significant correlation between lumbar DDD and physical activity, smoking, and BMI. Identification of causative lifestyle factors could help prevent the occurrence and progression of lumbar DDD. (2020ESJ214)

Keywords: MRI; Degenerative; Lumbar spine; Young adults; Risk factors.

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INTRODUCTION

Among the various causes of morbidity in young adult individuals aged ≤ 30, low back pain (LBP) is one of the most common causes ensuing reduced productivity and consumption of healthcare resources.[25] Degenerative changes of the lumbar spine are the foremost of underlying factors of LBP.[17,7]

Various genes have been implicated in degenerative disc disease (DDD) including the ones encoding collagens, interleukin 1, aggrecan, vitamin D receptor, and matrix metalloproteinase3- (MMP-3).[14] Environmental risk factors responsible for DDD and its progression include age, occupational, back injuries, smoking, obesity, sedentary lifestyle, and lack of physical activity.[21,10,16]

Degeneration of the intervertebral disc, endplates, and vertebral bodies is part of physiological aging. The incessant technological advancement and materialism have ushered in an era of workaholics, competitiveness, and stress. This, of course, led to an increased pace of human body wear and tear and a myriad of mental and physical ailments. Various studies have brought to light a high prevalence of DDD in adolescents and young adults.[16] A positive association between obesity and backache has also been reported in the literature.[8,26] There is evidence to suggest that there is an increased incidence of LBP in adolescents and young adults with a history of long hours of sitting and reduced physical activity.[6,12] Hence, it is imperative to ascertain the causal factors for DDD so that early lifestyle modifications can be done and premature spine degeneration can be prevented. We could find only a few studies in the literature evaluating DDD in the young Indian population.[21,3]

We aim to study the array of MRI findings of lumbar degenerative disc disease in young adults and quantitatively evaluate the risk factors for this condition.

PATIENTS AND METHODS

Two hundred patients between 21 and 30 years of age presenting with LBP were prospectively included in this study. All the patients complained of moderate-to-severe back pain for at least four weeks. Detailed history of sciatica and LBP was taken, including onset, nature, course, severity, and aggravating and relieving factors of pain. The severity of pain was graded by the Visual Analogue Scale[9] (VAS). Screening tests such as straight leg raising, crossed straight leg raising, and testing strength and reflexes in the lower extremities were conducted. Patients with a spinal deformity, infection, trauma, congenital malformations, and primary canal stenosis were excluded from the study. The study was done in Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, for a period of 6 months between January 2020 to June 2020.

Baseline data on demographic and clinical characteristics were collected throughout the course of study on a predesigned performa. Detailed history regarding smoking (number of cigarettes per day) and number of hours of physical activity per day was taken. Anthropometric assessments recorded were weight (kg), height (meter), and body-mass index (BMI, Kg/m2).

WHO criterion for BMI was referred to, which divides patients into four groups: underweight, normal, overweight, and obese. An individual is underweight if his BMI is below 18.5, normal if BMI is 18.5–24.9, overweight if BMI is 25–29.9, and obese if BMI ≥30.[18] For this study, we divided the patients into two groups: obese with BMI ≥30 and not obese with BMI 18.5–29.9. The physical activity was graded as active or sedentary. Active lifestyle was defined as adults doing at least 150 minutes of moderate-intensity aerobic physical activity in a week or 75 minutes of vigorous-intensity aerobic physical activity in a week according to the WHO Global Recommendations on Physical Activity for Health, 2010.[19] Subjects were classified as smokers or nonsmokers for

the third risk factor. Daily smokers, whatever the number of cigarettes they smoke, were included in this study as smokers.

MRI was independently reported by two radiologists, and the findings were tabulated. Intervertebral disc degeneration and lumbar facet joint degeneration were graded as described by Pfirrman et al.[20] and Weishaupt et al.[27], respectively. Grading of lumbar neural foraminal stenosis was done.[15] Any difference in opinion was solved by consensus.

The study was approved by the local ethics committee of the institute. Informed written consent was obtained from all patients, and the study was conducted in accordance with the Declaration of Helsinki.[2] The confidentiality of any individual or the institution was not breached. The study in no way involved experimentation on human or animal subjects. The procedure (MRI) that was carried out is routinely done on LBP subjects, and no new intervention was done for this study. The ethical issues in the study have been paid due attention to, and the study did not delay any residents from performing their duties.

Statistical Analysis

The data were analyzed with SPSS software version 20. Descriptive statistics (percentage, mean, median, and mode) were calculated. Chi-square test was used to determine the statistical difference between variables. Crude odds ratio (OR) and adjusted OR were calculated. The level of significance was fixed at <0.05 at a 95% confidence interval (CI).

RESULTS

Of the 200 patients suffering from LBP of moderate-to-severe degree for a minimum of 4 weeks who were referred for spine MRI, 140 were male and 60 females. The mean VAS of LBP was 6.7 ± 2. The mean age was 26 ± 8 (range, 21–30). Patients were classified according to MRI findings into those who have lumbar DDD on MRI (112 patients, 79 males and 33 females) and those who have no abnormality and no DDD on MRI images (88 patients).

Fifty-four patients with DDD were smokers, 74 were obese (BMI >30), and 46 had a sedentary lifestyle. The majority (N = 34) of patients were found to have a multilevel disease with L4-L5 and L5-S1 levels involved (almost a third of the patients, 30.3%) (Figure 1). The most common change in disc was reduced signal intensity of the intervertebral disc (grade II disc degeneration), seen in 83 (74.1%) patients with DDD. The most common feature of degeneration in vertebrae was Modic type II endplate changes seen in half of the patients with DDD (Figures 2 and 3). Nerve root indentation or compression was seen in 46 (58.2%) males and 15 (45.5%) females (Table 1). Forty-six patients (41%) had facet arthropathy, 17 (15.2%) had canal stenosis, and 34 (30.5%) had foraminal stenosis.

The correlation was estimated with risk factors (BMI >30, sedentary lifestyle, and smoking) and increasing grades of IVD degeneration, facet arthropathy, and foraminal stenosis. A significant correlation was found between all the risk factors taken into consideration (BMI, sedentary lifestyle, and smoking) and increasing grades of IVD degeneration and facet arthropathy ($p < 0.05$). A positive association could also be manifested among BMI and increasing grades of foraminal stenosis. (Tables 2, 3, and 4). According to crude analyses, the odds for having disc degeneration were significant with all three risk factors taken into consideration independently (Tables 2, 3, and 4).

Table 1. Incidence of various MRI features in the study sample (N = 200).

Paramveters	Number (%)
MRI feature of DDD	112 (56)
Reduced disc signal intensity	83 (41.5)
Reduced disc height	76 (38)
Disc bulge	74 (36)
Disc protrusion	50 (25)
Disc extrusion	10 (5)
Annular tears	10 (30.3)
Foraminal stenosis	61 (30.5)
Facet arthropathy	46 (23)

Table 2. Correlation between risk factors (obesity, sedentary lifestyle, and smoking) and grade of IVD degeneration (N = 200).

Parameters	No IVDD	Grade I	Grade II	Grade III	Grade IV	Grade V	*p* value	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
BMI = 18.5–29.9	64	4	5	2	2	1	<0.0001	4.889 (2.539–9.415)	0.073 (0.029–0.184)
BMI ≥30	53	5	7	10	30	17			
Active lifestyle	51	5	4	3	12	13	0.007	0.926 (0.525–1.633)	0.314 (0.136–0.724)
Sedentary lifestyle	66	3	11	7	20	5			
Nonsmoker	68	3	7	4	10	4	<0.0001	2.623 (1.462–4.706)	0.270 (0.136–0.536)
Smoker	48	6	8	7	22	13			

Table 3. Correlation between risk factors (obesity, sedentary lifestyle, and smoking) and grade of facet arthropathy (N = 200).

Parameters	No arthropathy	Grade I arthropathy	Grade II arthropathy	Grade III arthropathy	*p* value	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
BMI =18.5–29.9	63	6	5	6	0.03	1.181 (0.599–2.330)	0.276 (0.118–0.646)
BMI≥30	91	10	9	10			
Active lifestyle	78	2	3	5	>0.001	3.695 (1.713–7.968)	0.152 (0.060–0.380)
Sedentary lifestyle	76	11	10	15			
Nonsmoker	84	3	3	6	0.002	3.40 (1.638–7.059)	0.299 (0.137–0.652)
Smoker	69	9	12	13			

Table 4. Correlation between risk factors (obesity, sedentary lifestyle, and smoking) and grade of foraminal stenosis (N = 200).

Parameters	Grade 0	Grade I	Grade II	Grade III	*p* value	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
BMI = 18.5–29.9	78	0	1	1	0.005	5.571 (1.238–25.075)	0.049 (0.020–0.493)
BMI ≥30	105	4	5	6			
Active lifestyle	81	2	3	2	0.111	1.134 (0.414–3.112)	0.408 (0.136–1.229)
Sedentary lifestyle	102	4	3	3			
Nonsmoker	91	2	2	1	0.090	2.374 (0.804–7.010)	0.381 (0.125–1.161)
Smoker	90	5	7	2			

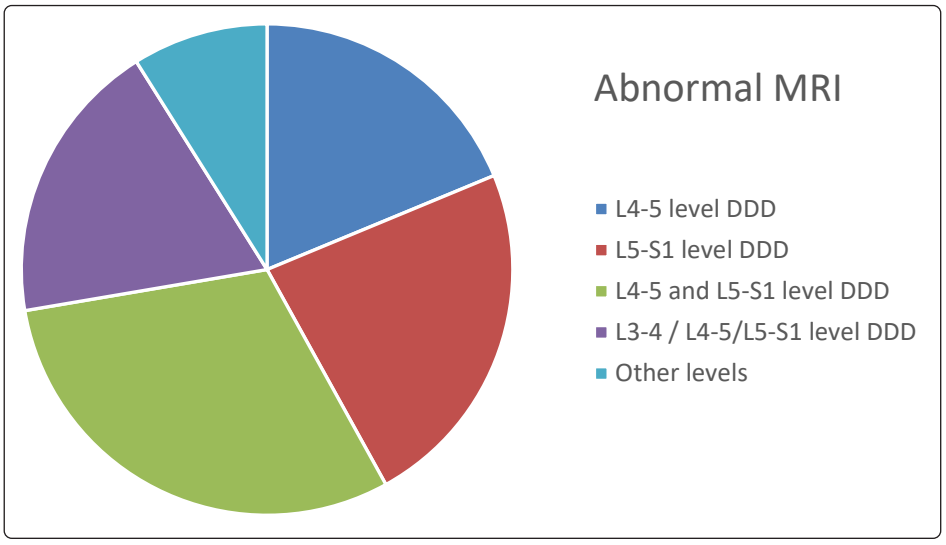

Figure 1. Distribution of DDD at various levels of the lumbar spine (N = 112).

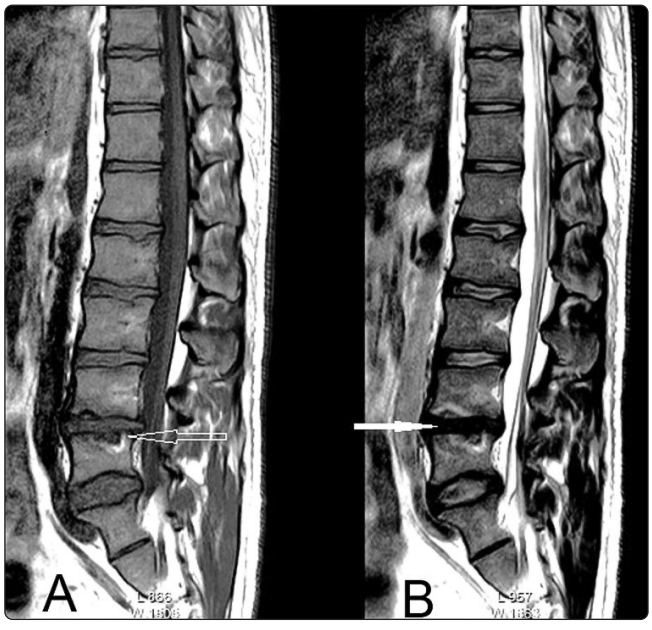

Figure 2. Sagittal images MRI of the lumbar spine: (A) T1W and (B) T2W in a 26-year-old male showing loss of T2W hyperintensity of the intervertebral disc at L4-L5 level in the form of disc desiccation changes (solid arrow) and Modic changes (arrow). Spinal curvature is also straightened.

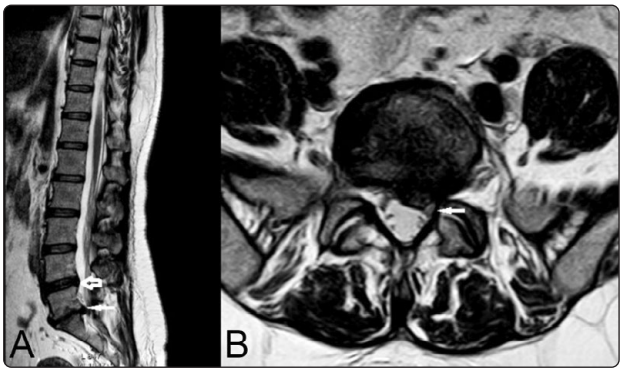

Figure 3. MRI of the lumbar spine of a 30-year-old female. T2W (A) sagittal and (B) axial images show a left paracentral disc protrusion at L5-S1 level indenting the thecal sac with compression of left S1 traversing nerve root in the lateral recess, with reduced disc height at this level (solid arrow). A disc bulge is also seen at L4-L5 level (arrow) with disc desiccation changes at L4-L5 and L5-S1 levels.

DISCUSSION

MRI is the first-line investigation performed for DDD of the lumbar spine. The role of imaging is to accurately assess the cause of the patient's pain based on which clinicians can choose a treatment option. The imaging features of the DDD of the spine include intervertebral disc degeneration assessed as reduced signal intensity, disc bulge, protrusion, or extrusion. The non-disc changes include nerve root indentation or compression, endplate changes, Modic changes, foraminal stenosis, facet arthropathy, and annular tears. In this study, we assessed the degree of degeneration of the spine in young adults in relation to three risk factors, that is, obesity, sedentary lifestyle, and smoking.

MRI changes of DDD were seen in 56% of the patients presenting with LBP in our study. Samartzis et al.[22] found disc degeneration in 35% of subjects between 13 and 29 years old without spinal deformity. Another study conducted by Al-Saeed et al.[1] on a young Arab population concluded that 65% of symptomatic subjects had MRI changes of lumbar spine degeneration. In a Finnish study by Takatalo et al.[26] , 47% of subjects between 20 and 22 years old were found to have DDD. Another study done by Savage et al.[23] found 34% of subjects between 20 and 30 years of age and 59% between 31 and59 years to be having DDD on MRI.

In this study, 57.9 % of patients had multilevel disease. The lower two lumbar levels (L4-L5 and L5-S1) were seen to be the most commonly involved (30.3% of patients). This observation was comparable with those made by Al-Saeed et al.[1] and Takatalo et al.[26] in their studies. Features on MRI such as reduced IVD signal intensity, reduced disc height, changes in disc contour, and nerve root compromise were also in agreement with the study done by Al-Saeed et al.[1]

Regarding the effects of obesity on the spine, our study depicted that 60% of patients with BMI >30 have changes on MRI. Several mechanisms are responsible for the effect of obesity on DDD. Obesity could result in serious postural changes that affect loading on joints and thus result in long-term adverse effects on bones and joints. All these changes result in greater degeneration and overloading of the spine and produce higher compressive forces contributing to LBP. Many other studies also found a significant correlation between obesity and LBP. In a study done by Samartzis et al.[22], the presence of juvenile disc degeneration was strongly associated with overweight and obesity. Al-Saeed et al.[1] demonstrated that 75% of overweight and obese patients had DDD on MRI. The HUNT study done by Heuch et al.[13] inferred that an elevated BMI was strongly associated with an increased prevalence of LBP. Another study done in the Middle East demonstrated that obesity is moderately associated with LBP.[5]

A prospective descriptive study done in Chennai, India, on 100 computer professionals with a sedentary lifestyle between the age of 20-40 years concluded that 18% of patients presenting with LBP had multilevel disc degeneration commonly affecting three contiguous spinal segments.[3] In the present study, 47.3% of patients who had MRI features of DDD were following a sedentary lifestyle. Reduced physical activity due to a sedentary lifestyle results in decreased muscular power and strength. Also, due to a sedentary lifestyle, the intervertebral disc is unable to maintain a normal concentration of water. The level of hydration of the nucleus pulposus influences development of degenerative and overload lesions. This degeneration leads to intervertebral disc herniation.

Out of the total number of smokers in our study, 64.3% had DDD on MRI. A study done by Sharma et al.[24] deduced that among the 300 patients studied, 76.7% of patients with lumbar DDD were smokers. Cigarette smoking releases proteolytic enzymes from neutrophils in alveolar capillaries. It also inhibits the activity of alpha-1-antiprotease, the most potent protease inhibitor. Through these two mechanisms, it increases proteolytic activity. This high serum proteolytic activity speeds up

the degenerative process and weakens the spinal ligaments.[11] A study done on young adults (18–35 years) in India identified various risk factors associated with LBP but could not determine the association between smoking and alcoholism and LBP. However, many other risk factors such as marital status, family history or previous history of spine problems, strenuous exercise, stress, and increased hours of studying hours were found to be statistically significant causes of LBP.[15] Another Indian study by Barani et al.[3] found out that 22.2% of their patients between the ages of 20–40 years who presented with a history of LBP were smokers, and all of them had degenerative disc changes on MRI. A study on the effects of smoking on twins demonstrated a small increase in disc degeneration associated with smoking.[4]

This study has some limitations such as the small sample size and the lack of a control group that is why we recommend a large sample size study with further dynamic X-ray to exclude instability.

CONCLUSION

The data of this study showed a statistically significant correlation between DDD and obesity, sedentary lifestyle, and smoking. Identification of causative lifestyle risk factors that affect DDD could help prevent the occurrence and/or progression of this condition.

REFERENCES

1. Al-Saeed O, Al-Jarallah K, Raeess M, Sheikh M, Ismail M, Athyal R: Magnetic resonance imaging of the lumbar spine in young arabs with low back pain. Asian Spine J 6(4):249, 2012
2. Association WM: World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects. Bull World Health Organ 79(4):373, 2001
3. Barani R, Amuthan AK: Multi-level disc degeneration in young individuals - a prospective MRI study of 100 computer professionals. EC Orthop 9.3:76–83, 2018
4. Battié MC, Videman T, Kaprio J, Gibbons LE, Gill K, Manninen H, et al: The twin spine study: contributions to a changing view of disc degeneration. Spine J 9(1):47–59, 2009
5. Bener A, Alwash R, Gaber T, Lovasz G. Obesity and low back pain. Coll Antropol 27(1):95–104, 2003
6. Boden SD, McCowin PR, Davis DO, Dina TS, Mark AS, Wiesel S: Abnormal magnetic-resonance scans of the cervical spine in asymptomatic subjects. A prospective investigation. JBJS 72(8):1178–1184, 1990
7. Borenstein DG: Epidemiology, etiology, diagnostic evaluation, and treatment of low back pain. Curr Opin Rheumatol 13(2):128–134, 2001
8. Cheung KMC, Karppinen J, Chan D, Ho DWH, Song Y-Q, Sham P, et al: Prevalence and pattern of lumbar magnetic resonance imaging changes in a population study of one thousand forty-three individuals. Spine (Phila Pa 1976) 34(9):934–940, 2009
9. Cline ME, Herman J, Shaw ER, Morton RD: Standardization of the visual analogue scale. Nurs Res, 1992
10. Elfering A, Semmer N, Birkhofer D, Zanetti M, Hodler J, Boos N: Young investigator award 2001 winner: Risk factors for lumbar disc degeneration: A 5-year prospective MRI study in asymptomatic individuals. Spine (Phila Pa 1976) 27(2):125–134, 2002
11. Fogelholm RR, Alho A V: Smoking and intervertebral disc degeneration. Med Hypotheses 56(4):537–9, 2001
12. Ganesan S, Acharya AS, Chauhan R, Acharya S: Prevalence and risk factors for low back pain in 1,355 young adults: a cross-sectional study. Asian Spine J 11(4):610, 2017

13. Heuch I, Hagen K, Heuch I, Nygaard Ø, Zwart J-A: The impact of body mass index on the prevalence of low back pain: the HUNT study. Spine (Phila Pa 1976) 35(7):764–768, 2010
14. Kalichman L, Hunter DJ: The genetics of intervertebral disc degeneration. Associated genes. Jt Bone Spine 75(4):388–396, 2008
15. Lee S, Lee JW, Yeom JS, Kim K-J, Kim H-J, Chung SK, et al: A practical MRI grading system for lumbar foraminal stenosis. Am J Roentgenol 194(4):1095–1098, 2010
16. Liuke M, Solovieva S, Lamminen A, Luoma K, Leino-Arjas P, Luukkonen R, et al: Disc degeneration of the lumbar spine in relation to overweight. Int J Obes 29(8):903–908, 2005
17. Luoma K, Riihimäki H, Luukkonen R, Raininko R, Viikari-Juntura E, Lamminen A: Low back pain in relation to lumbar disc degeneration. Spine (Phila Pa 1976) 25(4):487–492, 2000
18. Nuttall FQ: Body mass index: obesity, BMI, and health: a critical review. Nutr Today 50(3):117, 2015
19. Organization WH: Global recommendations on physical activity for health. World Health Organization, 2010
20. Pfirrmann CWA, Metzdorf A, Zanetti M, Hodler J, Boos N: Magnetic resonance classification of lumbar intervertebral disc degeneration. Spine (Phila Pa 1976) 26(17):1873–1878, 2001
21. Prescher A: Anatomy and pathology of the aging spine. Eur J Radiol 27(3):181–195, 1998
22. Samartzis D, Karppinen J, Mok F, Fong DYT, Luk KDK, Cheung KMC: A population-based study of juvenile disc degeneration and its association with overweight and obesity, low back pain, and diminished functional status. JBJS 93(7):662–670, 2011
23. Savage RA, Whitehouse GH, Roberts N: The relationship between the magnetic resonance imaging appearance of the lumbar spine and low back pain, age and occupation in males. Eur Spine J 6(2):106–114, 1997
24. Sharma MK, Petrukhina E: Strong association of smoking with lumbar degenerative spine disease. Open Neurosurg J 6(1), 2013
25. Taher F, Essig D, Lebl DR, Hughes AP, Sama AA, Cammisa FP, et al: Lumbar degenerative disc disease: current and future concepts of diagnosis and management. Adv Orthop, 2012
26. Takatalo J, Karppinen J, Niinimäki J, Taimela S, Näyhä S, Järvelin M-R, et al: Prevalence of degenerative imaging findings in lumbar magnetic resonance imaging among young adults. Spine (Phila Pa 1976) 34(16):1716–1721, 2009
27. Weishaupt D, Zanetti M, Boos N, Hodler J: MR imaging and CT in osteoarthritis of the lumbar facet joints. Skeletal Radiol 28(4):215–219, 1999

الملخص العربي

تقييم التصوير بالرنين المغناطيسي لمرض العمود الفقري القطني التنكسية لدى الشباب: تقييم كمي لعوامل الخطر

البيانات الخلفية: من الواضح أن هناك زيادة مقلقة في حدوث الإصابة بمرض العمود الفقري القطني التنكسية لدى المراهقين والشباب. وبالتالي ، من الضروري التأكد من عوامل الخطر وتحديدها حتى يمكن إجراء تعديلات مبكرة في نمط الحياة ، وبالتالي يمكن منع تنكس العمود الفقري القطني المبكر.

الغرض: دراسة مجموعة نتائج التصوير بالرنين المغناطيسي لمرض العمود الفقري القطني التنكسية عند الشباب وتقييم عوامل الخطر بشكل كمي.

تصميم الدراسة: دراسة حالة تصويرية مستقبلية.

المرضى والطرق: تم تضمين ما مجموعه 200 مريض شاب تتراوح أعمارهم بين 21 و 30 عامًا يعانون من آلام أسفل الظهر في هذه الدراسة. تم تصنيف نتائج التصوير بالرنين المغناطيسي لـ 200 شاب وتقييمها كميًا فيما يتعلق بثلاثة عوامل خطر ، وهي النشاط البدني والتدخين ومؤشر كتلة الجسم. تم إجراء تصنيف تنكس القرص الفقري وتنكس المفصل القطني وتضيق الثقبة.

النتائج: كانت التغييرات المتوسطة من النوع الثاني وخفض إشارة القرص الساطع T2 هي أكثر المظاهر شيوعًا لداء الفقار وتنكس القرص الفقري (IVD) ، على التوالي. تم العثور على العلاقة بين السمنة وزيادة درجات تنكس القرص لتكون أكثر أهمية في فاصل ثقة 95 ٪. تم العثور على ارتباط كبير بين كل من عوامل الخطر (السمنة ، نمط الحياة المستقرة ، والتدخين) وزيادة درجات انحطاط IVD واعتلال المفاصل مع قيمة P <0.05. أظهر التضيق الثقبي ارتباطًا إيجابيًا بمؤشر كتلة الجسم بفاصل ثقة 95٪.

الخلاصة: يمكن لهذه الدراسة التعرف على علاقة ذات دلالة إحصائية بين مرضي العمود الفقري القطني التنكسية والنشاط البدني والتدخين ومؤشر كتلة الجسم. يمكن أن يساعد تحديد عوامل نمط الحياة المسببة في منع حدوثمرض العمود الفقري القطني التنكسية وتطوره.