Pelvic fixation is a challenging aspect of pediatric spine surgery. A common technique involves iliac screws inserted through the posterior superior iliac spine (PSIS), linked by connectors to standard thoracolumbar rods. Implant prominence at the PSIS may cause skin prominence or discomfort. Iliac screw placement may necessitate dissection of paraspinal muscles and adjacent skin. The distal portions of spinal incisions are the most prone to dehiscence, which may, in part, be due to the subfascial dissection needed to expose the PSIS for iliac screw insertion. The harvesting of iliac crest bone graft may compromise the iliac crest in the region of traditional iliac screws.

The recently popularized method of sacral alar-iliac (SAI) fixation uses screws inserted through the sacral ala into the ilium. The starting point is approximately 25 mm caudal to the superior endplate of S1 and 22 mm lateral to the midline, angled about 40° laterally and 40° caudally. This technique may reduce implant prominence because the screw lies ~15 mm deeper than iliac screws inserted through the PSIS. The wound may be closed with intact muscle flaps. Deformity correction is facilitated because the SAI technique allows compression and distraction of the pelvic implants in line with the other spinal implants. The screw may be up to 105 mm.

**Insertion Method**

Fluoroscopic guidance is initially used for screw placement. With experience, it may become optional, especially in patients without developmental pelvic asymmetry such as cerebral palsy. The S1 screws are inserted first, starting in the superior articular facet of S1 and aiming medially, so that the screw rests at the tricortical portion of S1. Then, 2 to 3 cm directly caudal to this point, the SAI screw insertion site is selected, usually at the lateral wall of the first sacral foramen. An awl is inserted and passes easily until it reaches the sacroiliac joint, where increased resistance is felt. Fluoroscopy verifies a trajectory just above the sciatic notch, ending at the anterior inferior iliac spine. The awl is then passed across the sacroiliac joint and within the ilium. The tactile feedback of cancellous bone provides assurance of intraosseous location. If resistance is felt, it is usually from the lateral wall of the ilium, which can be confirmed with a “teardrop view”, aiming the fluoroscopy machine parallel to the ilium and noting the location of the awl within the confines of the ilium. If little resistance is felt, it may signal that the trajectory is too far caudal or medial, which can be fixed with a new starting point, if needed. The more sagittally aligned the ilium is, the more lateral the starting point must be. Patients with cerebral palsy often have different anatomy between the right and left sides.

Next, a larger awl or tap may be used. The depth of the channel is measured. One should aim for a screw 70 mm or longer, having a width of 9 or 10 mm. The screw is inserted, and the surgeon should feel insertional torque. The head of the screw finishes at the same depth as the S1 screw and directly below it. The teardrop view may be checked again, if needed.

Once all anchors are in place, deformity correction may proceed from caudal or from cranial, depending on which will be the most difficult to instrument. In most cases, if there is major distal deformity or pelvic obliquity it is best to begin caudally, but if there is severe proximal kyphosis or scoliosis, this region may be approached first. In cases of pelvic obliquity, it is best to allow 1 to 3 cm of length distal to the SAI screw on the concave side for later
deformity correction. In any case, the S1, SAI, and lumbar screws should all be collinear; the SAI screws allow the pelvis to be manipulated like any vertebra.

The correction of pelvic obliquity may be verified by use of a sterile “T-square” made of 2 perpendicular long rods. When the base of the T-square is placed parallel to the iliac crests, the perpendicular rod should align with the spine at the sacrum and T1. At the end of the deformity correction, there should always be a minimum of 5-10 mm of rod distal to the SAI screw to minimize risk of loosening.

Results

We have experienced no vascular or neurologic complications with the SAI screw insertions. Pelvic obliquity is corrected to <10° in most cases. In 90° patients, postoperative complications were radiographic lucency of more than 2 mm (8 pts), deep wound infections (5 pts), screw breakage (5 pts), set screw dissociation (1 pt), sacroiliac pain (1 pt) and anchor migration (1 patient). There were no cases of implant prominence or skin breakdown.

Pelvic fixation is sometimes indicated in growing rod constructs, in cerebral palsy, spinal muscular atrophy, and myelodysplasia. A combination of SAI screws and S1 screws work well.

Discussion

Pelvic fixation is used in spinal deformity surgery for 2 purposes: (1) to improve correction of deformity, especially if the apex is in the lumbar spine; and (2) to stabilize the lumbosacral junction to facilitate arthrodesis. Screws in the first and/or second sacral vertebrae can provide fixation, but these anchors do not always hold up to the loads applied. The use of long anchors projecting into the ilium has been shown by McCord to provide the most mechanically effective form of pelvic fixation because as the moment of the anchors extends far anterior and lateral to the spine. Galveston and unit rods have been commonly used with anchors in the iliac wings. Recently more “modular” assemblies have come into use with screws that could be individually placed into the ilia and joined to long rods, sometimes with connectors. This technique requires subfascial dissection to the PSIS which may compromise the muscle flap. In addition, the anchors inserted through the PSIS are more prominent than those in the remainder of the implant.

For this reason, Chang et al developed a trajectory to insert iliac screws through a sacral starting point, using the widest screw possible. This starting point is immediately caudal to the starting point of S1 screws, at the top of the S2 ala, extending into the thickest portion of the ilium just above the sciatic notch. It traverses the fibrous or the articular portion of the sacroiliac joint. The trajectory allows a length nearly equal to that of traditional iliac screws. In addition, the more oblique angle does not allow them to back out. The anchor is in line with all of the other spinal anchors such that no connector is needed. The length and width of the anchor allows pelvic obliquity to be corrected even in the presence of osteopenic bone. The author now strives for a minimum screw length of 80 mm and 8-10 mm diameter.
References