Percutaneous cervical transfacet screw placement

This method allows for a screw to be inserted percutaneously through the articular (zygapophyseal) facet joint. This eliminates the need for a connecting rod between segments, which remains a major limitation of longer segment minimally invasive lateral mass screw-rod constructs.

The advantages of applying minimally invasive surgery principles to the posterior cervical spine include a reduction in muscle damage, decreased blood loss, reduced risk of infection, and the potential for early hospital discharge and return to normal functioning. The risk of infection after open posterior cervical fusion has been reported to be as high as 18%, [1] and as with other regions of the spine, this could potentially be dramatically reduced through the use of a percutaneous technique. Potential uses for percutaneous posterior cervical stabilization include supplemental fixation in the setting of multilevel anterior cervical discectomy and fusion or corpectomies; stabilization of pseudarthrosis after anterior cervical discectomy and fusion; and treatment in the setting of trauma, tumor, infection, or deformity surgery for which a circumferential approach is required without the need for posterior laminectomy.

Holly and Foley [2] described a percutaneous technique for placement of lateral mass screws in the cervical spine relying on isocentric C-arm (Philips Healthcare, Andover, Massachusetts) and image guidance; however, a safe and reproducible technique for percutaneous subaxial cervical fixation with simple uniplanar fluoroscopic guidance has yet to be described.

Many challenges exist with the development of a percutaneous posterior cervical fixation technique, including proximity of critical structures, anatomic variability, radiographic difficulties caused by the overlapping shoulders in the lower cervical spine, and radiation exposure. Transfacet screws may be an ideal option for percutaneous fixation of the postaxial cervical spine.

They are simple to place, with no connecting rods, locking caps, or other associated devices. Subaxial cervical transfacet screw placement was first described in 1972, by Roy-Camille and Saillant, [3] as an alternative method of fixation when lateral mass screw placement is not available because of fracture. Subsequent cadaveric studies have evaluated the biomechanical properties of transfacet fixation and shown it to be equivalent or superior to lateral mass screw and plate or rod constructs in both pullout [4] and flexion, extension, and lateral bending and axial torsion with single-level and multilevel constructs [5] [6].

Takayasu et al. [7] reviewed the outcomes of 25 patients at 4 months to 5 years in whom a total of 81 subaxial cervical transfacet screws were placed. In 10 instances the transfacet screws were used alone, and in 71 instances they were used as anchors with rods for multilevel fusions. All screws were placed by an open technique with the assistance of lateral-view fluoroscopic guidance. No vertebral artery or nerve root injuries occurred. Five screws appeared loose on subsequent imaging, and all 5 screws had been used in the setting of a rod and screw anchorage for a multilevel construct. One patient required revision. Fusion was achieved in all patients.

Despite evidence to suggest that transfacet screws can be safely applied in an open manner, no feasibility studies have been conducted to assess safe percutaneous placement. In a cadaveric study by Lauren et al., [8] transfacet screws were placed percutaneously using biplanar fluoroscopy in cadaveric specimens. Because of multiple breaches of critical structures, including the central canal and the vertebral artery foramen, the study was discontinued after screw placement in 3 cadavers. The authors concluded that with current instrumentation and techniques, percutaneous placement of transfacet screws cannot be safely performed.

Case series

2012

Surgery was successfully performed in three consecutive cases with the use of existing small fragment cancellous screws intended for orthopedic applications.

Ahmad et al in a report describe an initial clinical experience with cervical trans-facet screws, which they found to be a technically feasible option in the subaxial cervical spine for truly percutaneous spinal fixation. However, until percutaneous bony fusion methods are developed, this approach is limited to the fixation application, such as supplementing an anterior fusion construct [9].

Cadaveric studies

Eight cadaveric cervical spines were harvested. One side of each spine was assigned to the percutaneous group, and the other side to the open group. The spines were instrumented from C-3 to T-1 (80 screws). The distance to the spinal canal, foramen transversarium, and neural foramen were measured to determine the likelihood of placing neurovascular structures at risk. The percentage of the facet joint captured and the angle of screw trajectory compared with the ideal trajectory were used to determine the accuracy.

There were, in total, 11 misplacements of screws: 2 screws using the open technique and 9 screws using the percutaneous technique ($p = 0.006$). From a neurovascular point of view, 3 percutaneous screws violated the foramen transversarium. Two of these percutaneous screws violated the neural foramen. No neurovascular foramina were violated using the open technique. The open technique resulted in a significantly greater distance from the screw to the spinal canal ($p < 0.001$). The distance from the screw to the foramen transversarium ($p = 0.015$), as well as the distance from the screw to the neural foramen ($p = 0.012$), did not demonstrate statistical difference when using either technique. As for the accuracy of facet capture, 8 screws exhibited less than 15% purchase of the facet joint. Six of these screws were placed using the percutaneous technique, and 2 screws were placed using the open technique.

There is a higher incidence of screw misplacement using the percutaneous transfacet in comparison to the open transfacet technique. The accuracies of facet capture using the 2 techniques were not statistically different. Surgeons will need to understand the potential risk of using the percutaneous technique as an alternative to open transfacet fixation [10].

2012

Jackson et al., describe a technique for percutaneous transfacet screw placement in the cervical spine without the need for lateral-view fluoroscopy.

Previously established articular pillar morphometry was used to define the ideal trajectory for transfacet screw placement in the subaxial cervical spine. A unique targeting guide was developed to allow placement of Kirschner wires across the facet joint at 90° without the guidance of lateral-view fluoroscopy. Kirschner wires and cannulated screws were placed percutaneously in 7 cadaveric

specimens. Placement of instrumentation was performed entirely under modified anteroposterior-view fluoroscopy. All specimens were assessed for acceptable screw placement by 2 fellowship-trained orthopaedic spine surgeons using computed tomography. Open dissection was used to confirm radiographic interpretation. Acceptable placement was defined as a screw crossing the facet joint, achieving purchase in the inferior and superior articular processes, and not violating critical structures. Malposition was defined as a violation of the transverse foramen, spinal canal, or nerve root or inadequate fixation.

A total of 48 screws were placed. Placement of 45 screws was acceptable. The 3 instances of screw malposition included a facet fracture, a facet distraction, and a C6-7 screw contacting the C7 nerve root in a specimen with a small C7 superior articular process.

The data show that with the appropriate radiographic technique and a targeting guide, percutaneous transfacet screws can be safely placed at C3-7 without the need for lateral-view fluoroscopy during the targeting phase. Because of the variable morphometry of the C7 lateral mass, however, care must be taken when placing a transfacet screw at C6-7.

This study describes a technique that has the potential to provide a less invasive strategy for posterior instrumentation of the cervical spine. Further investigation is needed before this technique can be applied clinically [11)].

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