Expert's comment concerning Grand Rounds case entitled “L5–S1 disc replacement after two previous fusion surgeries for scoliosis” (by S. Jehan, S. Elsayed, J. Webb and B. Boszczyk)

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Abstract

The attempt to preserve motion below a long fusion is certainly praiseworthy even if it is clearly understood with the patient that the result might be only temporary, buying some good years in the most active part of life. The analysis of the case presented here suggests that such an approach could be recommended in the right patient, with the right team. More experience and reports are necessary to evolve from an anecdotal report to a new path in the treatment of adult scoliosis.

Keywords Scoliosis · Artificial disc · Spinal fusion · Motion preservation

The authors have tackled a problem that is more and more often encountered yet not well addressed in the literature; there has only been one case report of a similar case published 3 years ago in *Spine* by Lehman and Lenke [1]. What should we do in the phase of adjacent disc degeneration below a long fusion for scoliosis? The logic of such treatment with disc replacement goes against what is conventionally accepted (extension of the fusion) so far in most current practice and in the literature. The follow-up of such a case is short (1 year) but promising, and we congratulate the authors for such a nice result. As such, treatment is in today's standards, like sailing in uncharted oceans. I have broken the discussion into three different parts and will follow with a formal analysis of the paper.

Three main poles of the discussion

1. Lower levels in idiopathic scoliosis

The treatment of idiopathic scoliosis in teenagers and young adults exceptionally requires fusion to the pelvis. The main disadvantages of pelvic fusion are: (1) difficulties in obtaining a solid fusion; (2) difficulties in achieving a perfect trunk balance and the impossibility of rebalancing; (3) limitations of social and professional activities; and (4) long-term risks of symptomatic sacroiliac degeneration, for which there is no real efficient treatment. The lower instrumented vertebrae should be the stable vertebrae leaving a fractional compensatory curve below. The more complete the correction, the least compensatory curve there is. In idiopathic scoliosis, the lumbo-sacral segment is typically not part of the main curve.

Alternatively, maintaining at least two levels of lumbar

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motion considerably reduces the risk of pseudarthrosis, allows closed to normal activity of daily living (assuming a regular moderate lifestyle), and prevent the risk of load transfer to the sacroiliac joints.

2. *The fate of the un-fused levels*

Several factors concur to lead to degenerative disease of the distal non-fused segments: (1) the obliquity of the discs of this compensatory segment (by definition dependant on the amount of residual curve in the fused scoliosis); (2) the natural history of degenerative disc disease as the patient gets older; (3) the stiffness of the fused segment above, adding stress to the mobile segments; and (4) the residual imperfections in sagittal and coronal balance which place asymmetrical loads on this segment. Most likely these factors aggravate each other in a way that degeneration of the lower segments is ultimately almost unavoidable.

3. *Surgical options*

(a) The traditional treatment after failure of conservative treatment is to fuse the un-fused symptomatic segments:

- (i) There are clear advantages of doing this at this stage rather than doing it initially. First, not all the lower segments become symptomatic to a point that surgery becomes necessary—the patient enjoyed several decades of motion allowing her or him to build a close to normal life. The extension of the fusion comes later when the activities typically decrease. The patients had time to rebalance during those years, and the surgeon has to be careful at the time of the fusion extension to respect this rebalancing. This option has some drawbacks: the same than 20 years earlier. Even though most people get less active at that point, nowadays people enjoy quite late in life outdoors and other social and athletic activities.
- (ii) Due to osteoporosis, there are risks of sacral fractures. Moreover, due to the poor quality of the fixation, the use of pelvic screws is often required with its lot of complications.
- (iii) In cases like the one presented here, there is one normal level between the long fusion and the new degenerative level. It would be highly debatable in this situation to fuse L5–S1 and leave L4–L5 in between. The fate of this isolated disc between two fusion blocks is grim. An extension to the pelvis of the previous fusion would probably be the treatment of choice.

(b) Indications of a disc replacement in this context:

- (i) First, as an American commentator, I am bound to make clear that in the US the FDA did not give clearance for any artificial disc in this indication. It has, however, been used off label after appropriate informed consent. The authors quote publications from American authors.
- (ii) Theoretically saving levels of mobility below a long fusion makes sense, perhaps even more than in patients with single level disease.
- (iii) The first factor to consider is the number of mobile segments below the fusion. In the case reported, the normal L4–L5 disc makes the ADR an even more attractive option. Other cases could be more questionable, for example, if L4–L5 was also degenerative. A two-level ADR would be a much more adventurous enterprise below such a long lever arm. Also in case of a degeneration of L5–S1 below, a fusion to L5 would be more challenging although this has occasionally been done successfully.
- (iv) What would be the challenge about?
 1. First, the stress applied on an ADR in this context is extremely high, and the risk of early expulsion or displacement is quite high. Later, the risk of subsidence and wear is certainly higher than normal, and the patients should be clearly aware that further procedures could be necessary in the future.
 2. The obliquity of the discs of the compensatory curve, proportional to the residual deformity of the main curve in a well-balanced trunk, places the ADR in a sub-optimal mechanical position increasing the sheer forces applied on the components.
 3. Another even more subtle caveat is the reaction of the ADR to a residual hidden imbalance. If any balance imperfection persists after the scoliosis correction, it can be hidden by a sharp compensation into the lower levels (this could actually contribute to the degenerative process). The insertion of a parallel prosthetic device can decompensate this equilibrium, and either unmask the trunk unbalance or create an acute tilt of the ADR placing it in awkward biomechanical situation increasing the risk of early failure.

Formal analysis of the paper

Case presentation

This type of case should be handled with the spirit and rigor of a scoliosis surgeon. It would have been useful to have information about the balance, the residual fractional curve on Ferguson views, and bending films. The segmental coronal tilt at the L5–S1 level would have most likely helped to predict the final tilt in the ADR.

Any surgical procedure motivated by pain has for objective to reduce pain. A pain score and a functional evaluation are mandatory to quantify the improvement. That is the reason why all my surgical patients are systematically evaluated by a Visual Analog Scale, The Oswestry Score, and SF36. These tests are repeated at fixed intervals (We do not always know which case will end up worth being reported. It is a good idea to collect data).

The mention “Radiographs showed satisfactory position of artificial disc replacement” is also questionable because of the final tilt of the disc on the centered X-ray. No post-operative scoliosis films are shown or discussed. As I mentioned earlier, one of the main problems remains the final balance.

Even though I expect that the artificial disc will function well for some time, 1-year follow up is too short to safely recommend this approach.

Discussion

The discussion is quite informative, and the reference list is useful for further consultation.

This approach, especially in this type of case, is certainly an exciting direction to take for clinical research. Because of severe administrative restrictions, these studies cannot be pursued in the US and have to be followed from other continents, especially Europe. Scoliosis centers with large populations of patients should run the show. Appropriate clinical and radiographic documentation throughout the follow-up period will be required.

Overall, this paper treats a very important topic, which will deserve in the future a more systematic and detailed approach. The presentation is a little succinct in term of descriptions of the complaints, the limitation in the patient’s activities of daily livings, and the quantification of such restrictions. The anatomical dynamic analysis of the deformity is curiously missing (this is the main point of the paper after all).

I read it with great interest, but at the end I remained somewhat slightly frustrated as many questions had yet to be discussed. This type of problem should be tackled by gathering data from several large scoliosis centers in a prospective fashion.

Reference

1. Lehman RA Jr, Lenke LG (2007) Long-segment fusion of the thoracolumbar spine in conjunction with a motion-preserving artificial disc replacement: case report and review of the literature. *Spine* 32(7): E240–E245