

Panel Discussion

Posterior Column Osteotomies in Adolescent Idiopathic Scoliosis: Panel Discussion

Lorena V. Floccari, MD¹; Kenneth D. Illingworth, MD²; Suken A. Shah, MD³; Daniel J. Sucato, MD⁴; James O. Sanders, MD⁵; Haemish Crawford, FRACS⁶; Tyler D. Metcalf, BS⁷; Craig R. Louer Jr., MD⁷

¹Department of Orthopedic Surgery, Akron Children's Hospital, Akron, OH; ²Department of Orthopaedic Surgery, Cedars-Sinai Medical Center, Los Angeles, CA; ³Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE; ⁴Scottish Rite Hospital, Dallas, TX; ⁵Department of Orthopedic Surgery, University of North Carolina at Chapel Hill, Chapel Hill, NC; ⁶Starship Children's Hospital, Auckland, New Zealand; ⁷Department of Orthopedic Surgery, Vanderbilt University Medical Center, Nashville, TN

Correspondence: Craig R. Louer Jr., MD, Department of Orthopaedic Surgery, Vanderbilt University Medical Center, 2200 Children's Way, Suite 4202, Nashville, TN 37212. E-mail: craig.louer@vumc.org

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Introduction

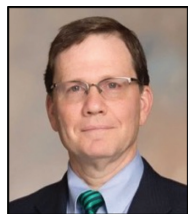
The technique for PCO in the correction of deformity in AIS has been outlined in the prior paper by Louer et al. (*JPOSNA*®, February 2023). In an effort to reach equipoise, we sought to discuss the use of these procedures with four senior pediatric orthopaedic spine surgeons. We recognize that all pediatric spine surgeons

must evaluate the risk/benefit ratio of PCO in light of a paucity of conclusive information; the latter is a result of heterogeneous patient factors and differences in surgical technique. These surgeons are leaders in the field with vast experience treating spinal deformity. Their responses have been edited for length and to reduce repetition.

Invited Experts



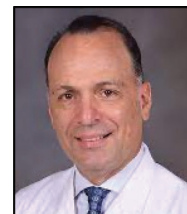
Haemish Crawford, FRACS
Starship Children's Hospital,
Auckland, New Zealand



James O. Sanders, MD
University of North
Carolina, Chapel Hill, NC



Suken A. Shah, MD
Nemours/Alfred I. duPont
Hospital for Children,
Wilmington, DE



Daniel J. Sucato, MD, MS
Scottish Rite Hospital,
Dallas, TX

What are your indications for PCO?

Sucato: Thoracic hyper-kyphosis is a well-accepted indication for [PCOs], as you're shortening the posterior column. The problem with scoliosis in the thoracic spine is that the chest/ribs are restricting you from deformity correction. I think more than PCOs, the game changer in correcting a large scoliosis is the versatility and the variety, diameter, and stiffness of metal rods that are available. The power of using rods and differential shaping of rods allows us to gain great correction. Spine deformity is like any other disease: mild, moderate, severe, and you probably ought to treat it with a dose-dependent approach. If you have a really severe curve, you'll likely need to fill all the pedicles, and you may need to use advanced techniques with rods and correction. Spending more time thinking about rods and correction, and not necessarily on osteotomies, is the philosophy that I really lean on. Besides using PCOs for kyphosis, I do think the other place that PCOs can be useful is in thoracolumbar/lumbar scoliosis curves for 3D deformity correction.

Sanders: I agree the true indication is kyphosis to shorten the posterior column. I started out doing a lot more osteotomies 10 years ago. Over time, I've realized that you're not gaining a huge amount more correction. I think most of the tightness is within the annulus fibrosus and other structures which are occurring up front rather than posteriorly.

Crawford: When you've got a significantly hypo-kyphotic thoracic curve in scoliosis, doing a [PCO] can help lengthen the posterior column to restore kyphosis. Another indication is when the curve is very tight on preoperative side-bending or traction x-rays where I'm considering an anterior release. This can be avoided by combining my PCO with a rib osteotomy for improved correction. I must say I'm usually underwhelmed by the correction I get.

Shah: Professor Ponte described his osteotomy for the treatment of kyphosis, but I think we're describing the "Ponte osteotomy" as a convenient term for what we're doing for scoliosis—a posterior column osteotomy or

disarticulation of the posterior elements. I would like a big stiff curve to have similar characteristics as a flexible smaller curve. I find it effective for treating virtually any kind of spinal deformity. Interestingly, we're seeing a lot of our adult deformity colleagues going away from 3 column osteotomies and doing more PCOs, in effect getting the same sagittal plane restoration as they were without the risk of a three-column osteotomy. It bears mentioning that we are training residents and fellows. When you look at everything written about deliberate practice and the practice of habit, you have to make something routine or you will not incorporate that into your habit. In order to use this powerful technique in a 90-degree rigid curve, one needs to have proficiency and performance in less severe curves so the procedure doesn't seem as daunting when it is most necessary.

How do you think PCOs will benefit the patients long term?

Sanders: We recently published our 40-year follow-up of Harrington instrumentation,¹ and those patients did incredibly well over time with function that really matches age-matched controls. These patients are getting no segmental derotation, and their ultimate function is very good. So what are we doing [with PCO]? Are we doing something that's better for patients in the end or are we gilding the lily? My personal conclusion is that PCOs are really unessential and just add a layer of danger that's unnecessary for patients to get a correction that's going to be satisfactory to them long term.

Shah: I think it's just trying to be better. I find it tremendously easier to do segmental de-rotation with PCOs. We need to look at 3D sagittal plane parameters because the fundamental problem in AIS is you are severely underestimating the loss of kyphosis. When we restore kyphosis in the thoracic spine, it seems to drive the cervical and lumbar reciprocal changes much better than if we leave them flat. So, we can always do better and manage risk. We have adopted more sophisticated instrumentation in the name of better outcomes, why not the PCO?

Sucato: The best data we have today doesn't support any meaningful benefit to the patient. The Harms Study Group data^{2,3} showed minimal improvements in the coronal plane which won't make a difference in the patient's outcome. We also matched patients with large curves and found no difference in restoration of thoracic kyphosis and very small gains in the coronal plane.⁴ I think the best data we have today doesn't speak to the use of PCOs for thoracic scoliosis and we have to be really careful about routinely recommending them in idiopathic scoliosis for any good data-driven reason.

What do you consider as the risks of PCO?

Sucato: The routine use of PCOs has shown that spinal cord monitoring changes are higher, blood loss is more, and the ability to gain more correction is minimal at best. Spinal cord changes can be due to a mechanical contusion during the procedure and ischemia from blood loss/hypotension and altered spinal cord blood flow from curve correction.

Crawford: I agree, the other potential longer-term problem which we haven't seen yet, but I think we may see, is that you're removing a lot of bone in the fusion area in a PCO. Even though we place a lot of bone graft, I worry about pseudarthrosis.

Shah: A lot has been said about the increased time, blood loss, and neurological alerts in prior papers, including mine. It was early in our experience, and we were just reporting what we were seeing. If you looked at the last 50 cases I did, we have nearly the same parameters of blood loss, time and transcranial motor-evoked potential alerts than we did [without PCO] when we reported that initial paper.

When doing a PCO, what is your technique? Do you use a traditional technique or an ultrasonic bone scalpel (UBS)?

Sucato: I typically use a traditional technique if I do them. Think about how much blood you lose in a facetectomy; it's almost nothing. The bone scalpel is not going to move the needle on that.

Sanders: I like the harmonic scalpel, but where it's a tight area, I will continue using the Kerrison to resect the ligamentum flavum and superior articular process.

Shah: I teach the traditional way first to learners, but in practice, I use the UBS to potentially decrease blood loss and avoid overuse injury. There are ergonomic advantages to the UBS, and I am interested in career preservation using automated methods whenever I can.

Crawford: I remove the inferior facet joints with the bone scalpel but complete the osteotomy with a rongeur to complete PCO. I also use the Watson Cheyne (Figure 1 and Video) to check that the osteotomy is complete to palpate the medial wall of the pedicle to assist accurate screw insertion.

Do you remove fragments of the superior articular process?

Sanders: I'm very nervous about leaving a floating piece there and have seen a case where a fragment of the

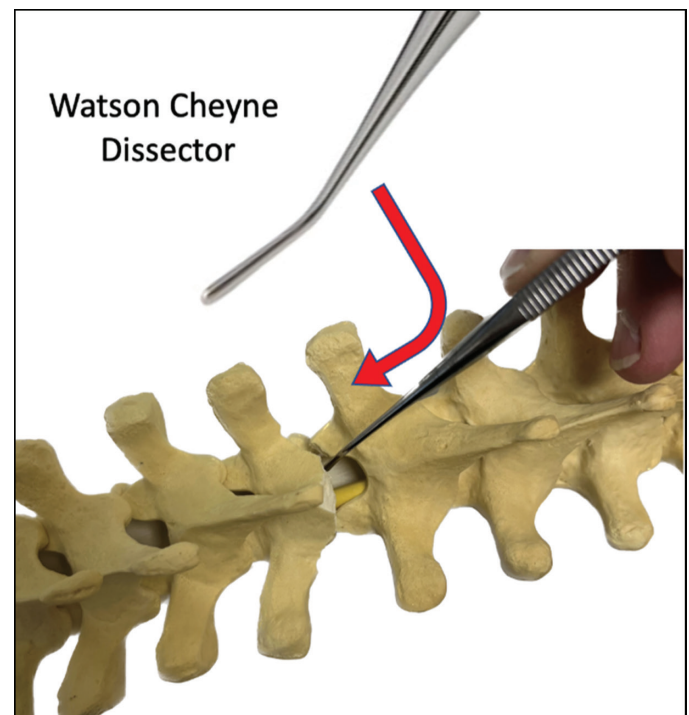


Figure 1. A Watson Cheyne is utilized for gentle palpation, such as for assessing completeness of PCO and the integrity of the medial wall of pedicle (See Video).

superior articular process dropped into the canal with changes in neuromonitoring.

Sucato: I think that's probably a discussion when you're using the UBS—if you cut through using a bone scalpel, whether you leave it or not. It's not doing anything for you, right? It's just articular cartilage that's sitting there. It's not a fusion or something that's going to create fusion for you.

Shah: I take them out where I'm doing it for kyphosis reduction or the first step of an eventual PSO because that fragment has been implicated in nerve root impingement, especially at the cervical thoracic junction. However, routinely for scoliosis? No, since that fragment is attached to the upper level with the ligamentous capsule.

What is your sequence in terms of PCO and pedicle screw tract preparation and placement?

Shah: I resect the inferior [articular] process, then cut the inferior third of the spinous process with a spinous process cutter. I always take the ligamentum to improve flexibility, and I cover the defect with gel foam and you must be very careful about what's happening across the canal. (I know others take the ligament last to decrease the potential for inadvertent cord injury.) I then cut the SAP [superior articular process] and then I place my screws. I use that sequence for a specific reason because we place screws freehand, and if there are difficult screws, I'll be able to use a Woodson elevator to feel the medial shoulder of the pedicle and just go with a starting point 2 millimeters lateral to that.

Sucato: My sequence is facetectomies and then I'll place screws up until the apex where I'm going to do the [PCOs]. At the apex, I prepare the screw tracts one

level at a time and then do my PCOs one at a time, and then I'll put the screws in. Once I get past the apex, I put gel foam and a paddy in to make sure everybody knows where the canal is open and to protect those levels and then continue with the screws above the apex. The canal is then open the rest of the case, but this sequence limits time where something could plunge into the canal. I think the concept of leaving the canal open as little time as possible is very important. I've had two calls in the last year from folks who've plunged into the open canal in exactly this scenario.

Sanders: I actually put in the screws and do the inferior facetectomies with the canal fully protected. I then take out the screws where I'm going to be doing the osteotomies and cover them with bone wax. I take out the flavum and the SAP, and then I go back and quickly replace the screws at the end. Newer modular screws may be a nice alternative. Just having the shank in is probably not much of an obstruction, but when you have a real head on the screw, I find it very hard to get out laterally and do it adequately.

Disclaimer

The authors report no conflicts of interest related to this manuscript.

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