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Original Article

Functional disability of occupational-related lumbar disc degeneration: Evaluation by magnetic resonance imaging with surgical correlation

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ABSTRACT

Objectives: The objectives of our work were to determine disability and study MRI findings of occupational-related lumbar disc degeneration and also to show the relationship between MRI grading of nerve root compromise with surgical grading.

Participants and methods: The study included 103 workers with lumbar disc prolapse. Nerve roots were assessed on MRI and during surgery for the degree of compromise. Oswestry Disability Index and Visual Analogue Scale were used for assessment of disability and pain intensity pre- and post-operative respectively.

Results: The majority of workers was less than 40 years and suffered from moderate to severe disability. 73.8% had grade IV disc degeneration mostly at the level of L4/L5. Nerve root compromise was found in 86.4% of workers. 48% of nerve roots were deviated and 32% were compressed, with significant correlation between MR grading of nerve root compromise and surgical grading ($r = 0.89$, $P < 0.0001$).

Conclusion: Disability of occupational-related lumbar disc degeneration is a grave health problem between construction workers. MR imaging is a reliable tool for grading nerve root compromise in disc degeneration. Nerve root compromise is a significant factor to explain pain than the morphologic extension of disc material outside the intervertebral space.

1. Introduction

Degeneration of intervertebral discs is the most frequently known cause of lower back pain all over the world [1]. In the developed countries low back pain is somewhat common. It is the most common reason of disability above the age of forty and the most frequent cause for seeking medical advice [2].

Occupational back pain affects functional capacity and quality of life and leads to limitations of physical daily activities among construction workers [3].

MRI data usually emphasize on the shape, extent and location of prolapsed disc, and the outcome of disc prolapse depends mainly on the size and site of prolapsed disc in relation to the width of the spinal canal. So prolapsed disc of similar size may be asymptomatic in one patient and rendering a severe pain in another [4].

MRI findings with nerve root compromisation are frequently symptomatic than those without. The criteria of disc herniation influence the clinical presentations. Central extrusions and protrusion are less prone to cause nerve compromise while centrolateral or far lateral lesions produce neural compromise [5].

MRI is an excellent tool for assessment of the correlation of disc material to nearby neural structure and soft tissue [6]. It is considered a chief technique for the clinical evaluation of intervertebral disc pathology [7]. The majority of categorization systems for degenerative inter-vertebral disc focus on structural morphology and signal intensity of the nucleus pulposus on sagittal T2-weighted MR images as reduced signal intensity indicates

Abbreviations: IVDD, intervertebral disc degeneration; MRI, magnetic resonance imaging; ODI, Oswestry Disability Index; VAS, Visual Analogue Scale.

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decreased water and proteoglycan contents as a result of degeneration process.

However, signal intensity cannot be assessed as an absolute terms because of many factors in signal detection and amplification [8]. The signal characteristics of the disc in T2 weighted MRIs indicate degeneration changes [7].

Convenient MR imaging can give a morphologic and semi-quantitative assessment of intervertebral disc degeneration [4]. So our aims of this study were to assess disability of occupational-related lumbar disc degeneration among construction workers, to study MRI findings in lumbar disc degeneration and to show the relationship between MRI grading of nerve roots compromise with surgical grading.

2. Participants and methods

2.1. Participants

This study was performed during the period from April 2015 to July 2016. The ethics committee of our University accepts the protocol of this study. The study included 103 males construction manual workers (mean age, 38.73 ± 12.43; age range, 23–60 years) presenting with low back pain with or without sciatica to the out-patient spine clinic and with lumbar disc herniation on MRI.

Disc herniation and 250 lumbar nerve roots at the levels of disc degeneration were evaluated on MR images for compromise. Workers with spine fractures, prior back surgery, spinal infection, sacroiliac arthritis, rheumatoid arthritis and metabolic bone disease were excluded. Each worker gave a written consent to participate in this study.

2.2. Methods

All workers were subjected to the following:

1. Face to face interview using a predesigned questionnaire

The questionnaire included demographic information (e.g. name, age, height, body weight, duration of present work and job description) and clinical data regarding low back pain and sciatica. Oswestry Disability Index (ODI) was used to assess functional disability and Visual Analogue Scale 100 mm (VAS) was used to assess pain pre-operative and 3 months post-operative.

subacute, or chronic low back pain. It consists of 10 multiple-choice questions of LBP one item on pain and nine items on daily activities (walking, sitting, lifting, personal care, standing, sex life, sleeping, social life, and travelling), and for every question the patient chooses one answer out of six that best express his/her disability [9]. The test is considered the gold standard' of low back functional outcome tool [10].

Score interpretation: ODI score ranges from 0% (no disability) to 100% (maximum disability). Scores from 0% to 20% point to minimal disability, 21% to 40% point to moderate disability, 41% to 60% point to severe disability, 61% to 80% point to crippled or home-bound, and 81% to 100% point to bedridden [11].

2. Complete general and neurological examination

All workers were clinically evaluated for pain distribution as well as neurological deficits. The dermatomal distributions of the sensory level were assessed.

3. Magnetic resonance imaging

All workers underwent MRI assessment using a 1.5 T MRI apparatus (General Electric SIGNA) using lumbo-sacral coil. Sagittal scout images are obtained parallel to the coil. For all workers the imaging protocol consisted of using multisection fast spin echo delay time (TE) to obtain T1 and T2WI as follows: Axial and sagittal T1 (TR = 400–500 ms, TE = 15–20 ms with a slice thickness 4 mm). Axial and sagittal T2 (TR = 3500–5000 ms, TE = 100–130 ms, with a slice thickness 4 mm).

4. Image assessment

Lumbar MR Images were reviewed by four observers (two Radiologists, one Neurosurgeon and one Orthopaedic Surgeon). Extent of disc prolapse, grade of disc degeneration, and nerve root compression were reported. Disc degeneration grading was assessed in the sagittal T2 WI; every intervertebral disc from L3-S1 was evaluated according to Pfirrmann grading of intervertebral disc degeneration [7] which assesses the degenerated intervertebral discs for signal intensity, height and the asymmetry in disc structure.

Pfirrmann grading of intervertebral disc degeneration.

Grade	Structure	Distinction of nucleus and annulus	Signal intensity	Disc height
I	Homogenous, bright white	Clear	Hyperintense, isointense to CSF	Normal
II	Inhomogeneous with or without horizontal bands	Clear	Hyperintense, isointense	Normal
III	Inhomogeneous, gray	Unclear	Intermediate	Normal to slightly decreased
IV	Inhomogeneous, gray to black	Lost	Intermediate to hypointense	Normal to moderately decreased
V	Inhomogeneous, black	Lost	Hypointense	Collapsed disc

Visual Analogue Scale 100 mm (VAS): The VAS is a point scale measuring 100 mm where the end points are the extremes of no pain and worst pain. The worker is asked to spot the level of his back pain on the scale.

Oswestry Disability Index Version 2.0 (ODI): The ODI has been developed to assess pain related disability in people with acute,

Disc herniation was classified as (1) normal: no disc extension beyond the interspace, (2) disc bulge: regular circumferential disc extension outside the interspace, (3) disc protrusion: asymmetrical disc extension outside the interspace with base touching the disc wider than any other diameter of the protrusion and (4) disc extrusion: localized disc extension outside the interspace with base touching the disc narrower than the width of the extruding material or sequestrated disc.

The compromise of lumbar nerve root was also graded according to Pfirrmann et al. [4]. Grade 0: No compromise is seen. There was no contact of disc material with the nerve root, with preserved epidural fat between the disc material and nerve root. Grade I: contact of the disc material with the nerve root, and epidural fat is not evident. Grade II: The nerve root is dislocated dorsally by the disc material. Grade III: The nerve root is compressed between the disc material and the wall of the spinal canal; it may appear crushed or be indistinguishable from disc material.

Table 1
General characteristics of participants.

Variable	Number of workers = 103 N (%)
Age groups in years	
23–30	37(35.9)
31–40	39(37.9)
41–50	19(18.4)
51–60	8(7.8)
Mean ± SD	38.73 ± 12.43
Height in cm (mean ± SD)	173.7 ± 10.22
Weight in kg (mean ± SD)	76.4 ± 9.76
BMI in (kg/m^2)	23.2 ± 4.23
Duration of work in years	
⩽1 year	24(23.3)
2–4	38(36.9)
5–7	21(20.4)
8 years and above	20(19.4)
Mean ± SD	3.87 ± 1.32

Table 2
Frequency of low back pain and other associated symptoms among participants.

Symptoms	Number (%) (n = 103)
Low back pain	103(100.0)
Continuous	60(58.3)
Intermittent	43(41.7)
Sciatica	
Right leg	40(38.8)
Left leg	35(34.0)
Bilateral leg	22(21.4)
No radiation	6(5.8)
Physical problems	
Limping when walking	31(30.1)
Disturbance of balance	27(26.2)
Difficulty with urination	23(22.3)
Difficulty with emptying bowel	20(19.4)
Stomach problems	17(16.5)
Emotional problems	
Irritable and short tempered	71(68.9)
Anxiety	83(80.6)
Mood change	65(63.1)
Functional problems	
Activities	93(90.3)
Pain at rest	57(55.3)
Sleep	73(70.9)
Sex life	31(30.1)

Table 3
Distribution of workers according to the degree of disability due to low back pain.

Degree of disability (ODI)	Number (%) (n = 103)
Minimal disability (0–20)	18(17.5)
Moderate disability (21–40)	42(40.8)
Severe disability (41–60)	36(34.9)
Crippled (61–80)	5(4.9)
Bedbound (81–100)	2(1.9)

5. Surgical assessment

Thirty-five (35) workers underwent surgical discectomy, in the surgical report, 98 nerve roots graded for compromise. The remaining workers have undergone conservative treatment. During surgery, the degree of nerve root compromise was evaluated using terms similar to those used in MR image–based assessment. Nerve root deviation was defined as posterior displacement of the nerve

Table 4
Frequency of workers according to the grades of disc degeneration.

Grades of disc degeneration	Number (%) (n = 103)
Grade I	7(6.8)
Grade II	11(10.7)
Grade III	27(26.2)
Grade IV	76(73.8)
Grade V	61(59.2)

N.B: The number of grades was not consistent with number of patients (103) because the same patient may have more than one grade.

Table 5
Frequency of MRI findings at disc levels.

MRI findings	Number of workers (n = 103)	%
Height of disc space reduce	103	100.0
L3/L4	23	22.3
L4/L5	92	89.3
L5/S1	79	76.7
Disc bulge	81	78.6
L3/L4	11	10.7
L4/L5	54	52.4
L5/S1	35	34.1
Disc protrusion	74	71.8
L3/L4	9	8.7
L4/L5	41	39.8
L5/S1	37	35.9
Disc extrusion	22	21.4
L3/L4	2	1.9
L4/L5	9	8.7
L5/S1	15	14.6
Nerve root compromise	89	86.4
L3/L4	5	4.9
L4/L5	68	66.1
L5/S1	41	39.8

N.B: The number of vertebral levels was not consistent with number of patients (103) because lesions were on either single or multiple levels in the same patients.

Table 6
Frequency of MR image-based grades of nerve root compromise.

MR image-based grades	Number of nerve root (%) (n = 250)
Grade 0 (Normal)	17 (6.8)
Grade I (Contact)	33 (13.2)
Grade II (Deviation)	120 (48.0)
Grade III (Compression)	80 (32.0)

Table 7
Correlation of MR image-based grading of nerve root compromise with surgical grading.

Surgical grades	MR image–based grades			Total
	Normal or contact	Deviation	Compression	
Normal or contact	26	1	0	27
Deviation	1	22	1	24
Compression	1	2	44	47
Total	28	25	45	98
Spearman coefficient				r = 0.89

root by herniated or a bulging intervertebral disc. Nerve root compression was defined as posterior displacement associated with deformation of the nerve root. Intraoperative observation of contact between the intervertebral disc and the nerve root is not possible because of the very close relationship of nerve root and the posterior part of the annulus fibrosus and because slight differences in site cannot be evaluated after the dorsal parts of the vertebra are detached during surgery. For the correlation of surgical grades with image-based grades, we merged the first two grades (normal and contact) used in MR image assessment into a single

Table 8
Pre-surgical and 3 months post-surgical analysis of VAS and ODI within the surgical group.

The surgical group	Pre-surgical (mean ± SD) min–max	3 months post-surgical (mean ± SD) min–max	P-value of paired-*t* test
VAS in mm	63.25 ± 7.42 (56–80)	10.23 ± 2.26 (5–15)	<0.0001**
Disability index (ODI in %)	57.62 ± 12.65 (42–89)	18.50 ± 3.87 (14–22)	<0.001**

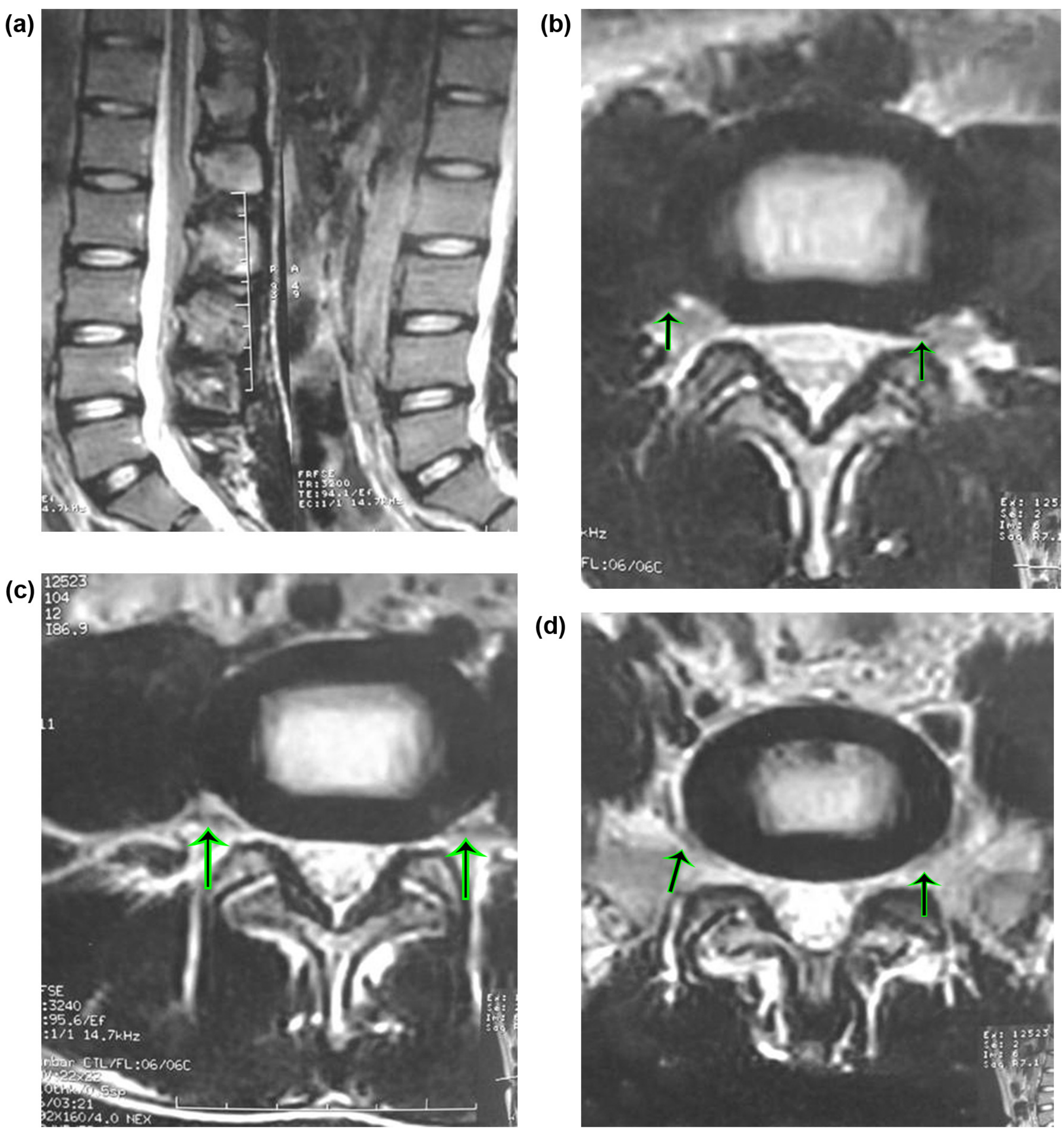

Fig. 1. (a) Sagittal T2 WI shows normal appearance of IVD (preserved bright signal intensity and normal height ... Grade I). (b) Axial T2 WI at level of L3/4 shows loss of posterior concavity of the disc touching both nerve roots (Grade 1 - green arrows) with no thecal sac compression. (c) Axial T2 WI at level of L4/5 shows loss of posterior concavity of the disc with minimal diffuse posterior disc bulge compressing the left nerve root (Grade II) with no evidence of thecal sac compression. (d) Axial T2 WI at level of L5/S1 shows minimal diffuse posterior disc bulge with normal nerve roots (Grade 0) and no thecal sac compression.

category. Thus, three categories were measured: normal or contact, deviation, and compression.

2.3. Statistical analysis

Data were collected and analysed using Statistical Package for the Social Sciences (SPSS) software (Version 21). Quantitative data were described as mean and standard deviations (SD). Unpaired Student "t" test was used to compare mean values of two groups. Spearman correlation coefficient was calculated for correlation between surgical grading and MR image–based grading. P value < 0.05 was considered as significant.

3. Results

3.1. General characteristics of participants

A total of 103 construction workers (mean age, 38.73 ± 12.43; age range, 23–60 years) were included in the study. The majority of the workers were in the age group less than 40 years (73.8%), while the least ratio (7.8%) was in the age group of 51 years and above. The mean height of the workers was 173.7 ± 10.22 cm, the mean body weight was 76.4 ± 9.76 kg and the mean of body mass index (BMI) was 23.2 ± 4.23 kg/m^2. The highest frequency of workers had duration of work from 2 to 4 years (35.9%) and the least percentage (19.4%) had worked for eight years and more (Table 1).

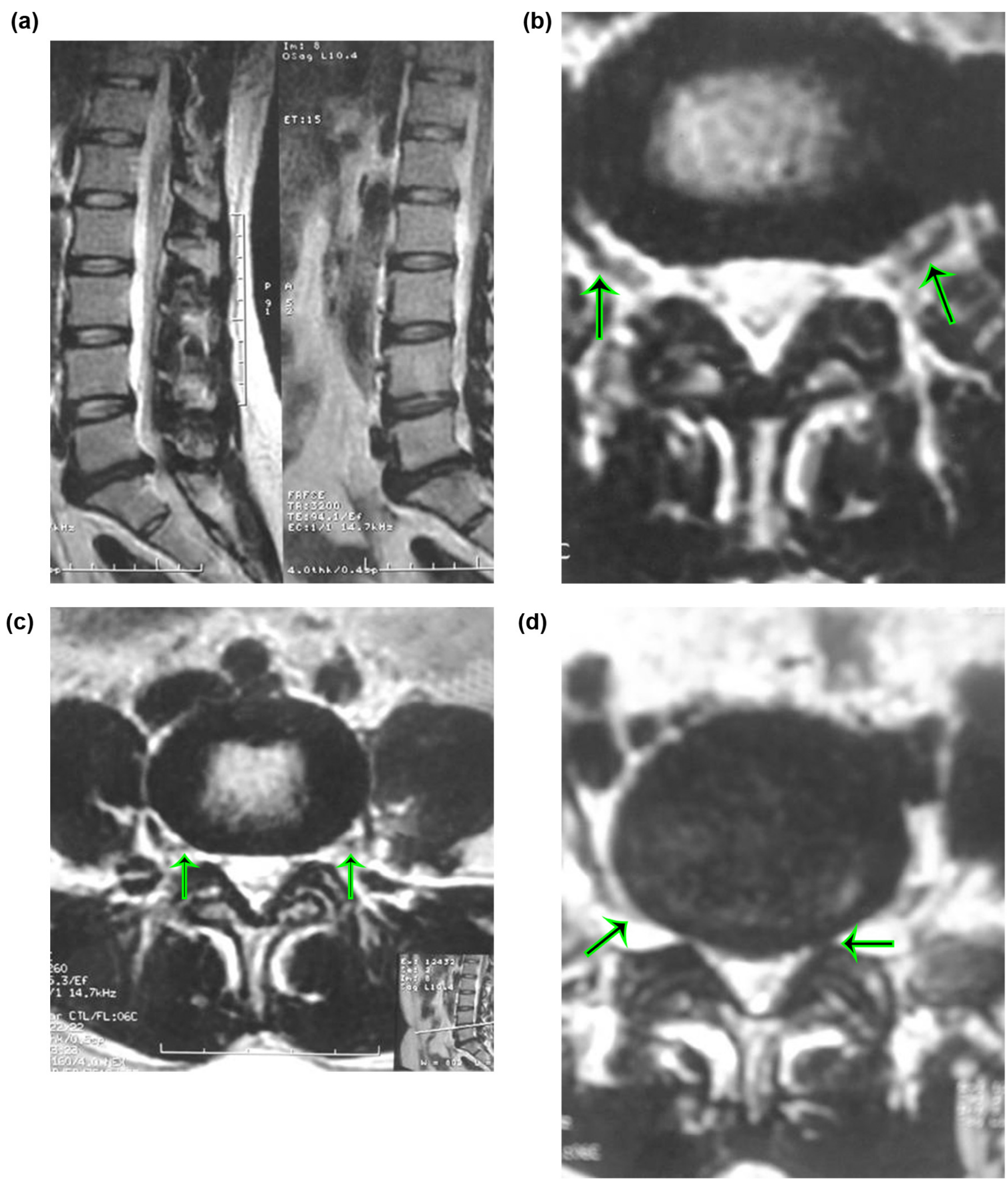

Fig. 2. (a) Sagittal T2 WI shows degenerative changes of L5/S1 IVD (Grade V). (b) Axial T2 WI at level of L3/4 shows normal disc contour with no nerve roots or thecal sac compression. (c) Axial T2 WI at level of L4/5 shows mild diffuse posterior disc bulge flattening the ventral thecal aspect and touching both nerve roots (Grade 1). (d) Axial T2 WI at level of L5/S1 shows diffuse posterior disc bulge indenting the ventral thecal aspect with compression and deviation of both nerve roots (Grade III).

All included workers had low back pain, with 60 (58.3%) workers had continuous pain and 43 (41.7%) had intermittent pain. The highest frequency of workers (38.8%) had right side sciatica, 35 workers (34.1%) had left side sciatica, bilateral sciatica was found in 22 workers (21.4%) and 6 workers (5.8%) had no sciatica (Table 2).

Other symptoms related to low back pain and sciatica are shown in Table 2. Anxiety was experienced among the majority of workers (80.6%). Irritability and short temperedness were found in high per cent (68.9%) of participants. Mood changes were present in 63.1% of workers. Most workers (90.3%) experienced back pain during their activities and a relatively high percentage (55.3%) experienced back pain at rest.

Table 3 shows distribution of workers according to the degree of disability due to back pain. The majority of workers suffered moderate to severe disability (75.7%). Minimal disability was reported among 17.5%, 5 workers (4.9%) were crippled and two workers were bedridden.

3.2. MRI findings

3.2.1. Grades of disc degeneration among studied workers

The majority of workers had grade IV (73.8%) and grade V (59.2%) disc degeneration, followed by grade III discs in 26.2% and grade II in 10.7% and the least frequency belonged to grade I (6.8%) (Table 4).

3.2.2. Disc herniation

Reduced disc space height was detected in all studied workers (n = 103; 100%) which was commonly reduced at the level of L4/L5 in 92 (89.3%) workers and at L5/S1 in 79 (76.7%) workers. The least frequency was detected at L3/ L4 in 23 (22.3%) workers. and bulging of the disc was found in 81 (78.6%) workers, commonly at the level of L4/L5 in 54 (52.4%) workers and at L5/S1 in 35 (34%) workers, with the least frequency reported at L3/L4 in 11 (10.7%) workers. All disc bulges were diffuse except at 9 levels where they were centrolateral. Protrusion of disc was detected in

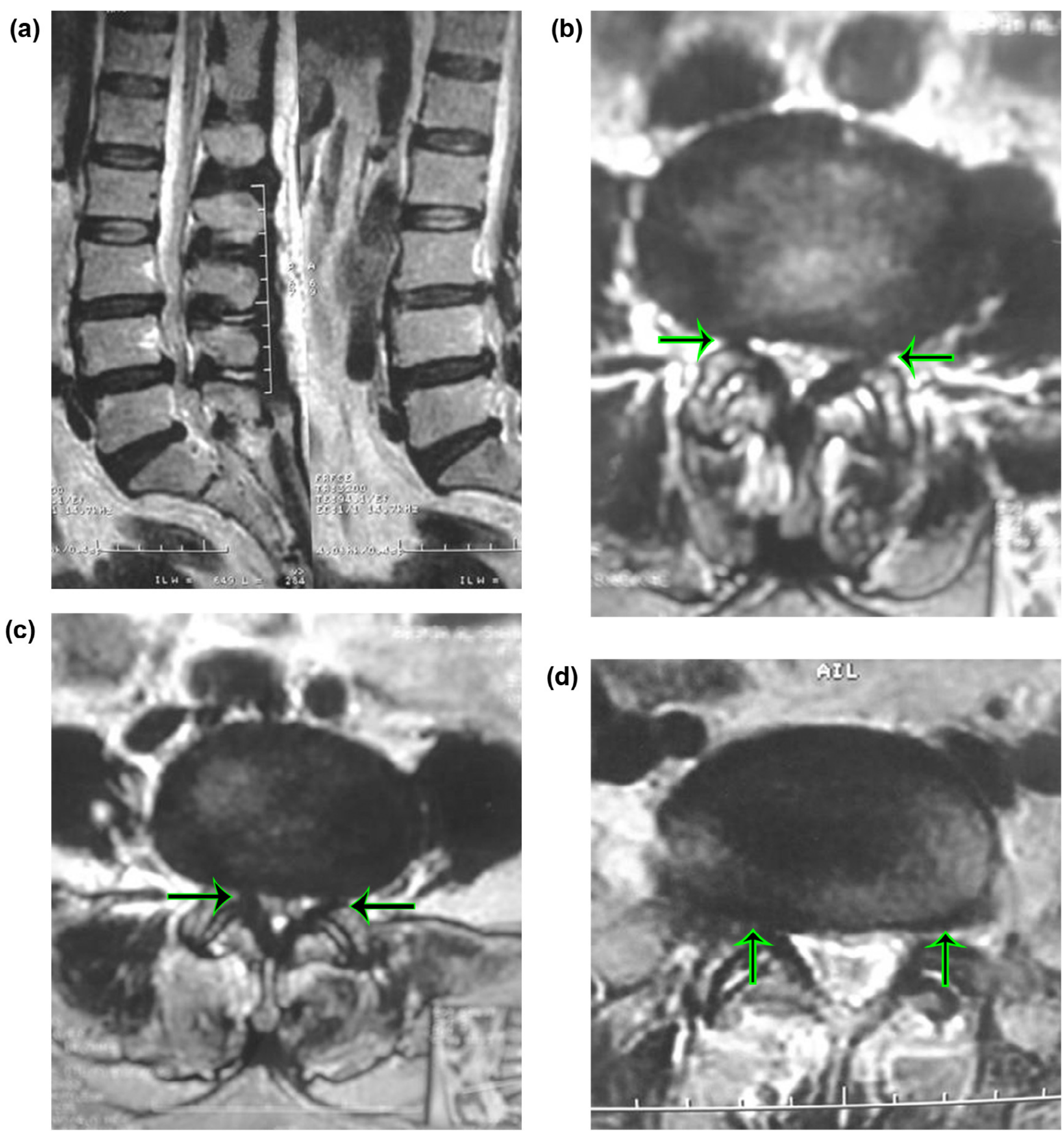

Fig. 3. (a) Sagittal T2 WI shows degenerative changes of IVD (Grade III). (b) Axial T2 WI at level of L3/4 shows diffuse posterior disc bulge compressing the ventral thecal aspect with compression and deviation of both nerve roots (Grade III). (c) Axial T2 WI at level of L4/5 shows diffuse posterior disc bulge compressing the ventral thecal aspect with compression and deviation of both nerve roots in between the disc and facet joints (Grade III). (d) Axial T2 WI at level of L5/S1 shows diffuse posterior disc bulge touching the ventral thecal aspect with compression of both nerve roots and deviation of right one (Grade II - III).

74 (71.8%) workers, most commonly at level of L4/L5 in 41 (39.8%) workers and at L5/S1 in 37 (35.9%) workers, with 8.7% at L3/L4. Central disc protrusion was found in 43 workers and centrolateral in 28 workers and it was far lateral in 3 workers. Disc extrusion was found in 22 (21.4%) workers, most commonly at level of L5/S1 in 15 (14.6%) workers, at L4/L5 in 9 (8.7%) workers, and at L3/L4 in two workers (1.9%). Disc extrusion was centrolateral in 14 workers and central in 8 workers (Table 5).

Nerve roots compromise was detected in 89 (86.4%) workers, most commonly at the level of L4/L5 in 68 (66.1%) workers and at L5/S1 in 41 (39.8%) workers with the least frequency reported at L3/ L4 in 5(4.9%) workers (Table 5).

3.2.3. Grading of nerve root compromise in the study population

A total of 250 nerve roots were assessed on MR images. By consensus of all observers, 17 nerve roots (6.8%) were normal, 33 (13.2%) were in contact with disc material, 120 (48%) were deviated dorsally, and 80 (32%) were compressed (Table 6).

During surgery 98 lumbar nerve roots were evaluated, of them 27 (27.6%) nerve roots were classified as normal or in contact with disc material, 24 (24.5%) were classified as deviated, and 47 (48%) were classified as compressed.

The correlation of MR image-based grades with surgical grades is shown in Table 7. The Spearman correlation coefficient was high ($r = 0.89$, $P < 0.0001$). In one nerve root which was graded on the

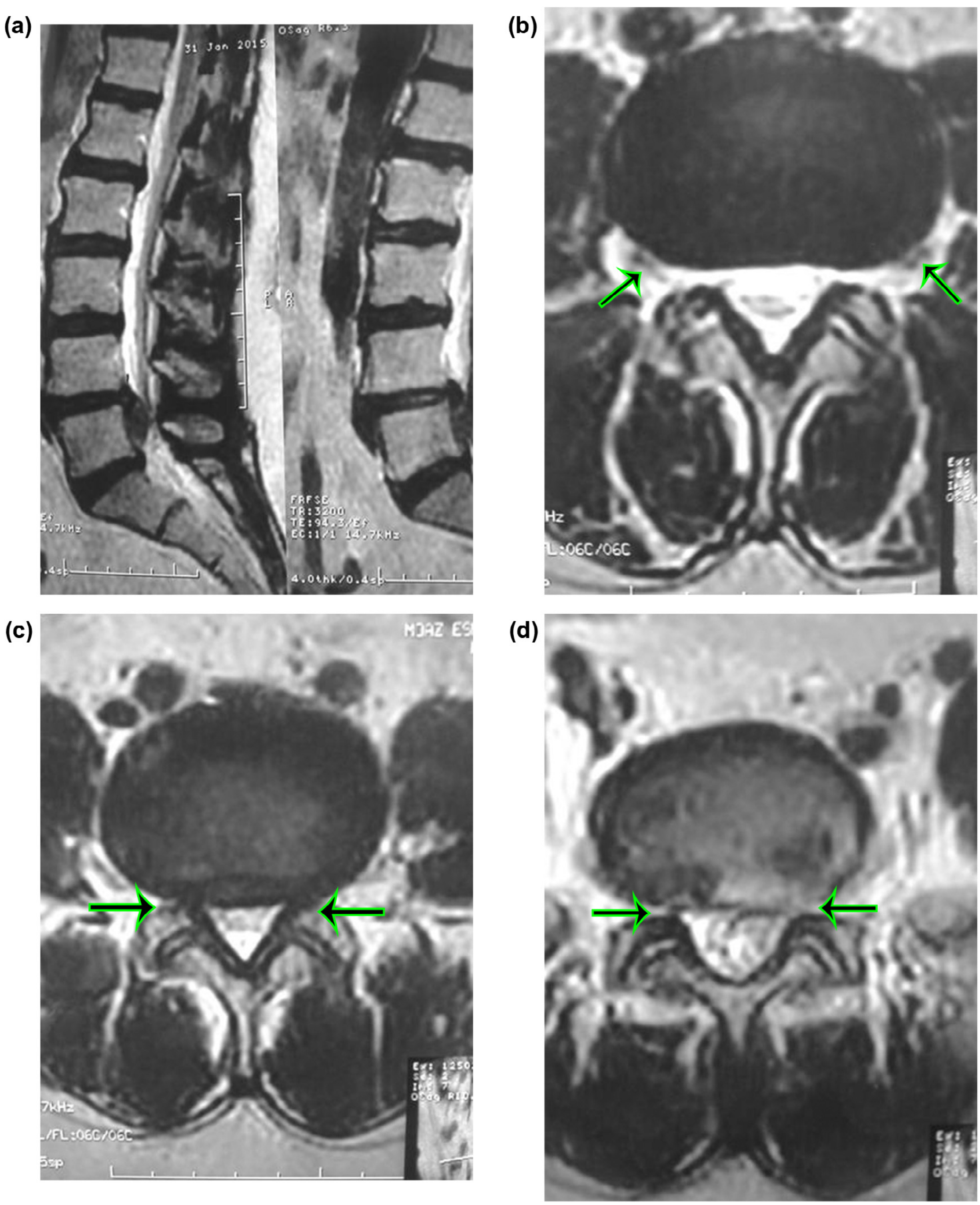

Fig. 4. (a) Sagittal T2 WI shows degenerative changes grade V of IVD. (b) Axial T2 WI at level of L3/4 shows loss of posterior concavity of the disc with normal nerve roots and no evidence of thecal sac compression. (c) Axial T2 WI at level of L4/5 shows posterior disc herniation with caudal migration (extrusion) compressing the ventral thecal aspect with compression and deviation of both nerve roots (Grade III). (d) Axial T2 WI at level of L5/S1 shows diffuse posterior disc bulge touching the ventral thecal aspect and compressing both exit nerve roots (Grade II).

MRI as deviated, surgery revealed normal or contact. In two nerve roots, compression was detected in one of them and the other was normal on the MR I, while deviation was found at surgery. At surgery 3 nerve roots were found compressed, while two of them were found to be deviated and one was in contact with the disc on the MR image.

Pre-surgical analysis and 3 months Post-surgical analysis by VAS and ODI within the surgical group are shown in Table 8. There were significant relief of pain (the mean value of VAS was 63.25 mm pre-surgical versus 10.23 mm post-surgical, $P < 0.0001$) and improvement in functional abilities and leisure time activities as assessed by ODI (57.62% pre-surgical versus 18.50% post-surgical, $P < 0.001$).

4. Discussion

The prevalence and disability associated with disc degeneration are rising. Lumbar disc degeneration is the most frequent cause of low back pain all over the world with disc herniation being the major aspect of disc degeneration. MRI scans allow an excellent noninvasive method of imaging to the lumbar spine. Its sensitivity, contrast, and multi planer images allow clarification of disc anatomy [12].

Our results revealed that most of workers were ⩽ 40 years old (73.8%) and the least ratio (7.8%) was found to be among the age group of 51 years and more. This could be explained by the higher levels of power the young people have as the construction work demands elevated levels of physical power. These findings were consistent with other studies [13–15].

Regarding gender and low back pain, all subjects in this study were male as also found in other studies [14–16].

In this study workers suffered from physical problems such as disturbances in balance and limping as an effect of low back pain. These findings corresponded with other studies which reported asymmetrical gait pattern (limping) during walking in patients with chronic low back pain [17,18]. The limping during walking

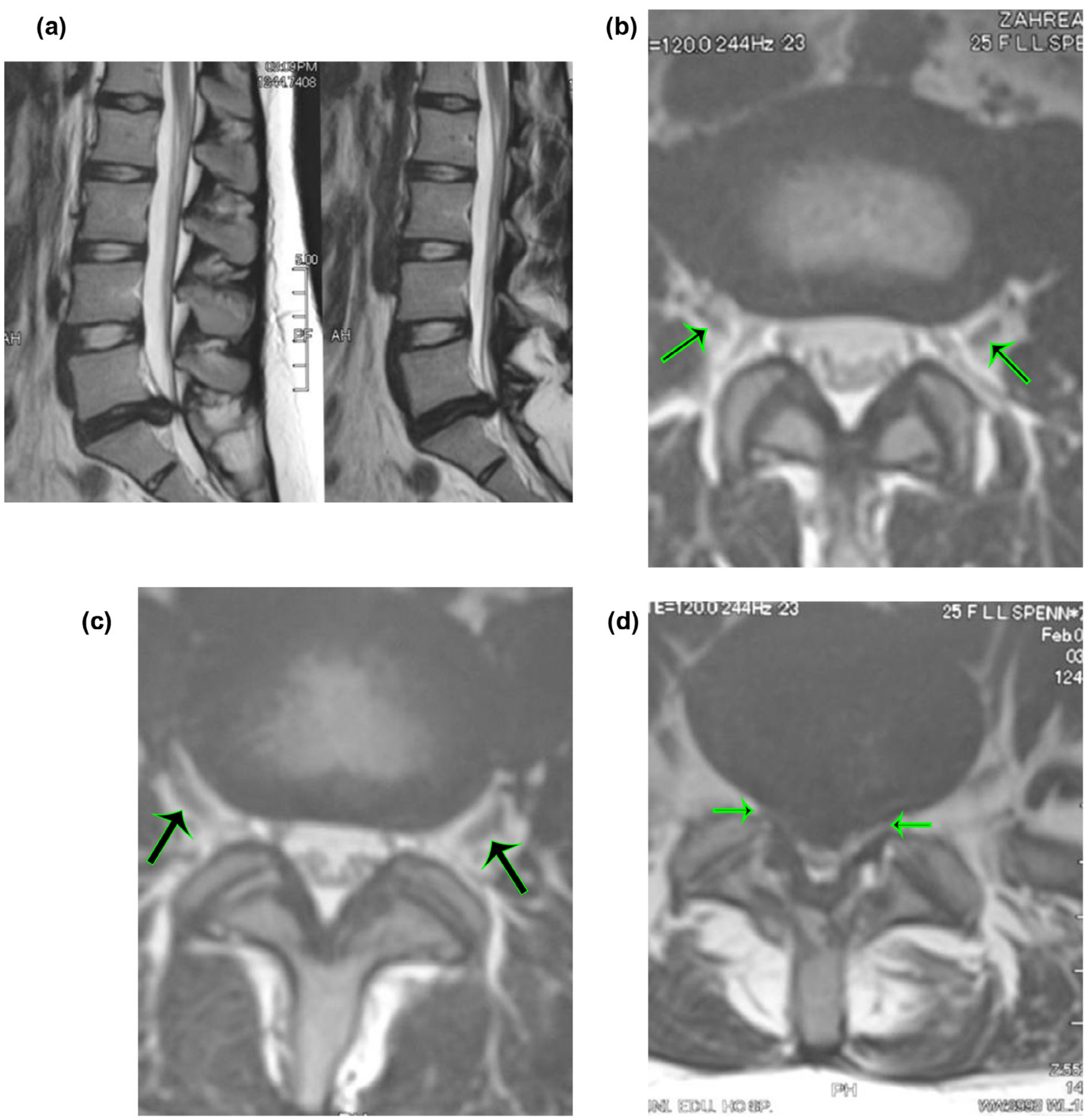

Fig. 5. (a) Sagittal T2 WI shows degenerative changes of L5/S1 IVD grade V. (b) Axial T2 WI at level of L3/4 shows normal contour of the disc with no disc bulge and no evidence of thecal sac or nerve root compression. (c) Axial T2 WI at level of L4/5 shows just loss of posterior concavity of the disc touching the ventral thecal aspect with normal both nerve roots. (d) Axial T2 WI at level of L5/S1 shows central and right paracentral posterior disc prolapse indenting the ventral thecal aspect with compression and deviation of both exit nerve roots more on the right side (Grade III).

may avoid painful action and change the spinal posture to decrease back pain. Mientjes and Frank [19] stated that patients with low back pain reported swinging in their trunks and extended their knees much less as a guarding action relative to healthy people.

Our results recognized that workers had visceral deficits such as difficulties in urination and voiding stool and also they had stomach and abdominal problems. This agreed with Leino and Magni [20] who reported that low back pain may cause abdominal and musculoskeletal complaints.

The current study reported that workers had emotional problems such as anxiety, irritability, short-temperedness, and mood changes as a result of low back pain. This result was similar to that reported by Julie and George [21,22] who recorded that anxiety, depression and fear-avoidance beliefs have been associated with disability as a result of low back pain.

The current study reported that the majority of workers (90.3%) suffered low back pain during work activities and at rest (55.3%) and that pain affected their sleep (70.9%) and sex life (30.1%). This limited their functional activities. This corresponded with a previous study [13].

Our results confirmed that the majority of workers suffered from moderate to severe disability (75.7%). Minimal disability was reported among 17.5%, 5 workers (4.9%) were crippled and two workers were bedridden.

These findings were supported by Arndt et al. [14] who found that the main causes for occupational disability were musculoskeletal disorders, cardiovascular diseases, neoplasms and mental disorders. Dorsal pain represented the majority of all musculoskeletal disorders with intervertebral disc disorders and spondylosis as major causes, although musculoskeletal disorders were the most important cause of disability in all age categories.

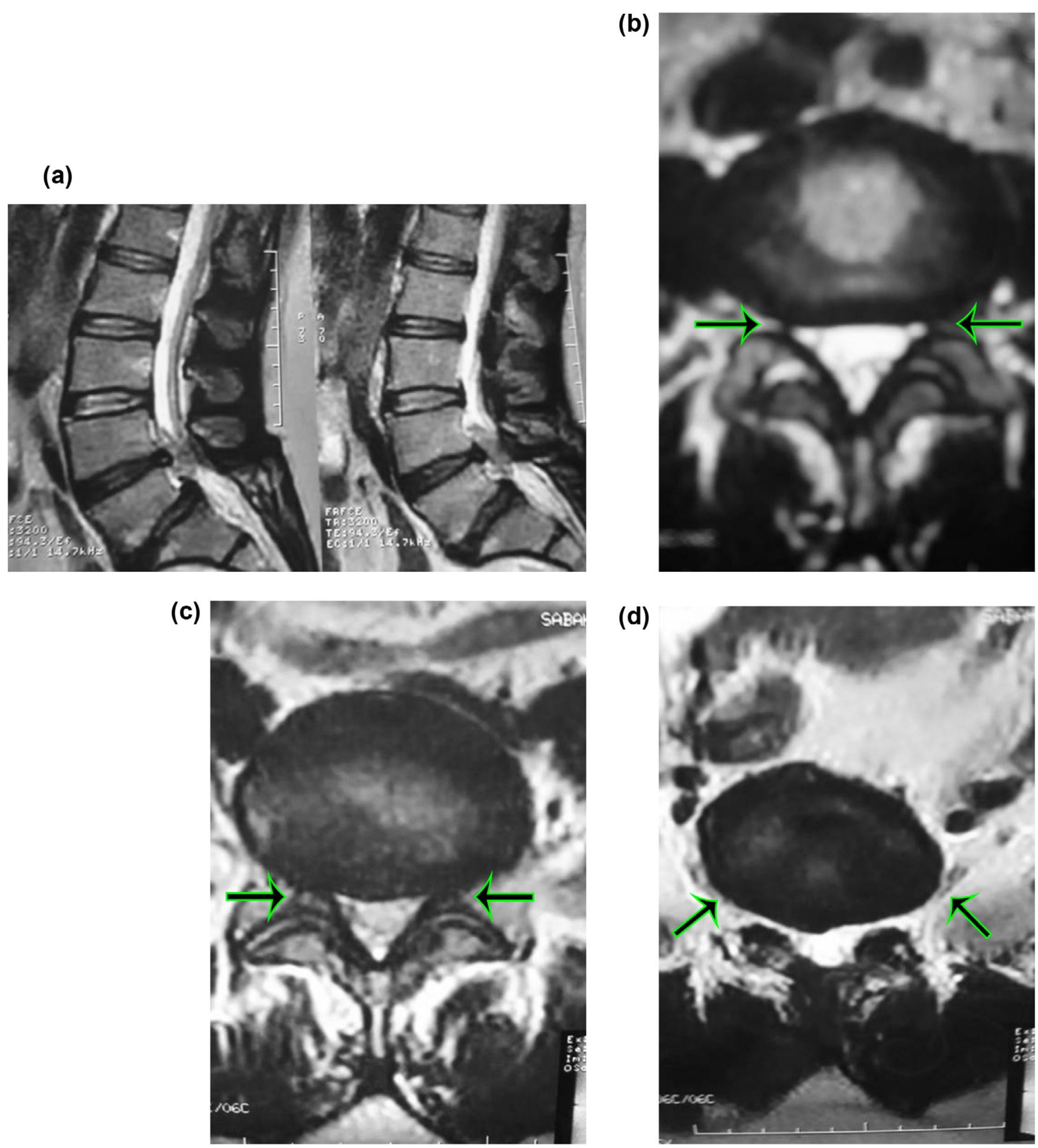

Fig. 6. (a) Sagittal T2 WI shows degenerative changes of L4/5 & L5/S1 IVD (Grade IV). (b) Axial T2 WI at level of L3/4 shows loss of posterior concavity of the disc touching the ventral thecal aspect and both exit nerve roots (Grade I). (c) Axial T2 WI at level of L4/5 shows diffuse posterior disc bulge compressing the ventral thecal aspect with compression and deviation of both nerve roots (Grade III). (d) Axial T2 WI at level of L5/S1 shows focal right paracentral posterior disc protrusion mildly indenting the ventral thecal aspect with normal both nerve roots (Grade 0).

In the current study, reduced disc space height was detected in all studied workers (n = 103; 100%) which was commonly reduced at the level of L4/L5 in 92 (89.3%) workers and at L5/S1 in 79 (76.7%) workers. The least frequency was detected at L3/L4 in 23 (22.3%) workers. Bulging of the disc was found in 81 (78.6%) workers, commonly at the level of L4/L5 in 54 (52.4%) workers and at L5/S1 in 35 (34.1%) workers, with the least frequency reported at L3/L4 in 11(10.7%) workers. All disc bulges were diffuse except at 9 levels where they were centrolateral. Protrusion of disc was detected in 74 (71.8%) workers, most commonly at level of L4/L5 in 41 (39.8%) workers and at L5/S1 in 37 (35.9%) workers, with 8.7% at L3/L4. Central disc protrusion was found in 43 workers and centrolateral in 28 workers and it was far lateral in 3 workers. Disc extrusion was found in 22 (21.4%) workers, most commonly at level of L5/S1 in 15 (14.6%) workers, at L4/L5 in 9 (8.7%) workers, and at L3/L4 in two workers (1.9%). Disc extrusion was centrolateral in 14 workers and central in 8 workers.

These results agreed with a previous study [12] which assessed MRI findings in 109 symptomatic patients with lumbar disc herniation.

In the current study a total of 250 nerve roots were evaluated on MR images for the presence and degree of nerve root compromise. Nerve root compromise was found in 89 (86.4%) workers; the commonest occurrence was found at the level of L4/L5 in 68 (66.1%) workers and at L5/S1 in 41 (39.8%) workers with the least frequency reported at L3/ L4 in 5(4.9%) workers. By consensus of all observers, 17 nerve roots (6.8%) were normal, 33 (13.2%) were in contact with disc material, 120 (48%) were deviated dorsally, and 80 (32%) were compressed.

These results were similar to those found by Saleem et al. [12] who found that spinal nerves were compromised in 89 (81.7%) symptomatic patients, most commonly at L4/L5 (45.9%) and L5/S1 (38.5%).

Also our results were confirmed by Boos et al. [23] who showed that the only morphologic distinction between symptomatic patients and asymptomatic controls was the presence of nerve root compromise (83% in patients versus 22% in control).

Debois et al. [24] and Beattie et al. [25] supported our results by reporting that nerve root compromise has a more significant role in explaining pain than morphologic extension of disc material outside intervertebral space does.

In the current study, by consensus of all observers, 17 nerve roots (6.8%) were normal, 33 (13.2%) were in contact with disc material, 120 (48%) were dislocated dorsally, and 80 (32%) were compressed.

In contrast to our results Pfirrmann et al. [4], who assessed 500 nerve roots on MR images for compromise in 250 patients with

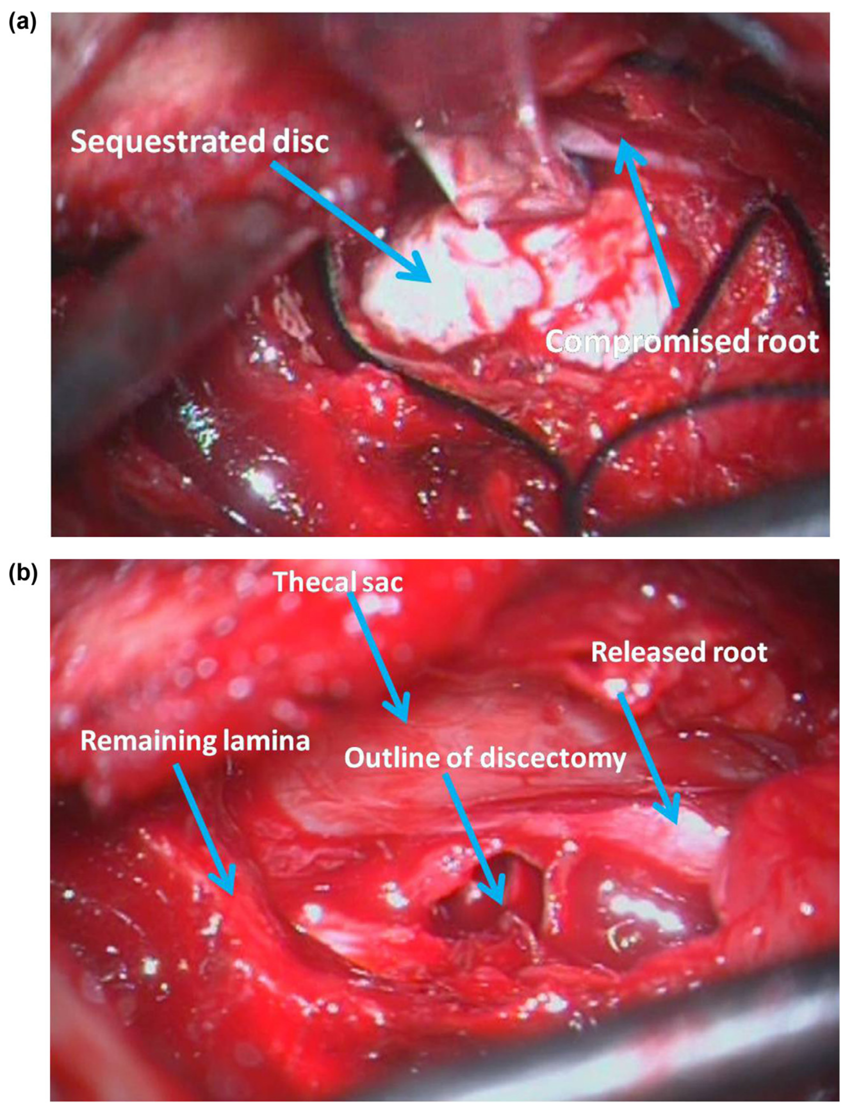

Fig. 7. (a) Intra-operative view showing sequestrated disc fragment with nerve root compression and deviation (Grade III). (b) Intra-operative microscopic view of discectomy showing root freeing and decreased disc hump.

disc herniation, found that the majority of nerve roots (42%) were normal, 21% were in contact, 10% were deviated dorsally, and 27% were compressed. This difference might be explained by different sample size and selection between the two studies.

In this study, 98 lumbar nerve roots were surgically assessed for compromise, of them 27 (27.6%) were normal or in contact with disc material, 24 (24.5%) were deviated, and 47 (48%) were compressed with high Spearman correlation coefficient between MR image-based grades and surgical grades ($r = 0.89$, $P < 0.0001$).

Our results were similar to those found by Pfirrmann et al. [4] who found that during surgery, 30 (32%) of 94 nerve roots were normal or in contact with disc material, 14 (15%) were deviated, and 50 (53%) were compressed with high Spearman correlation coefficient between surgical grades and MR image-based grades ($r = 0.86$, $P < 0.001$).

The limitations of our study were that construction workers are difficult to study because they commonly change work place, are often hired for short-term appointments and commonly change employers, therefore disturbing the study sample throughout data collection. Also surgical assessment of nerve root compromise was restricted by the close proximity of the nerve root and intervertebral disc (Figs. 1–7).

5. Conclusion

Disability of occupational-related disc degeneration is a grave health problem between construction workers. MR imaging is a reliable tool for grading nerve root compromise in lumbar disc degeneration. Nerve root compromise is a significant factor to explain pain than the morphologic extension of disc material outside the intervertebral space.

Conflict of interest

There is no relevant potential conflict of interest.

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