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CORR Insights

CORR Insights®: Transsacral Osseous Corridor Anatomy Is More Amenable To Screw Insertion In Males: A Biomorphometric Analysis of 280 Pelves

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Where Are We Now?

Percutaneous iliosacral screw placement often stabilizes posterior pelvic ring injuries. Safe placement of S1 screws is the goal of surgery, and the areas for screw placement are adjacent to sacral foramina, which contain the S2 nerve. Two corridors may be used: Transverse or "biiliosacral" and "oblique." Generally, placing transverse transsacral iliosacral screws is ideal for posterior pelvis fixation of pelvic ring injuries with a posterior sacral fracture or sacroiliac disruption.

But it can be difficult to recognize narrow or absent S1 corridors. In order to ensure proper screw placement can be made, the surgeon needs to detect on fluoroscopic or plane images any anatomic S1 variation that would preclude transverse iliosacral screw placement. Surgeons can determine whether there is sufficient area to place a transverse iliosacral screw by using a precise lateral sacral view combined with both inlet and outlet views. A reduced fracture or dislocation is necessary to ensure safe corridors may be used, as incongruity may lead to misplacement.

When a patient's sacral anatomy does not provide a wide enough corridor for transverse screw placement in all patients at S1, the "oblique" iliosacral screw path may be used to obtain iliosacral fixation. This path uses only the lateral aspects of the sacrum. Alternatively, if a transverse corridor is present at S2, a transverse screw may be used at that level. Using a sophisticated analysis of CT scans to determine the shape of the S1 and S2 sacral segments, the study by Gras and colleagues noted that of the 280 pelves found, about 11% did not have a transverse corridor at S1, with a greater proportion in females (16%) versus male pelves (7%). Furthermore, the authors found that the S2 corridor

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was larger in those that did not have a wide enough transverse segment in S1.

Characterization of the sacral anatomy is currently best accomplished with the use of a CT scan, and high-quality CT scans now generally are performed for patients with suspected pelvic ring injuries at most trauma centers. Even so, surgeons need to rely on intraoperative fluoroscopic views to determine the safe placement of iliosacral screws.

Where Do We Need To Go?

The study by Gras and colleagues gives a good approximation of the proportion of adult male and female S1 and S2 corridors allowing for transverse iliosacral fixation. What is not clear is how surgeons can clearly see radiographic landmarks in the operating room or readily determine whether there is enough space for transverse sacral fixation should the need arise for a particular injury. This ability to determine corridors within the sacral S1 and S2 levels is critical to ensure safe placement of the screws.

The current study by Gras and colleagues, as well as prior work by others [2, 4, 7], demonstrates the critical role that CT scanning should play in determining the presence or absence of safe corridors for iliosacral screw fixation. Using a preoperative CT scan, these images should be supplemented in the OR with high-quality fluoroscopically obtained inlet, outlet, and lateral-sacral views.

As noted, CT scans offer the most accurate views of anatomic corridor placement [5, 6]. There are two ways to obtain accurate CT scan data for anatomic corridor placement. One way is to perform the iliosacral screw placement in a procedure room or operating room that has a CT scanner in place, allowing for real-time CT scan and screw placement. CT scans, however, have increased levels of radiation than standard fluoroscopy or radiographs, and multiple CT scan cuts may provide excessive radiation over time. Additionally, procedure or operating rooms with CT scanners do not necessarily allow ideal space for both the entire operating room team and the surgical equipment needed for orthopaedic procedures or for polytrauma patients. To care for complex patients, this scenario might necessitate a second anesthetic or transportation of a patient between rooms, which may not be ideal for operating room utilization, infection control, or patient care.

The second way to obtain accurate CT scan data for anatomic corridor placement is the use of standard CT landmarks associated with computer navigation, as it shows promise for safe placement of iliosacral screws. Computer navigation is being used successfully with other orthopaedic procedures, such as total knee replacement and pedicle screw placement [3]. Accurate use of computer navigation is dependent on the precise set up and determination of standard landmarks. The set up does require more operating room time. Because of the narrow corridors involved, any error in reduction or set up may lead to erroneous placement of screws.

Further scientific efforts should be made to reduce the radiation levels seen with CT scans but utilizing this method more directly in the OR, through improvements in CT scan technology, computer navigation, or incorporation of some aspects of both techniques.

Some corridors do not allow for transverse screw placement. That does not necessarily mean they are "dysmorphic." Rather, they are part of normal human variation. The inability to place a transverse screw does generally allow for an oblique placement of a screw. Several studies [1, 4, 7] document the CT findings of anatomical variation, but the further characterization of the S1 vertebrae should be done to determine if the oblique screw may not be possible as well.

How Do We Get There?

Routine clinical practice incorporates the use of a CT scan to further

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characterize pelvic ring injuries. Most trauma centers have an initial CT scan for patients with suspected pelvic ring (and other types) of injuries. The CT scan allows for more accurate characterization of the sacral anatomy and helps to determine whether there is the ability to safely place a transverse iliosacral screw. The use of computer navigation or real-time CT scan might allow for more-precise screw placement rather than rely on fluoroscopic views for the safe placement of iliosacral screws.

CT imaging has been utilized in certain circumstances to provide scans of limited anatomical areas with reduced radiation. While not eliminating the radiation, this would at least make the real-time use of a CT scanner a practical technique for use in posterior iliosacral screw fixation. Multidisciplinary studies designed to reduce the radiation of operative CT scans would provide a tool to more reliably place iliosacral screws with greater safety to the operating room team.

Computer navigation would allow for less radiation (fluoroscopic or CT) by allowing for less real time use of the imaging devices. An investigation linking real time CT views with computer navigation seems to be a good next step towards more accurate placement. This hybrid technique would allow for less patient and surgical team exposure.

While there are good studies characterizing the S1 and S2 anatomy, further discussion about "normal" anatomy is warranted. The characterization of a "dysmorphic" S1 level is based on the anatomic variation not allowing for transverse placement of iliosacral screws. Better analysis of sacral anatomy, documenting the existing variations, would enhance our understanding of the anatomy and possible improved treatment of posterior ring injuries.

References

1. Gardner MJ, Morshed S, Nork SE, Ricci WM, Chip Routt ML Jr. Quantification of the upper and second sacral segment safe zones in normal and dysmorphic sacra. *J Orthop Trauma*. 2010;24:622–629.
2. Gras F, Marintschev I, Wilharm A, Klos K, Mückley T, Hofmann GO. 2D-fluoroscopic navigated percutaneous screw fixation of pelvic ring injuries–a case series. *BMC Musculoskelet Disord*. 2010;11:153.
3. Mendel T, Noser H, Wohlrab D, Stock K, Radetzki F.The lateral sacral triangle–a decision support for secure transverse sacroiliac screw insertion. *Injury*. 2011;42:1164–1170.
4. Khakha RS, Chowdhry M, Sivaprakasam M, Kheiran A, Chauhan SK. Radiological and functional outcomes in computer assisted total knee arthroplasty between consultants and trainees - A prospective randomized controlled trial. *J Arthroplasty*. 2015; 30:1344–1347.
5. Takao M, Nishii T, Sakai T, Sugano N. CT-3D-fluoroscopy matching navigation can reduce the malposition rate of iliosacral screw insertion for less-experienced surgeons. *J Orthop Trauma*. 2013;27:716–721.
6. Takao M, Nishii T, Sakai T, Yoshikawa H, Sugano N Iliosacral screw insertion using CT-3D-fluoroscopy matching navigation. *Injury*. 2014;45: 988–994.
7. Zwingmann J, Hauschild O, Bode G, Südkamp NP, Schmal H. Malposition and revision rates of different imaging modalities for percutaneous iliosacral screw fixation following pelvic fractures: A systematic review and meta-analysis. *Arch Orthop Trauma Surg*. 2013;133:1257–1265.