Orthopaedics & Traumatology: Surgery & Research 105 (2019) 713–718

Contents lists available at ScienceDirect

Orthopaedics & Traumatology: Surgery & Research

journal homepage: www.elsevier.com

Original article

Immediate and late discal lesions on MRI in Magerl A thoracolumbar fracture: Analysis of 76 cases

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ARTICLE INFO

Article history:
Received 21 September 2018
Accepted 14 March 2019

Keywords:
Thoracolumbar fracture
Intervertebral disc
MRI
Discal lesion
Disc degeneration

ABSTRACT

Introduction: Magerl type A thoracolumbar fracture is frequent, but consensus is lacking on management, which ranges from non-operative treatment to corpectomy. It is, however, essential to spare adjacent discs in young patients. Historically, Magerl defined type A fracture in terms of isolated bone involvement. Subsequently, several authors suggested that discal lesions are associated, but results were inconsistent. The present study assessed the presence of immediate post-trauma discal lesions and late degeneration.
Hypothesis: Type A fracture does not entail discal lesion.
Material and method: Fifty-four patients with type A fracture and immediate post-trauma MRI (76 fractures, 138 discs) were retrospectively reviewed. Twenty-seven also had follow-up MRI at a mean 32 months. Two observers analyzed adjacent discs on Oner's classification, on the immediate post-trauma MRI, and on follow-up MRI to assess disc degeneration.
Results: Immediate post-trauma analysis of the cranial discs of the fractured vertebrae found 81% normal (type 1), none type 2, 7% type 3, 4% type 4, 7% type 5 and 1% type 6. Caudal discs were 97% type 1. Analysis at follow-up found degeneration in only 15% of cranial and 9% of caudal discs.
Discussion: A large majority of type A fractures lead to no immediate discal lesions, and only 15% of cranial discs subsequently degenerate. MRI analyzing disc signal and morphology is essential before removing material.
Level of evidence: IV, retrospective study.

1. Introduction

Magerl classified thoracolumbar fracture in 3 types [1–3]. In types B and C, treatment is agreed to be vertebral fusion; in type A, which is the most frequent, on the other hand, consensus is lacking and management ranges from brace to corpectomy [4–6]. Sparing the disc spaces, however, is crucial, and determining whether there is a discal lesion adjacent to the fractured vertebra seems to us to be an essential factor guiding treatment.

Historically, type A fracture was seen as a bone lesion [2]. However, several studies reported regional angulation correction loss at follow-up [7–9]. On average, 75% of correction loss concerned the disc space, and 25% the vertebral body. The conclusion to be drawn was that there was a discal lesion.

Several teams used MRI to study adjacent disc status, with contrasting findings. In 1998, Oner et al. analyzed adjacent discs on MRI in 75 fractures, and described a classification in 6 types of discal lesion [10]. They concluded that thoracolumbar fracture is frequently associated with discal lesion. However, this was a retrospective study on follow-up MRI, and 17 of the 75 fractures were type B, where there is known often to be discal lesion. In 2013, the same team reported 21 type A3 fractures managed by internal fixation [11]. MRI performed post-trauma and at material removal 12–18 weeks postoperatively found initially healthy discs, with only 13% progressing to degeneration. Wang et al. performed a similar study on 26 type A fractures [12], and found 92% overlying disc degeneration on Pfirrmann's MRI classification [13]. In contrast, Alanay et al. analyzed MRI scans in 15 A3 fractures and found morphologic alteration but no signal abnormality [14]. And finally, in 2015, Loriaut et al., analyzing 95 type A fractures [15], found no post-trauma loss of disc height or change in MRI signal in adjacent discs.

Thus, neither immediate post-trauma disc lesion nor progression toward degeneration is clearly established in type A fracture.

The present study of type A fracture assessed:

- the rate of immediate post-trauma discal lesion adjacent to the fracture;

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https://doi.org/10.1016/j.otsr.2019.03.008
1877-0568/

- disc degeneration during follow-up, and;
- risk factors for discal lesion.

2. Material and method

A retrospective study was conducted on adult patients managed in our department between January 2007 and September 2017 for type A thoracolumbar fracture confirmed on CT. Fractures of type B or C, on ankylosed spine, above T5 or lower than L5 or of osteoporotic origin (low-energy trauma or known osteoporosis) were excluded. Inclusion required immediate post-trauma MRI of the injured region. Fifty-four patients (36 male, 18 female; mean age, 44 years) were included, for 76 fractures. Twenty-seven (34 fractures) also had follow-up MRI at a mean 32.4 months. Twelve were managed by 6 weeks' brace immobilization; 42 were operated on for reduction and percutaneous ($n = 9$) or open ($n = 33$) internal fixation without fusion. After consolidation confirmed on CT, material was removed at 9–12 months.

The usual demographic data were collected, plus number of fractured vertebrae and of adjacent discs, lesion level, and Magerl/AO fracture type [2,3]. Lateral X-ray measured local kyphosis (LK), defined as the angle between the superior and inferior endplates of the fractured vertebra, and regional kyphosis (RK), defined as the angle between the superior endplate of the overlying vertebra and inferior endplate of the underlying vertebra. Traumatic regional angulation (TRA) was defined as RK minus the expected physiological angulation (PA): TRA = RK – PA. PA values were those reported by Guigui et al. [16].

Two observers independently analyzed adjacent disc status on post-trauma MRI T2-weighted sagittal slices. The chosen sagittal slice was that passing through the middle of the vertebral spinous process on axial slice. Discs were classified following Oner (Fig. 1):

- type 1: normal disc;
- type 2: "Black" disc with normal morphology and diffuse signal loss;
- type 3: equivalent to small Schmorl hernia without change in signal or disc height;
- type 4: anterior discal subsidence with unchanged middle and posterior sections and no change in signal;

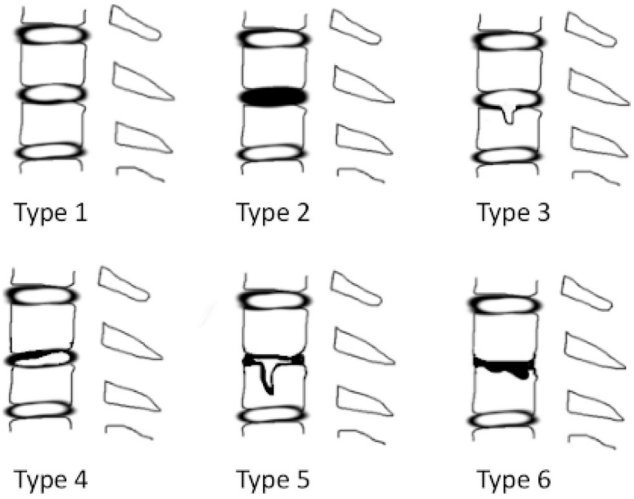

Fig. 1. Oner classification.

- type 5: large central hernia through superior endplate, causing height loss and some contact between adjacent vertebral plates; no signal change;
- type 6: loss of disc height and "black" disc in all 3 sections.

On this classification, only types 2 and 6 associate changes in both morphology and signal intensity, indicating disc degeneration.

The same analysis was performed in the 27 patients with follow-up MRI, to assess disk stability or degeneration.

Age, gender, LK, TRA and fracture type (A1, A2, A3) were assessed as potential risk factors for immediate (t0) or late (t1) discal lesion.

Statistical analysis used Fisher exact test for qualitative variables and Wilcoxon test for quantitative variables (due to non-normal distribution). The significance threshold was set at $p < 0.05$. The Cohen kappa coefficient was used to assess inter-observer variation.

3. Results

Seventy-six fractures were analyzed on post-trauma MRI, at a mean 0.5 months, for 138 adjacent discs. Thirty-nine patients had 1 fracture, 10 had 2 fractures, 3 had 3 and 2 had 4.

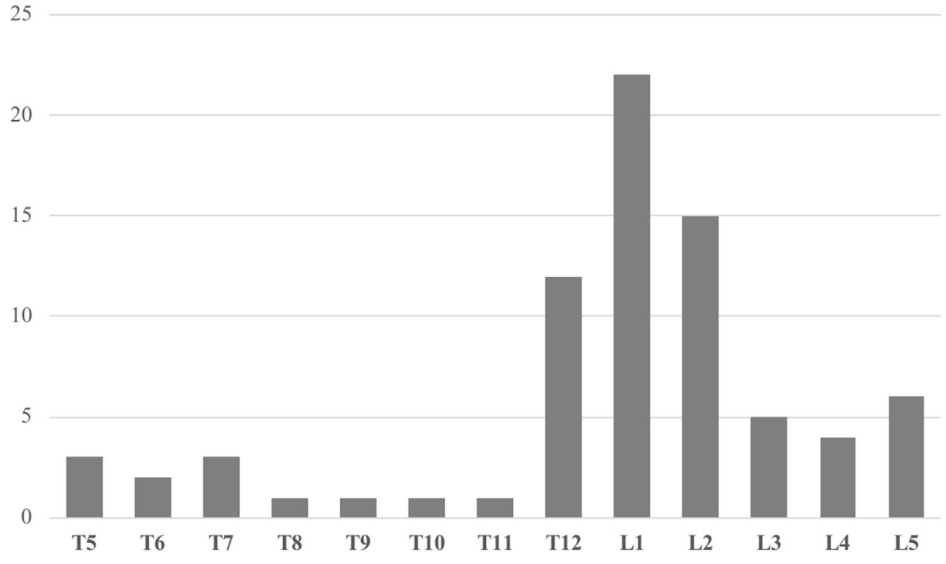

Fig. 2. Histogram of involved levels.

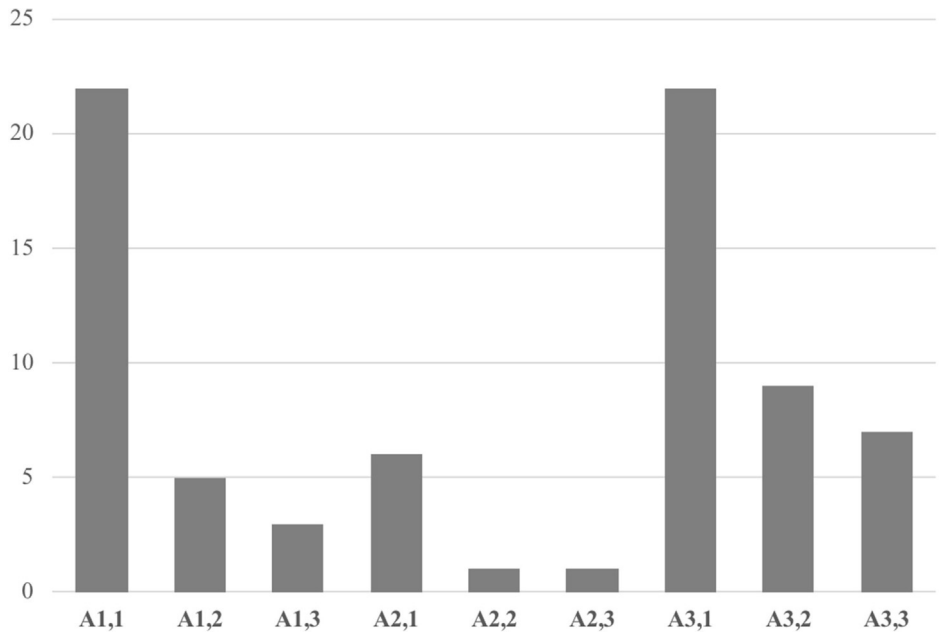

Fig. 3. Histogram of fracture types on Magerl/AO classification.

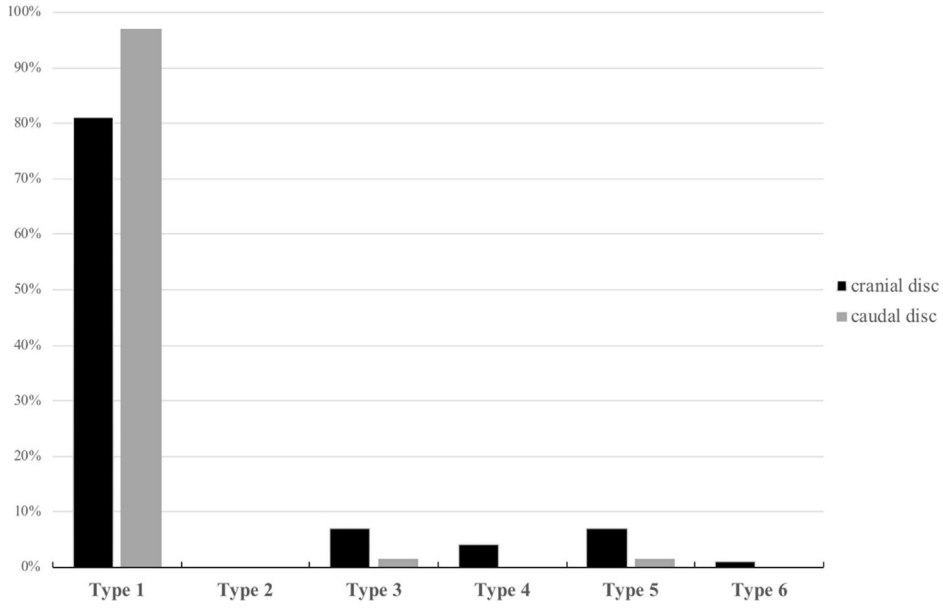

Fig. 4. Histogram of disc type on Oner classification, immediate post-trauma.

Twenty-seven had follow-up MRI, at a mean 32.4 months, for 64 discs adjacent to 34 fractures. Figs. 2 and 3 show lesion levels and Magerl/AO fracture type. Mean LK and TRA were respectively +19.3° and +14.6° preoperatively and +6.4° and +4.8° postoperatively. Oner score reproducibility was satisfactory: kappa = 0.74.

3.1. Adjacent discs at immediate post-trauma

One hundred and thirty eight discs were analyzed. Eighty-one percent of cranial discs were type 1 (normal), none type 2, 7% type 3, 4% type 4, 7% type 5 and 1% type 6. Ninety-seven percent of caudal discs were type 1 and 1.5% type 3 or 5 (Fig. 4).

3.2. Adjacent discs at follow-up

Twenty-seven patients had both immediate and follow-up MRI, for 64 discs.

Fifty-six percent of cranial discs were type 1, 3% type 2, 14% type 3, 3% type 4, and 12% type 5 or 6 (Fig. 5). Eighty-two percent of caudal discs were type 1, 9% type 2, 3% type 3 and 6% type 5, with no types 4 or 6 (Fig. 6).

3.3. Risk factors for discal lesion

Statistical analysis found no predictive factors for immediate post-trauma discal lesion. Magerl type A2 or A3 did not emerge as a risk factor for immediate or follow-up discal lesion. Male gender was a risk factor for late cranial disc lesion (Table 1).

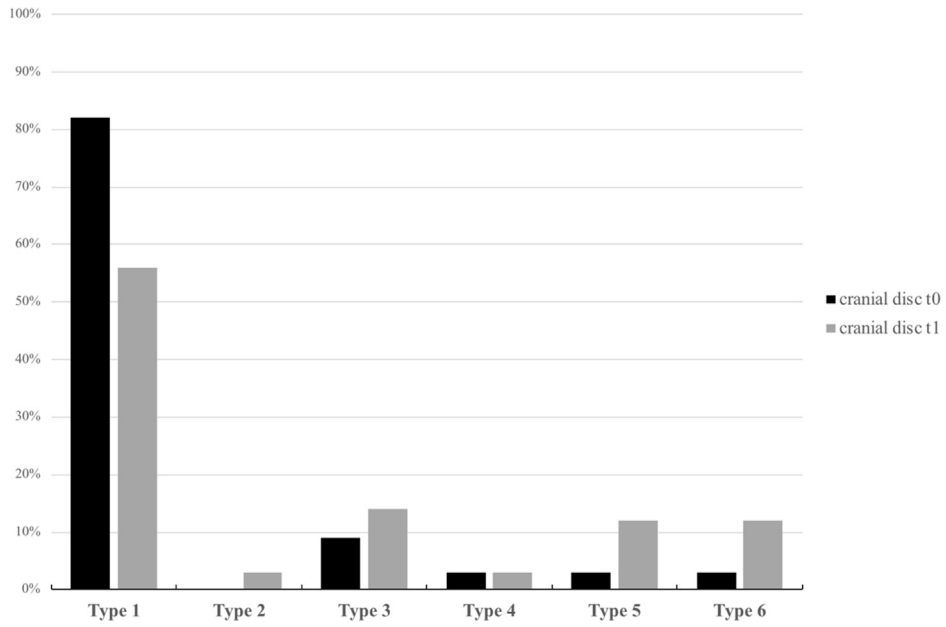

Fig. 5. Histogram of cranial disc progression on MRI from immediate post-trauma (t0) to follow-up (t1).

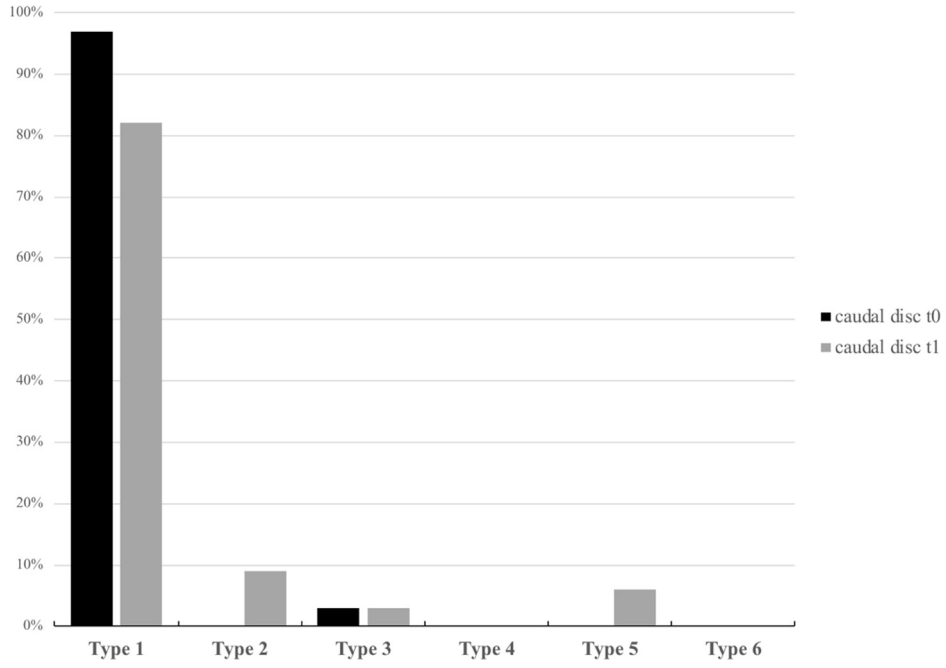

Fig. 6. Histogram of caudal disc progression on MRI from immediate post-trauma (t0) to follow-up (t1).

4. Discussion

The present retrospective series confirmed the low rate of discal lesion immediately following type A thoracolumbar fracture, with 81% and 97% normal over- and under-lying discs, respectively. Ghanem et al. also addressed this question, but with less clear-cut findings [17]. They reported signal change in most adjacent discs, but showed that some had abnormal MRI with no lesion on discography. They included types A and B, in a sample of only 54 discs. The present series had the strong point of focusing exclusively on type A, with 138 discs on immediate post-trauma analysis.

Disc degeneration at follow-up was also analyzed. On Oner's classification, this is associated with morphologic and with signal intensity changes [10]. However, we consider isolated morphologic or signal intensity change (Oner types 3, 4 and 5) insufficient to determine disc degeneration; only types 2 and 6, equivalent to Pfirmann grades 4 and 5, defined by loss of signal intensity associated with disc space collapse, correspond to disc degeneration [13].

On follow-up MRI, only 15% of cranial and 9% of caudal discs progressed to type 2 or 6. This is in agreement with Fürderer et al., who reported 81% of discs with normal signal both initially and at a mean 10 months [18].

To explain this post-traumatic disc degeneration, in-vitro studies were performed on intra-discal circulation to identify factors for disc nutrition. One hypothesis was that vertebral plate calcification reduces nutrient input, the disc being an avascular structure. Reduced oxygen and glucose levels and increased lactic acid

Table 1
p-values for clinical and radiological parameters.

	Age[a]	Gender(M)[b]	LK[a]	TRA[a]	A1[c]	A2[c]	A3[c]
Cranial lesion (t0)	0.27	0.73	0.30	0.38	1.00	1.00	0.38
Caudal lesion (t0)	0.71	0.55	0.65	0.37	1.00	1.00	1.00
Cranial lesion (t1)	0.64	0.02*	0.45	0.60	0.27	0.47	0.91
Caudal lesion (t1)	0.25	0.66	1.00	0.06	1.00	1.00	0.38

Asterisk (*) represents significant difference. LK: local kyphosis; TRA: traumatic regional angulation.
[a] Wilcoxon test.
[b] Fisher exact test.
[c] logistic regression.

levels in the nucleus induce cell death, lower matrix production, and hence disc degeneration [19].

No clinical or radiological factors emerged for immediate post-trauma discal lesion. Fracture type (A1, A2 or A3) was non-predictive both immediately and at follow-up. Males, however, showed significantly greater risk of late discal lesion, in agreement with other reports of greater male prevalence for disc degeneration [20].

One limitation of the present study was that pre-trauma disc status was unknown; certain lesions seen on MRI may have preceded trauma. Many studies reported disc degeneration rates of between 6% and 20% in asymptomatic subjects, with age correlating with degeneration: 40% prevalence before 30 and up to 90% after 50 years of age [21,22]. This limitation was unavoidable, as no pre-trauma MRIs were available, and so pre-trauma lesions cannot be ruled out.

Given these findings of a large majority of cases without discal lesion immediately after type A fracture and the low rate of long-term degeneration, the correction loss observed at follow-up seems related to defective superior endplate elevation and secondary slippage of a healthy disc into the residual depression. In the absence of major bone destruction, it seems to us to be logical to associate vertebral body expansion to posterior fixation so as to restore angulation and maintain it until consolidation has been achieved, avoiding disc "intrusion" and secondary correction loss. Material removal should be proposed after consolidation. Several studies showed that lumbar spine segmental motion can be restored after material removal [23,24]. This would also avoid material breakage and adjacent segment injury. MRI should be performed in advance to analyze the adjacent discs; this can be done with the fixation material in place, as new MRI sequences limit artifacts. If the discs are healthy, complete material removal can be proposed. In case of degeneration on MRI, two attitudes are possible: complete removal, informing the patient of the risk of secondary low-back pain, or removal associated to segmental fusion at lesion level.

Secondary corpectomy may be considered in case of unfeasibility or insufficient reduction leading to intolerable kyphosis.

5. Conclusion

MRI is indispensable for initial assessment of thoracolumbar fracture, analysis of mobile element integrity (discs, ligaments) and screening for overlooked adjacent fractures. At follow-up, it is necessary for assessing the intervertebral disc.

Type A fracture is not associated with discal lesion in the vast majority of cases, either immediately or at follow-up. It seems logical if possible to prefer reconstruction techniques sparing the intervertebral discs, and to propose material removal after follow-up MRI. Long-term disc progression and the correlation between degeneration and functional signs remain to be analyzed.

Disclosure of interest

The authors declare that they have no competing interest.

Funding

None.

Contributions

Nicolas Barut: inclusion of patients, data collection, article writing.
Laura Marie-Hardy: data collection.
Raphael Bonaccorsi: inclusion of patients.
Marc Khalifé: statistics.
Hugues Pascal-Moussellard: supervision of article.

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