

ORIGINAL**Accurate diagnosis of low back pain in adult elite athletes**

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Abstract : Background : There is few reports evaluated accurately the pain generator of low back pain in elite athletes. The purpose of this report was to show case series and to investigate the cause of unidentified low back pain of elite athletes. **Methods :** Twenty-three adult elite athletes consulted our sports spine clinic to seek a second opinion for low back pain between April 2013 and March 2016. Their cause of low back pain had not been identified by nearby doctor. Spine surgeons had diagnosed using diagnostic injection and STIR-MRI and the final diagnosis made by the spine surgeon were collected. **Results :** The mean age of 23 patients (16 male, 7 female) was 30.4 years. The most common sport played was baseball. The final diagnosis made by a spine surgeon was as follows : disc related low back pain (n = 12), facet joint arthritis (n = 5), vertebral endplate injury (n = 4), early-stage lumbar spondylolysis (n = 1), supraspinous ligament injury (n = 1). **Conclusions :** A thorough medical interview, careful physical examination, appropriate diagnostic imaging, and injection block examination can effectively identify the cause of low back pain. *J. Med. Invest.* 66:252-257, August, 2019

Keywords : low back pain, diagnosis, athlete, elite athlete, MRI

INTRODUCTION

Low back pain (LBP) is common complaint in total population (1), but also among athletes (2, 3). A lot of studies have reported that the prevalence of LBP is much higher in athletes compared to non-athletes (4, 5, 6). It was reported that more than 30% of athletes experience LBP during their carriers (7). Also in elite athletes, LBP is one of the most common causes of missed playing time. About 75% of elite athletes have one or more episodes of LBP (8, 9). It is said that the pathology most commonly associated with LBP in athletes is degenerative disc disease, disc herniation, and spondylolysis/spondylolisthesis (10).

Generally, it is not relatively difficult to diagnose LBP of athletes as disc herniation and spondylolysis/spondylolisthesis. However, some of them are in trouble with LBP the cause is unknown. The pain source may be often overlooked, and then it may be concern with their athletic carrier for elite athletes. Especially for elite athletes, it is important to specify what the cause of LBP is.

To our knowledge, there is little reports evaluated accurately the pain generator of LBP in elite athletes. The purpose of this report was to show case series and to investigate the cause of unidentified LBP of elite athletes.

MATERIALS AND METHODS

We experienced 23 adult elite athletes (16 male, 7 female) who consulted our sports spine clinic seeking a second opinion for unidentified LBP between April 2013 and Mar 2016. Data on age, gender, type of sport played were collected retrospectively from medical records. Experienced spine surgeons had diagnosed these patients through detailed medical interview, careful physical

examination, appropriate diagnostic imaging. As diagnostic imaging, we had taken plain X-ray in lumbar extension and flexion. And reconstructed sagittal, axial, and coronal computed tomography (CT) images were taken as needed. We also routinely performed T1- and T2-weighted magnetic resonance imaging (MRI) and short tau inversion recovery (STIR) imaging. STIR-MRI is particularly useful for detecting bone marrow edema (11). When images did not show obvious evidence of pathology, we performed diagnostic facet joint and disc block examination. And then, the final diagnosis was collected.

RESULTS

The mean age of the subjects was 30.4 ± 8.5 (20–54) years. The most common sport played was baseball. The final diagnosis made by a spine surgeon was as follows : disc related LBP (n = 12), facet joint arthritis (n = 5), vertebral endplate injury (n = 4), early-stage lumbar spondylolysis (n = 1), supraspinous ligament injury (n = 1). Table 1 shows the details of all cases.

CASES

We show 3 cases that were identified their pain source as disc related LBP, facet joint arthritis, vertebral endplate injury.

Case 1 : Disc related LBP

A 34-year old man, professional baseball player (outfielder), had felt sharp low back pain while playing baseball for several years. The pain would worsen during lumbar anteflexion. He had consulted several hospitals, and all doctors had diagnosed the deterioration of L5 spondylolysis. They had told him that he had to be performed operation to disappear his low back pain. Finally, he had consulted to our hospital. STIR-MRI revealed central lumbar disc herniation at the level of L3/4 and L4/5 (Fig 1). And high signal intensity zone (HIZ) had clearly appeared at posterior site of L4/5 disc. We had performed discography at these levels, and the strong replicative pain had occurred in L4/5 discography. The pain disappeared temporarily just after disc

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Table 1. Details of all cases

Case	Gender	Age	Sports	Level	final diagnosis
1	Male	34	Baseball	Professional	disc related low back pain
2	Female	33	Track field (hammer throw)	Olympic-level	facet joint arthritis
3	Male	34	Combined combative sports	Professional	vertebral endplate injury (Type 1 Modic change)
4	Male	20	Ice skate (short track)	Top amateur	vertebral endplate injury (Type 1 Modic change)
5	Male	22	Ice skate (short track)	Top amateur	facet joint arthritis
6	Male	54	Golf	Professional	vertebral endplate injury (Type 1 Modic change)
7	Female	21	Track field (hurdle)	Olympic-level	spondylolysis (early stage)
8	Female	26	Swimming (diving)	Olympic-level	disc related low back pain
9	Female	25	Ski (mogul)	Olympic-level	disc related low back pain
10	Male	33	Baseball	Top amateur	disc related low back pain
11	Male	29	Baseball	Top amateur	disc related low back pain
12	Female	30	Wrestling	Professional	vertebral endplate injury (Type 1 Modic change)
13	Male	40	Baseball	Professional	facet joint arthritis
14	Male	24	Baseball	Professional	disc related low back pain
15	Male	23	Baseball	Professional	disc related low back pain
16	Female	48	Dance (tap dance)	Professional	supraspinous ligament injury
17	Male	29	Baseball	Top amateur	disc related low back pain
18	Male	34	Baseball	Professional	disc related low back pain
19	Male	35	Baseball	Professional	disc related low back pain
20	Male	27	Baseball	Professional	facet joint arthritis
21	Male	36	Baseball	Professional	disc related low back pain
22	Male	22	Baseball	Professional	disc related low back pain
23	Female	21	Softball	Top amateur	facet joint arthritis

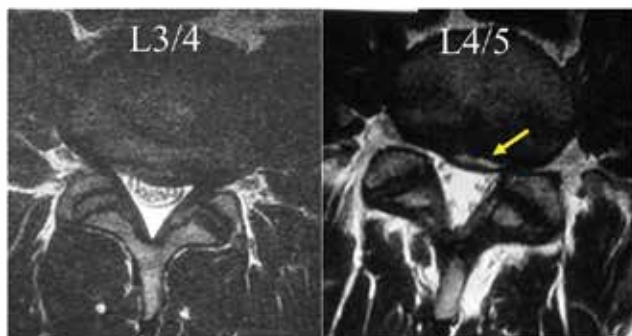


Figure 1. Axial view of STIR-MRI in case 1 (disc related LBP) HIZ had clearly appeared at posterior site of L4/5 disc (arrow).

injection using 1% lidocaine. And then, we could diagnose that the cause of his LBP was disc injury at L4/5. He underwent full endoscopic lumbar discectomy and thermal annuloplasty to HIZ area of L4/5 under local anesthesia (Fig 2). After surgery, his suffering LBP disappeared completely. Rehabilitation contained of core muscle training and lower leg stretching had done. Finally, he had returned professional baseball game with his full activity level.

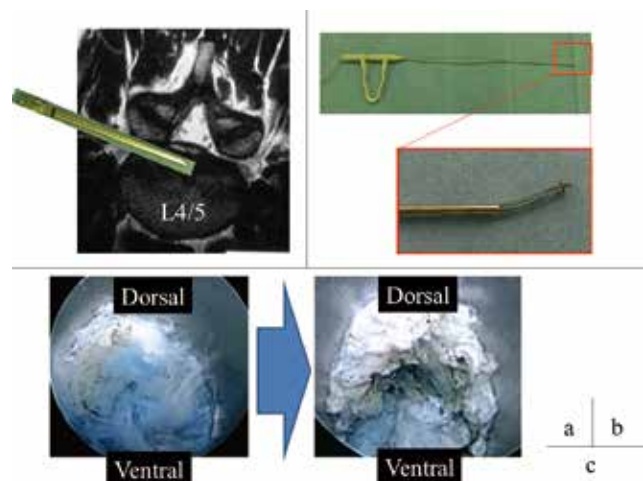


Figure 2. Percutaneous endoscopic surgery (Case 1)
 2-a. Percutaneous endoscopic lumbar discectomy and thermal annuloplasty to HIZ area of L4/5 was performed.
 2-b. The bipolar system was used in thermal annuloplasty.
 2-c. The blue stained herniation nucleus pulposus was removed and cauterized.

Case 2 : Facet joint arthritis

A 33-year-old female hammer throw athlete presented with several years history of LBP. First the pain occurred only while playing hammer throwing. She had consulted several hospitals, but doctors said the cause of her LBP was degenerative disc or psychogenic factors. She had consulted to our hospital to second opinion. At the first medical examination, she had LBP at the left side and the pain had increased during lumbar retroflexion and right rotation. T2 weighted mid-sagittal MRI showed the degenerative change and slight bulging at the level of L3/4, 4/5, 5/S (Fig 3). And left para-sagittal and axial MRI and axial CT showed lumbar lateral recess stenosis of L4/5 at left side because of facet hypertrophy and disc bulging (Fig 3). Her LBP disappeared temporarily after a facet joint injection, confirming a diagnosis of facet joint arthritis. After several facet injections, her LBP disappeared. She had rehabilitation including core muscle training. And finally she returned hammer throw national competitive meet after 6 months operation.

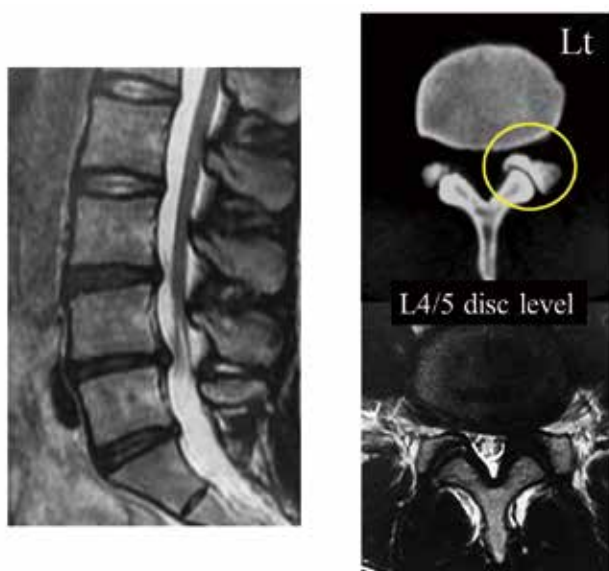


Figure 3. Sagittal and axial view of T2 weighted MRI and axial CT scan (Case 2)
MRI showed the degenerative change and slight bulging at the level of L3/4, 4/5, 5/S.
Axial CT showed facet hypertrophy and osteoarthritis change in left side of L4/5 (circle).

Case 3 : Vertebral endplate injury

A 34-year-old male professional combined combative sports athlete had felt severe LBP for several years. The pain occurred at the time of fighting position, which is lumbar anteflexion. Though he consulted several hospitals, the cause of pain had been unclear. So he finally consulted our hospital. His pain got worse during lumbar anteflexion, but not during retroflexion. Sagittal T1-MRI showed low signal intensity of vertebral endplate at L5/S, and sagittal STIR-MRI showed high signal intensity of the same site (Fig 4). This signal change was type 1 Modic change, which demonstrated the inflammation of vertebral endplate at L5/S. Sagittal CT also revealed a deformity of L5 caudal vertebral endplate. This pain disappeared temporarily just after disc injection to L5/S using 1% lidocaine and steroid. And then, we could diagnose that the cause of LBP was vertebral endplate injury at L5/S. After total 2 times disc injection, his LBP had

disappeared. Interestingly, signal change had occurred in MRI (Fig 5). T1 and also STIR-MRI showed low intensity of the same site. This signal change was type 3 Modic change, which demonstrated the bone sclerosis. After core muscle training, he returned combative match.

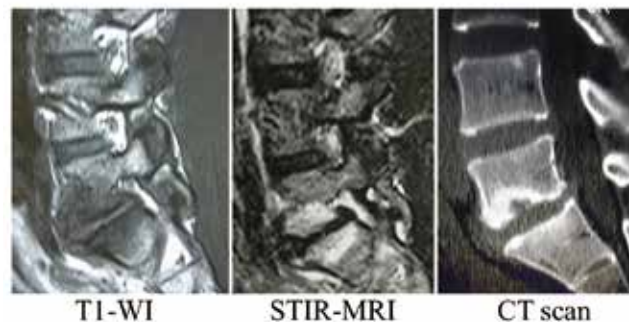


Figure 4. Sagittal view of MRI and CT scan (Case 3)
Left panel ; T1 weighted MRI showed low signal intensity of vertebral endplate at L5/S.
Middle panel ; STIR-MRI showed high signal intensity of vertebral endplate at L5/S.
Right panel ; CT scan showed a deformity of vertebral endplate at L5.

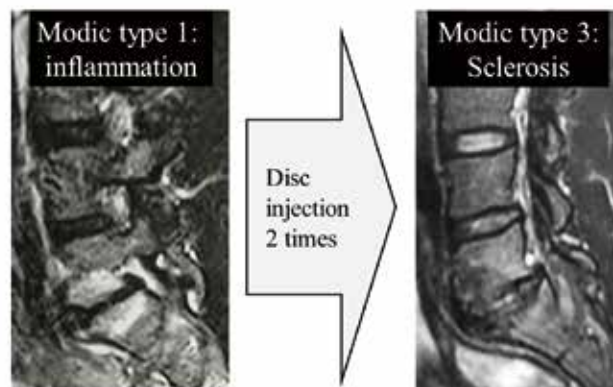


Figure 5. The Modic change from type 1 to type 3 (Case 3)
After total 2 times disc injection, signal change had occurred in MRI.

DISCUSSION

In this case series, we evaluated data from 23 elite athletes and revealed that the main cause of LBP of elite athletes was disc related low back pain, facet joint arthritis, and vertebral end plate injury.

According to historical literature for elite athletes, Spencer and Jackson reported that strains and sprains appear to be the most popular causes of LBP (12). Alexander *et al.* reported that most athlete injuries to the lower back involve a contusion or a muscular strain related to a sudden contraction of the muscle (13). Spencer and Jackson indicated that athlete's LBP was caused by continuous radial tears in the annulus fibrosis of the intervertebral discs (12). Whereas, Bogduk considered that the most common sites of LBP are facet joint and the intervertebral discs, and that the relationship of LBP to muscoligamentous strain or sprain is tenuous (14,15).

In these two decades, there have subsequently been remarkable advances in the development of imaging systems, including

MRI and CT. Using these imaging systems and various types of functional diagnostic injections, it is now becoming possible to identify the cause of LBP.

MRI is reported to be very useful for investigating inflammatory conditions (16,17). In general, T2-weighted MRI appears able to detect abnormal findings, but sometimes the signs can be missed. STIR-MRI is an inversion technique that nulls the fat signal change based on T1 values (18); furthermore, it is a powerful visualization tool because the image can provide useful information about intra-articular effusion or inflammation as a very clear high-signal area (19). In case 1 and 3, STIR-MRI clearly showed a high intensity area at the disc and vertebral endplate, respectively. We were then able to diagnose disc-related LBP in case 1 and vertebral endplate injury in case 3.

The reason that some physicians could not diagnose elite athlete's LBP might be the difference of elite athlete and normal people. Severe symptoms that disturb normal daily life are not difficult to diagnose. Images including X ray, CT and MRI shows obvious abnormal findings, e.g. big disc herniation, spondylolysis, vertebral fracture and so on. In case the normal people have LBP only in playing sports, some complains about it but the other is not in trouble because slight LBP doesn't disturb daily life. But elite athletes should be in trouble even if their LBP is not severe because they always require their top performance in playing time. Actually in most cases, the LBP of top athletes don't disturb their daily life but they complain about their LBP in playing time. If the physicians don't know this difference, they might tend to miss the cause of LBP of elite athletes because its abnormal findings of symptom and images are not conspicuous.

The main cause of unidentified LBP in elite athletes, we reported in this case series, was disc related low back pain, facet arthritis, and vertebral end plate injury. Details of these pathologies are below.

Disc related LBP

Disc-related LBP due to internal disc disruption is considered to be the most common cause of chronic LBP (20, 21). Provocative discography has been considered the gold standard for diagnosis and management of disc related LBP in spite of its invasiveness and associated complications. In 1992, Aprill and Bogduk described HIZ on MRI for diagnosing disc related LBP (22). They demonstrated a prevalence of 28.6% for HIZ, with sensitivity, specificity, and positive predictive values of 71%, 89%, and 86%, respectively, for diagnosing symptomatic LBP. Some histological studies have shown inflammatory granulation tissue at sites of HIZ (23-25). These inflammatory tissues produce pro-inflammatory cytokines and mediators that sensitize the nociceptors within the disc and cause pain (23). In the 12 cases diagnosed disc related LBP in this series, HIZ in STIR-MRI appeared in 7 cases. The positive ratio of HIZ was 58.3%.

In case 1, STIR-MRI was effective for detecting HIZ, and we could diagnose his LBP was disc related pain because of temporary pain relief by disc injection block.

Facet joint arthritis

The facet joints are the only synovial joints in the spine, and

each consists of hyaline cartilage overlying subchondral bone, a synovial membrane, and a joint capsule. Because of their high level of mobility and the large forces impacting the facet joint, especially in the lumbar area, the facet joints can develop significant degenerative changes and be a potential source of pain and disability. In comparison with standard radiographs, CT improves anatomic evaluation of the facet joints because of its ability to image the joint in the axial plane and the high contrast between bony structures and the surrounding soft tissue (26). CT is the preferred imaging method for lumbar facet joint osteoarthritis. Lewinnek and Warfield reported that 96% of their patients with facet joint osteoarthritis responded to intra-articular facet injections (27).

In case 2 here, it is possible that there is an increase in the load on the left facet joint with twisted position in swinging hammer before throwing. This may induce the facet hypertrophy and arthritis. After temporarily effective facet joint injection, a final diagnosis of facet joint arthritis was made.

Vertebral endplate injury

Modic changes are signal intensity changes of the endplate and vertebral bone marrow that are seen on MRI and which are differentiated into three types based on T1 and T2 weighted MRI (Table 2) (28, 29). Mok *et al.* reported that Modic changes were present in 5.8% of the population (30). These changes were highly associated with the presence of disc degeneration and correlated with the presence of LBP. They had described that the presence of Modic changes may be a marker for lumbar degenerative phenotypes associated with LBP. Cao *et al.* reported that intradiscal steroids are an effective treatment for chronic LBP patients with Modic changes on MRI (31). Type 1 Modic changes are associated with an active inflammatory process, involving vertebral endplates adjacent to the intervertebral disc, and stimulated by local proinflammatory mediators and cytokines (32, 33).

Table 2. Modic classification

Modic classification	MRI T1	MRI T2	Represents
Type 1	Low	High	Vascularized bone marrow or edema
Type 2	High	High	Proliferation of fatty tissue
Type 3	Low	Low	Sclerotic bone

In case 3, after two times disc injection with steroids, his chronic LBP disappeared with signal change to Modic type 3. Intradiscal injection with steroids might be effective not only to symptoms but also to structural changes at lumbar vertebral end plate. We believe that there is little deleterious effect of a needle puncture on a disc that is already degenerated, probably painful.

Table 3 shows the summary about the diagnosis of the LBP of the athlete.

Table 3. Summary about the diagnosis of the LBP of the athlete

Diagnosis	Symptom	Images	Diagnostic injection block
Disc related LBP	Pain with anteflexion	MRI ; Degenerative disc with HIZ	Temporary pain relief after disc injection block
Facet joint arthritis	Pain with retroflexion	CT ; Facet hypertrophy or deformity	Temporary pain relief after facet injection block
Vertebral endplate injury	Pain with anteflexion	MRI ; Type 1 Modic change	Temporary pain relief after disc injection block

CONCLUSION

In this case series, we showed that the main cause of unidentified LBP in elite athletes was disc related low back pain, facet joint arthritis, and vertebral end plate injury. A thorough medical interview, a careful physical examination and appropriate diagnostic imaging, such as STIR-MRI, are important when looking for the cause of LBP.

CONFLICT OF INTERESTS-DISCLOSURE

nothing for all authors

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