Expert's comment concerning Grand Rounds case entitled “Staged corrective surgery for complex congenital scoliosis and split cord malformation” (by Muhammad Asad Qureshi, Ambreen Asad, Ibrahim Farooq Pasha, Arslan Sharif Malik, Vincent Arlet)

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The authors have presented the surgical management of a case of a 12-year-old girl with the diagnosis of congenital scoliosis associated with split cord malformation type II. Although the presented radiological images have not shown clearly that it was a type II split cord malformation (fibrous septum with diplomyelia and separate or same dural layers). I totally agree that in split cord malformation type II with normal neurological findings and the spinal cord ending at a normal level, the corrective surgery can be achieved safely without any neurosurgical procedure when the surgery is performed under spinal cord neuromonitoring. The literature supports this common opinion [1, 9, 10]. But, without using neuromonitoring, this surgical strategy would be too risky.

I would like to comment on some points about the authors' approach to the patient. There are no long-cassette standing anteroposterior and lateral X-rays presented, so it is very difficult to judge about global coronal and sagittal balance of the patient. According to my opinion, by evaluation of long cassette standing AP X-rays, the distal level of fusion should be one or two levels below the currently selected level. If you compare the early postoperative and 2 years postoperative X-rays and clinical photographs, you will see the development of adding on phenomenon distally, shift of the trunk to right side and prominent right lumbar hump. This is probably due to the selection of short fusion.

In the preoperative evaluation of such cases with congenital deformities, we routinely take the preoperative three-dimensional computerized tomography (CT) of the spine within the deformity limits. CT will help you to understand pedicle configuration at all levels in which the pedicle screws are intended to be placed and give more detailed information about the congenital bony anomalies. With the help of CT, one can assess the current anatomy of the posterior elements (pathologies such as unilateral or bilateral laminar synostosis, etc.) which is very hardly seen on direct radiographies.

Another discussion point is the question about whether the anterior surgery would be necessary or not. There is no data in the manuscript about the preoperative flexibility characteristics of the curve and preoperative assessment of global balance of the spine. So, it is difficult to understand how much flexibility was gained by anterior discectomy and halo-femoral traction thereafter until second surgery. In such circumstances, we believe that in traction X-rays taken under general anesthesia (UGA) give better opinion about curve flexibility and can lead to do posterior only surgery with pedicle screws with or without osteotomy (Smith–Petersen, pedicle subtraction, posterior vertebral

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column resection) in one session. This approach can eliminate the thoracotomy and the subsequent halo-femoral traction application, which carries significant complications and morbidities. Also, there is no information about the preoperative pulmonary status of the patient (either pulmonary function test or lung CT), as we know the adverse effect of thoracotomy in the pulmonary status of patients having this kind of deformity.

Our approach in the severe curves ($>70^\circ$) of neglected congenital scoliosis without any intramedullary abnormalities or with split cord malformation type II anomalies is to obtain traction X-rays taken UGA. Looking for an optimal method of analyzing curve flexibility and, at the same time, the curve response to surgical correction, we have started using supine traction radiographs taken with the patient UGA just before surgery [4]. One of the major advantages of the supine traction radiograph with the patient UGA is that muscle spasm and related patient discomfort are avoided, and there is no need for patient or parent cooperation. These radiographs are better in showing flexibility, proximal and distal correction ratios and thus, overall global balance of the spine. The major disadvantage of this technique is that the final decision about surgical strategy becomes clear in the operating room and the surgeon should explain his plan to parents just before the surgery.

If the traction X-rays taken UGA shows well-global balance of the trunk over pelvis, sufficient correction in proximal and distal part of the congenital deformity, good shoulder balance and rib-cage position and the curve magnitude is less than 50° – 55° , we perform posterior only surgery with pedicle screws. By this way, it is possible to obtain more correction after surgery. In some cases in whom the proximal thoracic deformity causes shoulder imbalance, asymmetrical Smith–Petersen or asymmetrical pedicle subtraction osteotomies could be performed to restore the shoulder balance.

If the curve magnitude in traction X-rays taken UGA is more than 50° – 55° and the curve flexibility is still more than 30–40%; we perform posterior surgery with intraoperative halo-femoral traction in selected cases. The details of the surgical technique was published previously [6]. Intraoperative halo-femoral traction is a safe, well-tolerated method of applying gradual, sustained traction to maximize postoperative correction in severe scoliotic curves. Complications can be minimized with gradual increases in traction to a maximum of 30–50% of the patient's body weight, and intraoperative neuromonitoring and wake-up test. Such techniques in severe curves provide a good correction and balance that is maintained by pedicle screw instrumentation, hence eliminating the necessity of anterior surgery. Intraoperative halo-femoral traction not only elongates spinal column but also elongates the thoracic cavity improving the compromised pulmonary function.

If the curve magnitude in traction X-rays taken UGA is more than 50° – 55° and, the curve flexibility is less than 30–40% and there are severe associated kyphosis or lordosis with scoliosis, we perform posterior vertebral column resection together with neurosurgical procedure (treatment of intramedullary abnormalities) [5]. I usually prefer posterior only approach. Vertebral column resection [2, 3, 7, 8] is a safe and effective technique in the surgical treatment of neglected severe scoliosis associated with kyphosis or lordosis because it is a spinal column shortening procedure and it allows to do correction in the same session. It should be performed by a highly experienced surgical team. Spinal cord neuromonitoring is the mandatory part of the surgical procedure.

As a conclusion, in neglected severe congenital scoliosis, we always prefer posterior only approach with pedicle screws together with or without osteotomy or vertebral column resection to avoid the morbidities of anterior surgery (thoracotomy) unless the fusion extends to the pelvis in that time anterior lumbosacral fusion may be necessary to strengthen the fusion. When the scoliosis is associated with severe kyphosis or lordosis, we perform posterior vertebral column resection. In lordoscoliosis, we place reduction pedicle screws on concavity of the deformity and we start correction on either side of osteotomy immediately proximal and distal to osteotomy site, then going up and down alternatively. The spinal cord should be evaluated at every correction step to confirm that there is no compression.

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