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Full-endoscopic Spine Surgery for Discogenic Low Back Pain with High-intensity Zones and Modic Type 1 Change in a Professional Baseball Player

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Abstract

Non-specific low back pain in athletes can be caused by discogenic back pain, Modic type 1 change, and facet joint arthritis. In this report, we describe a full-endoscopic surgical strategy that we have used to treat a patient with both discogenic pain and Modic type 1 change. The patient was a 32-year-old professional baseball player who played an infield position and had a 2-year history of low back pain. Three years earlier, he had undergone micro-endoscopic discectomy for left herniated nucleus pulposus at L5/S1. His leg symptoms resolved postoperatively, and he returned to playing baseball the following season. However, his low back pain gradually increased. Two years after the initial surgery, he was experiencing low back pain in daily life and found it very difficult to play baseball. Short T1 inversion recovery (STIR) magnetic resonance imaging (MRI) revealed Modic type 1 change and high-signal intensity zones in degenerated discs at L4/5 and L5/S1. Injection of xylocaine 1% reduced the pain temporarily, confirming that the pain generator was at L4/5 and L5/S1. The pathological diagnosis was discogenic pain with Modic type 1 change. We performed full-endoscopic disc cleaning (FEDC) surgery for the Modic type 1 change and thermal annuloplasty (TA) for the discogenic pain at these levels. The patient's low back pain decreased steadily thereafter. Six months after surgery, he returned to baseball, playing for a full season without pain. We have successfully treated a professional baseball player with discogenic pain and Modic type 1 change by full-endoscopic surgery.

Keywords: full-endoscopic surgery, thermal annuloplasty, discogenic low back pain, high intensity zone, Modic change

Introduction

Low back pain is a common problem in the general population[1)] and is especially common in athletes. The reported incidence of low back pain in athletes is as high as 30%,[2)] and 75% of elite athletes report having experienced low back pain at least once during their careers.[3,4)] The main causes of non-specific low back pain in athletes are reported to be discogenic back pain, Modic type 1 change, and facet joint arthritis.[5)]

Some reports suggest that low back pain originates from the intervertebral discs,[6–9)] and more than 40% of cases of chronic low back pain are attributed to intervertebral disc damage.[6,7)] Burgmeier and Hsu reported an association between low back pain and disc degeneration in elite athletes.[10)] Patients with low back pain may have a high-intensity zone (HIZ), that is, a high-intensity area within the annulus fibrosus, in an intervertebral disc on T2-weighted magnetic resonance imaging (MRI).[11)] A recent report highlighted the significance of HIZ in patients with chronic low back pain.[12)] Furthermore, chronic inflammatory granulation tissue with neovascularization has been found at sites of HIZ.[13,14)] Modic type 1 change has been reported to be a pathology causing non-specific low back pain.[15,16)] However, there is limited

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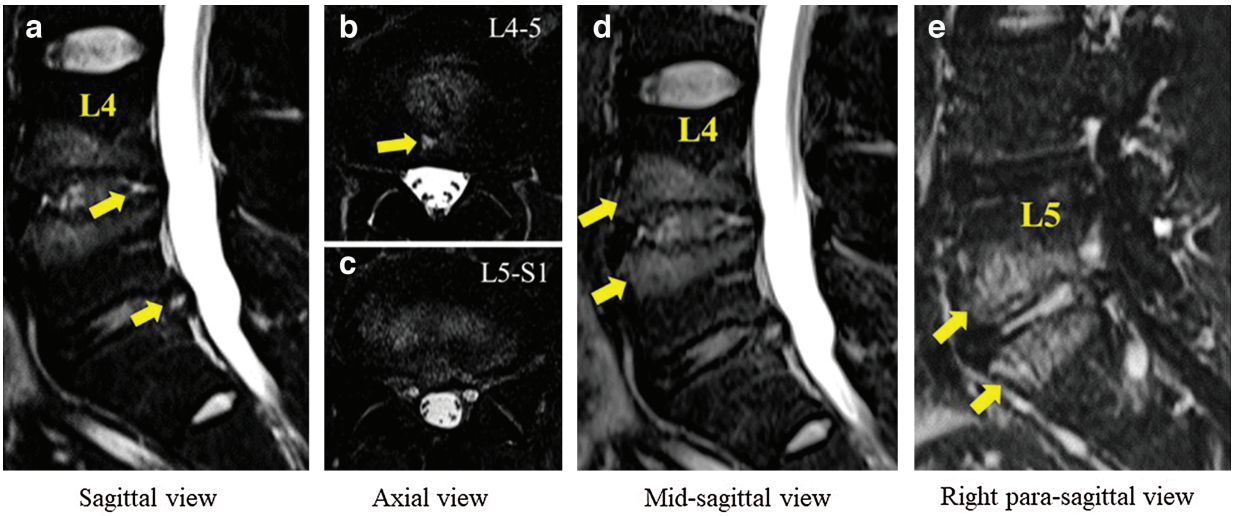

Fig. 1 HIZs and Modic type 1 change. (a–c) STIR MRI before surgery shows HIZs in the discs at L4/5 and L5/S1 (arrows). (d and e) On STIR-MRI, a mid-sagittal view shows Modic type 1 change in the lower part of the endplate at L4 and in the upper part of the endplate at L5 (arrows) and a right para-sagittal view shows Modic type 1 change in the L5 and sacral endplates (arrows). HIZs: high-intensity zones, MRI: magnetic resonance imaging, STIR: short T1 inversion recovery.

information in the literature on endoscopic findings in HIZ lesions.

The patient in this report was a professional baseball player who presented with severe low back pain due to intervertebral disc degeneration with HIZ and Modic type 1 change. Arthrodesis is generally accepted as the gold standard treatment for such pathologies. However, in a professional athlete, early accurate diagnosis and minimally invasive treatment are required to allow an early return to playing sport at a professional level. Our patient was treated successfully by full-endoscopic lumbar discectomy (FED) under local anesthesia. This procedure can be performed via an 8-mm skin incision with minimal damage to the back muscles, which would be essential for professional athletes. We performed full-endoscopic disc cleaning (FEDC) surgery for Modic type 1 change and thermal annuloplasty (TA) for discogenic pain. This report describes the endoscopic findings for HIZ and use of FED to treat a professional athlete.

Case Report

A 32-year-old male professional baseball player who played an infield position became aware of low back and leg pain during fielding practice in preseason training. MRI scans ordered by the team doctor showed a herniated nucleus pulposus at L5/S1. Three months of conservative treatment did not alleviate the pain; therefore, micro-endoscopic discectomy was performed at L5/S1. His low back and leg pain decreased after surgery and he resumed playing baseball at a professional level the following season. However, the low back pain gradually returned. By approximately 2 years after surgery, the pain was severe, particularly in flexion. By this stage, he could no longer play baseball and the pain was interfering with his activities of daily living. He was referred to our department for a second opinion and to determine the pathology of the low back pain.

The neurological findings at his first visit indicated tenderness at the spinous processes at L4 and L5 and the paravertebral muscles on both sides at L4/5. There was severe low back pain during lumbar flexion. There was no muscle weakness in either leg. All deep tendon reflexes were normal and sensation was intact. The straight leg raise and femoral nerve stretch tests were normal.

Plain radiographs obtained before surgery showed normal alignment with no instability of the lumbar spine. A T2-weighted sagittal MRI scan (Fig. 1a) showed grade IV degenerative disc changes at L4/5 and L5/S1 with slight collapse of the disc spaces. Although slight disc bulging was observed at L4/5 and L5/S1 on axial views, there was no compression of nerve structures such as the nerve roots, cauda equina, and dura mater (Fig. 1b and 1c). Short T1 inversion recovery (STIR) images showed HIZ lesions in the posterior parts of the L4/5 and L5/S1 discs. There were also low-intensity changes on a T1-weighted image and high-intensity changes on T2-weighted

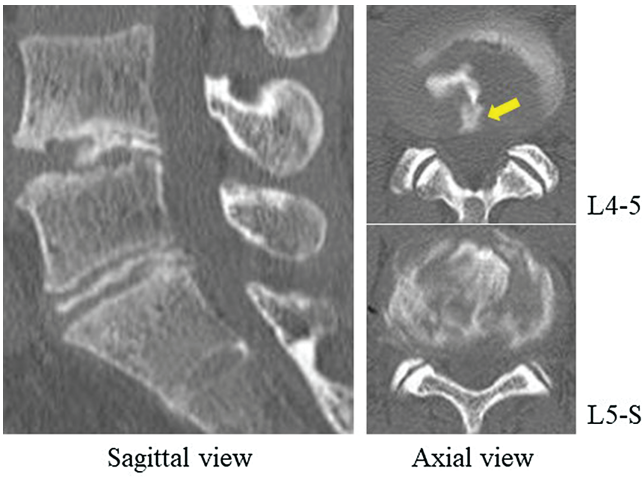

Fig. 2 CT scan after discography shows an annular tear at the L4/5 disc (arrow). CT: computed tomography.

and STIR images at the L4, L5, and sacral endplates, indicating Modic type 1 change (Fig. 1d and 1e).

Provocative discography was positive, with leakage of contrast medium into the annular tear at the L4/5 disc and the patient reporting severe low back pain similar to the pain he experienced when fielding. Computed tomography scans after discography showed an annular tear (Fig. 2). We performed provocative discography simultaneously at the L5/S1 disc, which caused only mild low back pain. The concordant low back pain was temporarily relieved by intradiscal injection.

The diagnosis was lumbar discogenic low back pain with HIZ and Modic type 1 change at L4/5 and L5/S1. We planned FED with TA and FEDC[17] at L4/5 and L5/S1 during the baseball off-season.

Surgical technique

First, FED-TA and FEDC were performed at the L4/5 level on the right under local anesthesia. The patient was positioned prone on a standard spine frame. The optimum location for cannula insertion was determined to be 8 cm right of the midline on preoperative computed tomography images. After draping, xylocaine 1% was administered for local anesthesia around the entry point under C-arm guidance. Next, we performed intraoperative discography using a mixture of indigo carmine and contrast medium. We inserted a guide wire into the disc under C-arm guidance and then made an 8-mm skin incision. A tapered cannulated obturator was placed in the right L4/5 foraminal area using an outside-in technique.[18] Next, the endoscope was inserted. Foraminoplasty was performed to widen the narrow foramen using a high-speed drill, after which the cannula could be positioned safely inside the disc.[19] Red flare tissue inflammation and neovascularization were seen when the endoscope was moved to the site of the annular tear. We also found aberrant neovascularization in the cranial and caudal endplates. After removing the red inflamed tissue, the bleeding site was ablated using a radiofrequency coagulator (i.e., TA; Fig. 3). Disc cleaning with full-endoscopic debridement was performed for the Modic type 1 change. FED-TA and FEDC were then performed at L5/S1 on the right using the same method. Although a degenerative annulus and nucleus pulposus were found at L5/S1, there was no inflammatory tissue or neovascularization.

Histological findings

The specimens had been taken from the site of the annular tear with the HIZ at L4/5 for pathologic examination. Hematoxylin–eosin staining showed that tissue from the L4/5 disc contained fibrous granulation tissue with neovascularization, partly within hemosiderosis. Tissue from the nucleus pulposus at L5/S1 included degenerative fibrocartilage. There was no granulation tissue in the L5/S1 disc sample.

Postoperative course

There were no intraoperative or postoperative complications, such as exiting nerve root injury, dural tear, or hematoma. The patient's low back pain decreased in the immediate postoperative period. Two hours after surgery, he was able to stand and ambulate. A Jewett hyperextension trunk brace was used for 3 months postoperatively to prevent flexion of the lumbar spine. Nonsteroidal anti-inflammatory drug therapy was prescribed for 6 months postoperatively to reduce the inflammation associated with the Modic type 1 change. His exercise program consisted of core exercises and stretching of the trunk muscles, followed by jogging and other conditioning exercises. MRI scans acquired 3 months after surgery revealed a lessening of the signal change at the L4, L5, and sacral endplates (Fig. 4). By 3 months after surgery, he had returned to his original level of activity and participated in baseball practice without the trunk brace. Finally, he resumed playing professionally 6 months after surgery, first playing in a minor league and then being called up to the top league 1 month later. There has been no recurrence during 12 months of follow-up.

Discussion

We have used a full-endoscopic technique to treat low back pain in a very active professional baseball

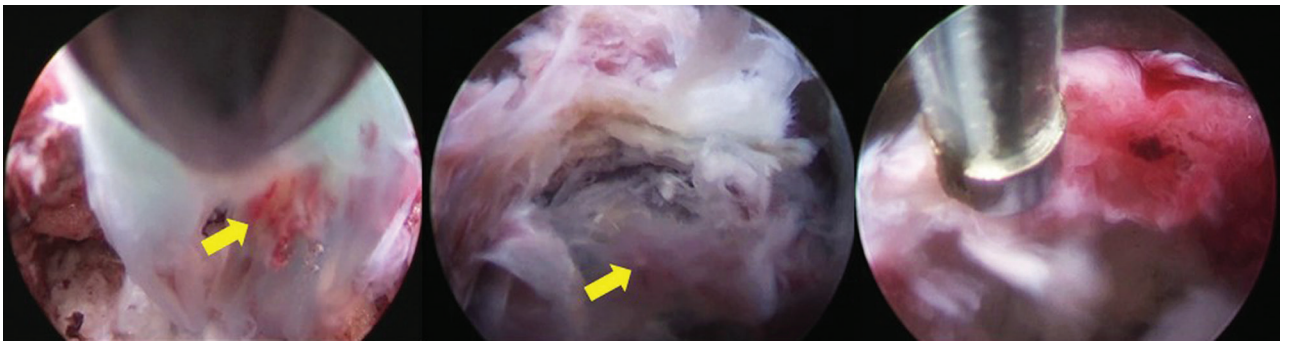

Fig. 3 Endoscopic findings. Endoscopic views of the L4/5 disc show the red flare tissue at the site of the annular tear in the disc at L4/5 (arrows, left and center). The bleeding site was ablated by TA using a radiofrequency coagulator (right). TA: thermal annuloplasty.

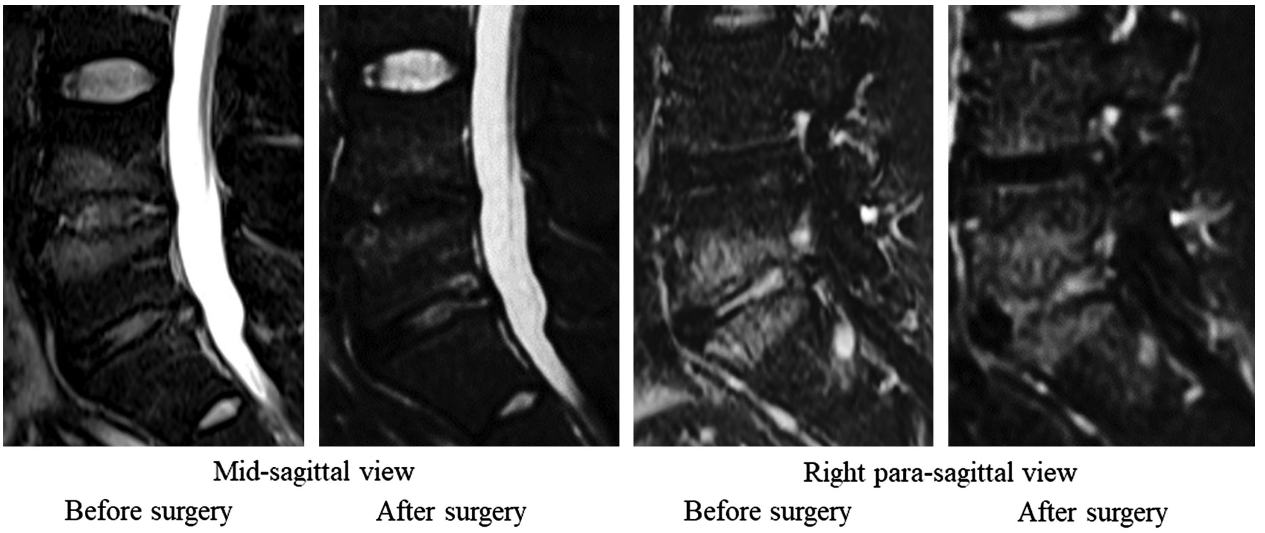

Fig. 4 Imaging findings before and after surgery. MRI obtained before and 3 months after the surgery show improvement of the Modic type 1 change at L4/5 improved after surgery. MRI: magnetic resonance imaging.

player with HIZ lesions in the lumbar intervertebral discs and Modic type 1 change.

Accurate diagnosis of low back pain

Yamashita et al. analyzed the pathology of non-specific low back pain in athletes and identified the main pain generators to be discogenic back pain, Modic type 1 change, and facet joint arthritis.[5] HIZ is a sign of discogenic low back pain and is characterized as a high-intensity region located in the annulus fibrosus of the intervertebral disc that is clearly dissociated from the signal of the nucleus pulposus. In 1992, Aprill and Bogduk reported a strong correlation between an annular HIZ on T2-weighted images and a symptomatic disc (HIZ had a prevalence of 28.6% and respective sensitivity, specificity, and positive predictive values of 71%, 89%, and 86%).[11] Wang and HU retrospectively reviewed 3185 discs on 637 lumbar MRI scans to determine whether there was a correlation between HIZ on lumbar MRI and patient characteristics.[20] Jha et al. identified HIZ in 28%–59% of patients with low back pain,[21] citing this finding as evidence of an association between lumbar annular HIZ on MRI and low back pain symptoms. Furthermore, provocative discography, together with MRI, has been confirmed to be useful for assessing discogenic low back pain.[12,21–24]

Modic change is also a cause of low back pain.[25–27] First identified by MRI in 1988,[15,16] Modic change is divided into types 1, 2, and 3. Features of Modic type 1 change include decreased signal intensity on T1-weighted images, increased signal intensity on T2-weighted images, and histological evidence of inflammatory changes in the vertebral endplates. Ohtori et al. found a relationship of endplate

abnormalities, especially Modic type 1 change, with inflammation and axon growth induced by tumor necrosis factor (TNF); TNF expression and protein gene product 9.5-positive nerve ingrowth in the degenerated endplates may be a cause of low back pain.[28] Moreover, Çevik and Yılmaz found that the relationship between low back pain and Modic type 1 change was stronger than that with the other types of Modic change.[29]

In our case, the main symptom was low back pain rather than pain in the lower extremities. The physiological findings suggested discogenic low back pain. MRI revealed an HIZ in the L4/5 intervertebral disc, and discography showed leakage of contrast medium into the annular tear at the L4/5 disc with concordant pain. Moreover, MRI revealed a Modic type 1 signal change in the vertebral endplates at L4/5 and L5/S1. Therefore, this patient's low back pain was caused by two pathologies, namely, a HIZ lesion at the L4/5 disc and a Modic type 1 change in the vertebral endplates at L4, L5, and S1.

Endoscopic and histological findings

A recent histological study found that HIZ lesions contained chronic inflammatory granulation tissue that acted as a pain mediator in patients with low back pain.[14] Peng et al. performed a histological analysis of the disc materials in HIZ-positive patients who had undergone lumbar interbody fusion surgery[13] and found that the HIZ lesions contained vascularized granulation tissue in the outer region of the annulus fibrosus. Lee and Kang[30] and Sugiura et al.[31] similarly reported that the endoscopic findings at the HIZ were suggestive of inflammation and neovascularization. A degenerative intervertebral disc releases nociceptive and growth factors that lead to ingrowth of nerve fibers into the intervertebral disc.[32] Although nerve ingrowth into degenerative discs and formation of granulation tissue with neovascularization might be a response to repair of the damage to the annulus, Freemont et al.[33] found that these discs healed poorly because of poor blood supply and high tensile stress, resulting in neoneuralization.

In our patient, the granulation tissue in the annulus fibrosus was identified as a reddish area containing small bleeding vessels. Histological examination also showed ingrowth of the vascularized granulation tissue into the annulus and hemosiderosis. There is a possibility that the low back pain in our patient was caused by repeated overload of the lumbar spine, as occurs in professional athletes, in areas of ingrowth of granulation tissues and nerve fibers. Hemosiderosis indicates repeated episodes of bleeding, and its presence in our patient also suggests that the mechanical stress and chronic inflammation at the affected site were due to repetitive overloading of the lumbar spine.

There are no reports on endoscopic findings in patients with Modic type 1 change. Intraoperative full-endoscopic inspection of the inside of the disc revealed aberrant neovascularization in the cranial and caudal endplates. After removing the reddened inflamed tissues, the bleeding site was ablated using a radiofrequency coagulator. In the initial report by Modic et al.,[16] histological analysis of an endplate with type 1 change revealed disruption and fissuring of the endplates and vascularized fibrous tissue, which is in good agreement with our endoscopic findings.

Treatment for discogenic pain with Modic type 1 change in elite athletes

Although there are several surgical options for discogenic pain and Modic type 1 change, interbody fusion might be the best choice.[34–36] However, our patient was a professional baseball player who needed to return to professional sports as soon as possible. If he had undergone fusion surgery, he would have needed to be on sick leave for at least a year, meaning that his position on his team would not have been secure. The FED technique requires only an 8-mm skin incision, causes minimal damage to the paravertebral muscles of the lower back, and can be performed under local anesthesia.[37–39] Moreover, FED-TA for discogenic pain with HIZ has the advantage of permitting direct visualization of the degenerated intervertebral discs and the sites of inflammation (granulation tissue in painful annular tears) under a direct endoscopic view, which allows safe and accurate debridement of the granulation tissue. As part of their investigation of the pathoanatomy of chronic annular tears containing granulation tissue, Yeung and Gore reported subsidence of low back pain after ablation using an FED system.[40] There are also some reports of full-endoscopic treatment being effective for chronic annular tears with HIZ.[31,41,42] There is very limited information on FED-TA in athletes, However, Sairyo et al.[43] and Manabe et al.[44] reported that elite athletes with HIZ who underwent FED-TA have an early return to their original competitive sports level.

Sairyo et al.[17] have recently published a report on FEDC surgery for Modic type 1 change. Suspecting an association between *Propionibacterium acnes* bacteria and intradiscal infection in a patient with Modic type 1 change, they performed intradiscal debridement and cleaning using a full-endoscopic technique with a water irrigation system. To avoid

fusion surgery in our patient, we performed PED-TA and FEDC.

Conclusion

We have successfully treated lumbar discogenic low back pain in a very active professional baseball player with HIZ and Modic type 1 change using a full-endoscopic system under local anesthesia. FED-TA might be an option for discogenic low back pain with HIZ and FEDC for Modic type 1 change in very active patients who need to return to their previous level of activity as soon as possible.

Conflicts of Interest Disclosure

The authors declare that they have no conflict of interest.

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