European Review for Medical and Pharmacological Sciences 2012; 16: 1859-1865

Repair of pars defect in a patient accompanied with disc herniation by a modified Buck's

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Abstract. – BACKGROUND: It has been generally accepted that spondylolysis will decrease the segmental stability of the lumbar spine, increase the load exerted on the disc at the spondylolytic level and the level above, accelerating disc degeneration.

AIM: Here we describe the Buck's technique enhanced with pedical screw-rod-hook construct and discuss the indication of direct repair of pars defect with disc herniation at caudal level and disc degeneration at cranial level of spondylolysis.

PATIENTS AND METHODS: A 19 year-old man had suffered low back trouble in the course of 5 years and unilateral sciatica of 7 months. To treat it the limited disc discectomy was performed first.

RESULTS: Buck's screwing with modified angle of insertion enhanced with pedical screw-rod-hook construct and allograft surrounding the defect was finally accomplished. At the follow-up of one month after operation, he had no back pain or sciatica, and no disability in daily activities (VAS: 0), the modified Prolo Scale score was 8.

CONCLUSIONS: Direct repair of spondylolysis with disc degeneration at cranial adjacent level combined with disc herniation at spondylolytic level may be debatable. We take it as an alternative to the established treatment.

Key Words:
Spondylolysis, Pars defect, Buck's technique, Disc degeneration.

Introduction

It has been generally accepted that spondylolysis will decrease the segmental stability of the lumbar spine, increase the load exerted on the disc at the spondylolytic level and the level above, accelerating disc degeneration[1-4]. Most Authors take disc degeneration as a contraindication of performing direct repair of pars defect, considering segmental fusion instead. Nevertheless, some investigators believe that this fusion has a biomechanical effect on the adjacent unfused spinal segments and will lead to a significant acceleration of pathologic lesions[5,6]. So, it would be a dilemma of deciding which surgical treatment to use for the patient in this study who has disc herniation at the spondylolytic level as well as degeneration at the cranial adjacent level.

Meanwhile, it is widely believed that nerve root compression in isthmic spondylolysis or spondylolisthesis is only rarely caused by disc herniation at the level of the pars defect[7]. Therefore, the decompression of the lateral recess stenosis caused by bony element surrounding at the pars defect rather than discectomy has been described and proposed by several Authors[1,8]. Correlation between disc herniation and discectomy with spondylolysis in treatment has not been reported before.

A variety of techniques for repair of the defect have been described, mainly including Buck[9], the Morscher[10] hook screw, the Scott wiring technique[11] and the segmental pedicle screw-hook fixation[11]. A certain ratio of device failure and pseudarthrosis has been observed[4]. The Authors suggest that a more rigid fixation would lead to a lower prevalence of pseudarthrosis and a better clinical result[4,8,12].

Performing the limited discectomy of the disc herniation below the spondylolytic defect, we repaired spondylolytic defects with a combined reconstruction construct including Buck's technique and pedicle screw-rod-hook (SRH) fixation in order to achieve more rigid and stable fixation. The purpose of the current study is to report this usage and discuss indication of this method.

Materials and Methods

A 19 year-old male student, who is a keen amateur basketball player, had suffered low back trouble in the course of 5 years and right sciatica down to the external malleolus for 7 months. The right straight leg raise test was positive.

Plain radiographs of the lumbar spine showed bilateral spondylolysis of the L5 vertebra without

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slip. The L4-5 and L5-S1 intervertebral space were not reduced; there were no osteophyte in the spondylolytic and adjacent vertebra. No radiological instability signs including sagittal translation and rotation were found in flexion- extension functional radiographs. The patient had a preoperative CT scan to evaluate the degree of sclerosis in the bony margins of the defect which told us that there was no lateral recess stenosis of L5 nerve root (Figure 1 A).

The state of spondylolytic and cranial adjacent disc was assessed by magnetic resonance imaging (MRI) (T2-weighted, fast spin-echo image, 3.0 Tesla). The Pfirrmann et al classification was used to assess the disc degeneration state[13]. According to the Pfirrmann classification, the structure of the L4-5 disc is grade 2 (The structure of the disc is inhomogeneous with a hyperintense white signal, the distinction between nucleus and annulus was clear but a loss of signal intensity in the nucleus is present, the disc height is normal without horizontal grey band); while the structure of the L5-S1 disc is grade 3 (the structure of disc is inhomogeneous with an intermediate grey signal intensity and an unclear distinction between nucleus and annulus, the disc height is normal). The sagittal scan revealed a horizontal herniation at the L5-S1 disc space apparently causing impingement on the right S1 nerve root (Figure 1).

Results

The patient failed to respond to the conservative treatment and had temporary relief of low-back pain after infiltration of 0.3 mL of 2% lidocaine into each defect of the pars interarticularis[14], whereas there was no obvious relief of right sciatica.

The patient was placed in a prone position on a Hall frame. The L5 vertebra including pars defect and interlaminar space of L5-S1 was exposed through a midline posterior incision. The lateral aspect of the inferior half of the superior articular process and the medial third of the posterior aspect of the transverse process were cleaned of soft tissue without interfering with the capsule of the facet. We performed a limited disc discectomy[15], which means only removing the sequestrated nucleus pulposus through right excision of the ligamentum flavum of L5-S1 without

Figure 1. Preoperative images. ***A,*** Axial CT reveals bilateral pars defect of the L5. ***B-C,*** Sagittal and axial images of MR reveal the disc herniation of L5S1 and disc degeneration of L4-5. ***D,*** Mimics reconstruction image shows the pars defect.

fenestration and annulotomy. No facet capsule and bony element injuries were induced. Therefore, the hook anchor site on the lamina remained intact.

We performed the Buck's technique first. The exposed defect was debrided and decorticated, the entry of the appropriate drill was simplified by taking a small piece of bone off the inferior edge of the lamina, then a 3.5 mm cortical screw (AO synthes) enters the inferior edge of the lamina bilaterally and travels upwards, forwards, and moderate outwards rather than slightly outwards which was described by Buck[9] (Figure 2). It is expected that the available area for bone grafting at the pars defect wouldn't be decreased by modified insertion angle of the screw[12]. The gap of the defect resulting from decortication was filled with cancellous allograft. Care was taken not to place bone graft vental to the defect because the exiting nerve root may be compromised (Figure 3 C). Since the longitudinal axis of the pars locates caudally in the sagittal plane, we inserted the screws percutaneously through one independent small skin stab with no need to extend the caudal aspect of the incision to allow the drill to achieve the correct trajectory in the sagittal plane.

The pedicle screw-rod-hook (SRH) implant included the variable-angle screw (MOSS Miami SI, DePuySpine) and the lamina hook (MOSS Miami, DePuySpine). The placement of pedicle screws in each pedicle of the spondylolytic vertebra was routine except for the starting point for the insertion. It was slightly more lateral than usual, near the intersection of a vertical line through the lateral border of superior articular process and a horizontal line at the superior border of the pedicle. Therefore, the insertion of the pedicle screw would not conflict with the head of Buck's screw (Figure 4). To conform to the pars length obtained by Buck's screw before, mild and appropriate compression force was applied between the hook and head of the pedicle screw with the hook compressor. Resection of the caudal 3-5 mm of the inferior facet joints of the cephalad vertebra is recommended by some Authors[1,16], this will theoretically reduce the chance of impingement of the inferior facets into the pars region when the patient is standing, particularly in hyperextension.

No transfusion was needed during surgery and no complications developed afterwards. The CT scan and X-ray were performed after operation (Figure 3). The patient was advised to be in bed for one month because of the discectomy performed and began to engage in daily activity without lumbarsacral hard corset the second month after the operation. Before the surgery, the patient presented severe pain (VAS: 9), at the follow-up one month after the operation, he had no back pain or sciatica and had no disability in daily activities (VAS: 0). The modified Prolo et al Scale score[17] was 8.

Discussion

Fusion of the involved level has been widely accepted as the treatment of symptomatic spondylolysis with or with-out degenerative disc signals and spondylolisthesis[1,18-20]. But, some investigators believe that lumbar fusion may lead

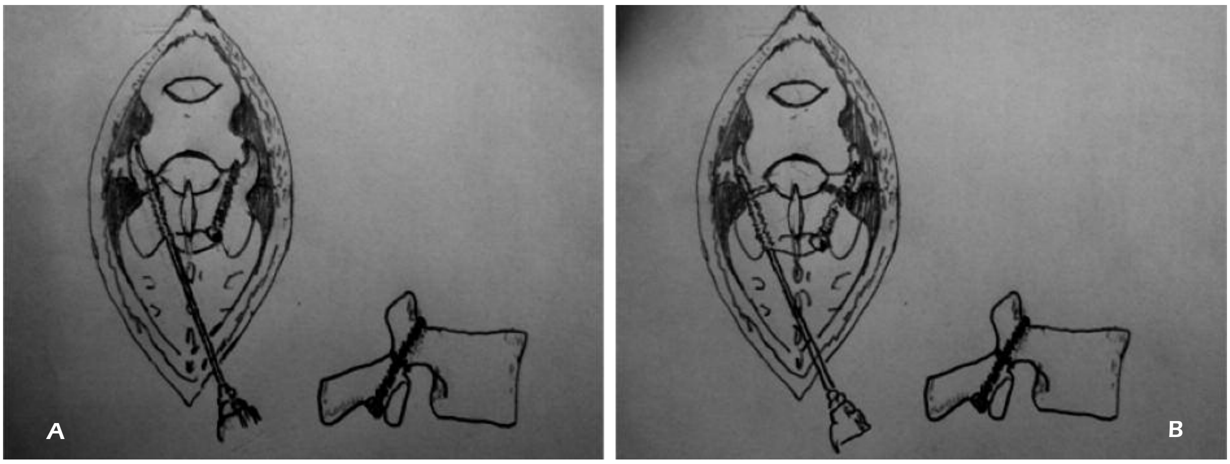

Figure 2. ***A,*** Pars repair with screw fixation as described by Buck. ***B,*** Screw inserting with a modified angle which is moderate outwards rather than slightly outwards which was described by Buck.

Figure 3. Postoperative images. ***A-B,*** AP and lateral X-rays. ***C-D,*** CT image shows the sagittal and axial position of Buck's screw.

to significant acceleration of degenerative lesions at adjacent levels[5,6,19,21]. It was determined that fusion altered the kinematics of the adjacent segments, redistributing the mobility toward relative hypermobility in the adjacent levels. These changes are certainly an important factor for persistent symptoms or new symptoms arising even after a successful fusion[22]. For all these reasons pars repair deserves consideration.

This study was complicated because the patient showed herniation of L5-S1 as well as adjacent degeneration of L4-5. We performed direct repair rather than segment fusion at the pars defect of L5 very in order to avoid subsequent ac-

Figure 4. ***A,*** Fixation accomplished in the operation with the view of SRH construct and the Buck's screw just locates beneath the SRH. ***B,*** Mimics reconstruction image shows relative location of the SRH construct and Buck's screw.

celeration of the degeneration of L4-5. We believed that the whole stability of the functional spinal unit would be preserved even after limited discectomy.

A review of the literature reveals that the results of pars repair in spondylolysis series seem to depend on the degree of disc degeneration, the existence of a previous slip, and the patient's age[1,4,12,23]. Many Authors agree that no intervertebral disc changes should be present and MRI must show normal disc hydration; if not, fusion must be performed[4,23]. However, in 1988 Louis[16] expanded the indications and proposed direct repair for people if the discal height was at least two thirds its normal height and if there was no slip of more than 10 mm, the patients' age were between 12 and 47. Being enlightened by Louis[46], Debusscher and Troussel[12] set the grade 3 of Pfirrmann et al classification[13] of disc degeneration as a satisfactory limit in his clinical procedure of spondylolytic defect repair with pedicle screw hook fixation. Moreover, Kakiuchi[8] also repaired spondylolytic defect with pedicle screw hook fixation, but his patients' disc degeneration stage even included grade 5 according to Eyre et al classification[24] which means a gross loss of the height of the disc and projections of more than two millimeters from the margins of the vertebral bodies and patients' age were 48, 58, and 60 respectively. Each achieved bony fusion and a satisfactory clinical result. But Debusscher and Troussel[12] and Kakiuchi[8] both did not explain why their cases succeded from the aspect of the relationship between disc degeneration and spondylolytic defects, they suggested that rigid fixation and bone grafting was an important factor.

The clinical relationship between disc degeneration and spondylolytic defects of the lumbar spine has been well reported[2,3,25]. According to Szypryt et al investigation[3], a definite increased prevalence of degeneration was noted in the disc below the level of the defect of the patients over 25 years of age, and the author insisted on segmental fusion rather than direct repair in management of the patient over 25 years of age in spondylolysis. But, Dai[2] has a different opinion: he believed that there is no reason to set an upper age limit for direct repair of spondylolysis if disc degeneration is excluded. It is the stage of disc degeneration not the age that interacts with spondylolysis. Clinically, spondylolysis accelerates disc degeneration; disc degeneration will be predisposed to segmental instability and subsequent segmental instability might be a cause of symptoms persistent even after defect healing[22]. So, we believed that what really matters is the stage of segmental stability rather than the stage of disc degeneration in regard to surgical treatment of pars defect. Whether the segment is stable or not would be the most important factor for defect fusion and clinical outcome. Although the disc degeneration of the patients in Kakiuchi's study[8] is severely high and the counterpart in Debusscher and Troussle[12] study is moderate (as mentioned before), they all showed no signs of instability. In addition, both study performed infiltration of defect as an inclusion criteria if the back pain is temporarily relieved. So, the other than the spondylolysis defect, sources of pain in spondylolysis such as disc degeneration and relative segmental instability were excluded before operation[14]. These might help the Authors to explain the successful outcome.

In this study, disc degeneration of both L4-5 and L5-S1 was confirmed by MRI. The Pfirrmann et al classification[10] was grade 2 and grade 3 respectively. No high-signal-intensity zone in the posterior *annulus fibrosus* on sagittal T2-weighted images was found which usually means the existence of annular tears[26]. We take it as an evidence of spontaneous healing of annular tear which definitely increased the segmental stability. No radiological instability sign including sagittal translation and rotation was found in flexion and extension functional radiographs. Based on all these findings, we concluded that the patient lumbar segment is stable at least from radiological aspect and we insist that is a prerequisite for defect repair.

Discectomy has the potential to induce postoperative instability, actually, from the long-term aspect; discectomy seems to definitely lead to degenerative changes which are often located near operated motion segments[27]. However, biomechanical investigation indicated that limited discectomy (the minimal amount of nucleus pulposus excision at surgery) does not lead to the spinal instability[28]. Furthermore, clinically, some satisfactory outcomes of limited discectomy in terms of postoperative instability were reported[29,30]. Basically, treating the lumbar disc herniation without tearing of the annulus fibrosus by making a 5 mm square annulus window and removing a minimal amount of nucleus pulposus to keep the center area intact, Kuroki et al[30] reported that they don't have any cases of spinal instability after more than 3 years follow-up. In addition, Mochida et al[29] showed in his comparative study that the change of ROM in the group with the center area of nucleus pulposus intact was smaller than a group with a large amount of nucleus pulposus removed after more than 2 years follow-up. We performed a similar procedure which only needed to remove the ligamentum flavum and sequestrated the nucleus pulposus without fenestration and annulotomy (the annulus fibrosus has been spontaneously healed as mentioned before). We believe that the limited discectomy in this study would not lead to subsequent segmental instability, thus meeting the criteria of defect repair as mentioned before.

It is generally believed that the spondylolysis is pseudarthrosis of the isthmus with a failure of the fracture consolidation[12,31,32]. So, it requires rigid osteosynthesis with compression device and cancellous bone graft. The biomechanical comparison of fixation techniques (Scott, Buck, modified-Scott, and pedicle screw-rod-hook fixation technique) carried out by Deguchi et al[33] demonstrates that the pedicle screw-hook construct and Buck's technique provided the smallest defect motions under flexion bending. For better defect healing, the Author recommends these two techniques from a biomechanical perspective. Moreover, it is revealed by Sairyo and Goel[34] that Buck's technique could reduce the hyper-stresses in discs in spondylolysis. But the disc stresses could not be normalized completely, especially during lateral bending. So the Author indicated that Buck's screwing alone could not provide complete stability at the pars defects.

We performed the Buck's technique combined with SRH construct in this study and took the advantage of this combination as tension band fixation. According to the biomechanical investigations[31-33], activities that involve alternating flexion and extension movements caused large stress reversals in the pars which eventually resolve into a shear force and a tensile force at the centroid of the cross sectional area of the pars interarticularis[32]. Since the tensile force described by Cyron and Hutton[31] is located along the longitudinal axis of the pars, once defect occurs in the pars interarticularis, motion across the defect becomes more significant than the motion of the inferior articular processes, especially in flexion and torsional loading[31,33]. In the procedure of defect repair in this study, the Buck's screw is inserted in the same longitudinal axis of the pars supporting axial directional stability, while the SRH construct providing compressive force on the pars and flexional and torsional stability. Respecting the altered role of the Buck's screw, we modified the angle of the Buck's screw insertion (as mentioned before) and subsequently increased the space for bone-grafting. We speculated that this combined construct would offer a more rigid fixation not only with regard to motion across the defect but also to the motion of the functional spinal unit. Therefore, the healing of the defect and preservation of stability is promising.

Conclusions

Direct repair of spondylolysis with disc herniation at the spondylolytic level combined with disc degeneration at the cranial adjacent level may be debatable. In addition, fixation with a combination of Buck's technique and SRH construct in the same level of the pars defect has not been described before. We take it as an alternative for established treatment if necessary. The clinical outcome shortly after operation seems to be statisfactory.

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