Expert's comment concerning Grand Rounds case entitled “Limited access surgery for 360 degrees in situ fusion in a dysraphic patient with high grade spondylolisthesis” (by M. A. König and B. M. Boszczyk)

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Abstract

The case of a 26 year-old woman with high grade spondylolisthesis, history of diastematomyelia and tethered cord, with acute onset of back pain and bilateral sciatica after a fall. This comment will focus on three issues: indication for surgery, indication for reduction and levels to be included in fusion. Surgery is indicated in this case for intermittent urinary incontinence and saddle anesthesia, and failure of conservative treatment to control pain. Other important determinant of surgical indication is risk of progression, depending rather on the degree of dysplasia as classified by Marchetti-Bartolozzi than on the degree of slip as classified by Meyerding. High dysplastic olisthesis is identified by excessive pelvic retroversion. Reduction is indicated in

patients with high torque through L5-S1. L5 severity index (SI) correlates with the magnitude of torque through L5-S1. Similarly, the decision to include L4 in fusion can be made based on the value of SI for L4.

Keywords Spondylolisthesis · Pelvic imbalance · Severity index · Reduction · Surgery

Introduction

The authors present the treatment of high-grade spondylolisthesis in a 26-year-old female patient with history of diastematomyelia, occult spina bifida and tethered cord syndrome with new onset of severe low back pain, bilateral L5/S1 sciatica after a fall [1]. In this case, basically we have to focus on 3 issues:

1. Indication for surgery.
2. Indication for reduction.
3. Unstable zone of spondylolisthesis (if L4 has to be enclosed in the surgery).

Indication for surgery

A conservative treatment should be considered if before the fall the patient was pain free, there is no neurological deficit and the imaging does not show fracture or progression of slippage.

In this case, surgery is indicated because of failure of conservative treatment and intermittent urinary incontinence with episodes of saddle anesthesia. Risk of progression of slippage and unbalanced pelvis are two stronger indications for surgery; a good classification would give us

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precise information about these two key points. Obviously degenerative, developmental or posttraumatic spondylolisthesis need different treatment, and for this reason a classification is necessary. The commonly used Meyerding classification for spondylolisthesis is based on the amount of translation of the cephalad vertebra on the sacrum in the lateral plain film. Like in this case, a slip of more than 50% (Meyerding Grade III) is defined as high-grade spondylolisthesis. However, the simple percent of slippage has a poor value in order to define the risk of progression, the pelvis balance and consequently the treatment.

According to the Marchetti–Bartolozzi classification [2] there are two main categories of spondylolistheses:

developmental and acquired. The case presented is clearly a developmental spondylolisthesis. There are high or low dysplastic developmental types and since the natural history and consequently the treatment are different, the key point is to define if it is high or low dysplastic. Independently from the percent of slippage, the main characteristics of high dysplastic are L5-S1 kyphosis, compensatory lumbar hyperlordosis, pelvic retroversion with verticalization of the sacrum and anterior displacement of the hips. Pelvic retroversion is the most important criteria in order to distinguish high from low dysplastic developmental spondylolisthesis; increased pelvic retroversion is an indicator of pelvic imbalance. The authors evaluated the sagittal balance

Fig. 1 a 29-year-old female patient with developmental spondylolisthesis. b SI is 23%, the pelvis is balanced. c Since SI in L4 is 12%, the unstable area includes only L5. d, e The result of only posterior L5-S1 instrumented fusion

in this case with the pelvic parameters pelvic tilt (PT) and the sacral slope (SS) with their arithmetical sum of the pelvic incidence (PI). Pelvises with low PT and high SS are balanced, whereas high PT and low SS are unbalanced. Since the authors defined this spondylolisthesis with balanced pelvis, I presume that they found low PT and high SS in a standing lateral plain film including the hips. If we want to follow this analysis, we need to know when PT is low and SS is high and vice versa and, on the other hand, the normal values of the pelvic parameters. Vaz et al. [3] studied 100 normal volunteers, 54 males and 46 females, mean age 26.5 (23–45) and reported a range of PT from -1 to 27.9 (mean 12.3) with a standard deviation (SD) of 5.9, and a range of SS from 19.5 to 65.5 (mean 39.4) with SD of 11.5. PI ranged from 33 to 85 (mean 51.7) with SD of 11.5. Those results clearly demonstrate that normal values of PT and SS are highly variable. Thus, it is not appropriate to classify one individual's PT or SS as high or low by comparing it to average values in the population. An alternative approach to identify the presence of pelvic retroversion as an indicator of imbalance is to compare the amount of measured sacral slope to the predicted sacral slope as a function of pelvic incidence. This approach assumes the existence of a numeric relationship between pelvic incidence and sacral slope in a balanced pelvis. In the same paper, Vaz et al. demonstrated an almost arithmetical relationship between pelvic incidence and sacral slope in healthy adults, sacral slope being always higher than 50% of pelvic incidence for a given individual. Following this approach, an individual with sacral slope $<50\%$ of pelvic incidence could be classified as imbalanced (compensating through pelvic retroversion).

Indication for reduction

Since olisthesis in an imbalanced pelvis has to be reduced in order to have a good outcome, we have to define this imbalance in a quantitative way. I proposed to measure the value of the torque in L5-S1 [4] for defining the balance of the pelvis in spondylolisthesis. Since we do not have a standing lateral plain film including the hips of this case, I show a case of Meyerding Grade III spondylolisthesis (under the mechanical point of view similar to the authors' case) in a 29-year-old female patient with history of severe back and bilateral leg pain for 1 year without any result from conservative treatment (Fig. 1a).

A horizontal line (Fig. 1b) is drawn through the center of S2 on a standing lateral radiograph of the lumbar spine that includes the hips. A vertical (L5 plumb line) is drawn through the middle of L5. It represents a parallel force to the gravity line and its direction is cranio-caudal. A second vertical (femoral plumb line) is drawn through the center of

the femoral heads. This line represents a caudal-cranial force. AC is the distance from the center of S2 to the femoral plumb line; BC is the distance from L5 plumb line to the femoral plumb line. Because of this distance those two forces create a torque in L5-S1. We can easily measure the amount of this torque with a formula that I defined for severity index (SI) [4]. The SI is calculated as follows: $SI = BC \times 100 \div AC$. SI is a direct measure of pelvic retroversion. With increasing pelvic retroversion, there is anterior displacement of the femoral heads and obviously BC and SI increase. Since the value of SI is $<20\%$ in normal subject and in low dysplastic developmental spondylolisthesis [4, 5], we can presume that under this value the pelvis is balanced. The SI of my patient and probably of the authors' patient is very close to 20%, and for this reason in situ instrumented fusion is indicated.

Unstable zone of spondylolisthesis

The unstable zone always includes the slipped L5 and sometimes L4, if there is a large torque ($SI > 20\%$) on L4 due to high pelvic retroversion. We can calculate SI in L4 in the same way of L5 (Fig. 1c). Anyway, since the pelvis is balanced, in cases like this SI in L4 is always $<20\%$. In the case presented by the authors L4 is not in the unstable zone and the only reason for including it in the surgery is to believe that L4-5 disc is symptomatic. This point is very controversial, especially if we consider that the authors' including L4 means having extended fusion to L3 (as L3-L4 was congenitally fused).

Personal preference

I operated my patient with only posterior L5-S1 instrumented posterolateral fusion with Wiltse approach and autologous intertransverse graft (Fig. 1d, e). According to the Grob technique [6], I placed two 70 mm 6.5 thread, 16 mm cancellous screws with washer. The implant costs added up to approximately 62 Euros. At the 2 years follow-up the patient is pain free and with stable implant, solid posterolateral fusion and evident spontaneous interbody fusion. This technique can represent a very good solution in grade II or III spondylolisthesis with collapsed disc and balanced pelvis.

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