The sequential hook insertion technique for universal spine instrumentation application

Technical note

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A new technique of universal spine instrumentation insertion for the management of thoracic and lumbar spine instability is presented and the results in 10 patients are described. The technique involves the sequential insertion of Texas Scottish Rite Hospital (TSRH) central-post hooks, followed by hook fixation to the rod; force is then applied with correction of deformity, if needed. This allows for methodical, safe, and rapid instrumentation insertion. The new TSRH central-post hook configuration permits manipulation of the hook/rod relationships to the advantage of the surgeon (and patient) by providing more room for both hook insertion and hook/rod fixation. This technique has reduced operative time, facilitated ease of deformity correction, and provided uniformly acceptable early postsurgical results.

KEY WORDS • spinal instrumentation • Texas Scottish Rite Hospital rod instrumentation • spinal stabilization • surgical technique

The operative insertion of universal spine instrumentation constructs is frequently complicated by a prolonged duration of surgery, which is often attributable to the complexity of the construct used. Manufacturers have attempted to reduce operative time by producing spinal implants with improved ease of application. Surgical techniques have also been modified for the same purpose.

Fear of neurological injury from sublaminar wire or hook placement has resulted in limited utilization of these implants in the region of the spinal cord at the thoracic and thoracolumbar level. With spine instrumentation insertion techniques, neural injury could take place during either the placement or the manipulation of the sublaminar component during surgery, or after implant placement. The incidence of injury during placement or manipulation could be significantly diminished by careful surgical technique, including avoiding intraoperative implant manipulation between the time of insertion of the sublaminar implants (hooks or wire) and securing them to the longitudinal member (the rod).

Early universal spine instrumentation data originated from application of Cotrel-Duboisset systems. Such systems, which utilize sublaminar, facet, or transverse process hooks, have traditionally been somewhat deficient in user-friendliness. Many of the commonly used systems require placement of all hooks or wires (including sublaminar components), followed by insertion of the rod and then fixation of the components to the rod. The presence of a number of unsecured implant components greatly increases the risk of inadvertent implant manipulation and neurological injury. Some hook/rod systems require the positioning of all hooks, followed by insertion of the rod through a hole or into a trough in the hook/rod interface portion of all hooks. Since hook alignment is rarely a straight-line configuration, significant implant manipulation is required, which again increases operative risk.

The intraoperative manipulation and securing of unattached implants is time-consuming, technically demanding, and potentially dangerous. In order to avoid neurological complications and to facilitate speed and safety of application, an insertion technique that employs immediate intraoperative hook-to-longitudinal member security would be optimal. A technique for sequentially inserting and then immediately securing sublaminar implants to the longitudinal member is
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described here, and the use of this method in 10 patients is reported.

Summary of Cases

The central-post Texas Scottish Rite Hospital (TSRH) hook/rod system of universal spine instrumentation was employed in 10 cases. This system uses a central-post configuration at the site where the hook is attached to the rod (Fig. 1), which facilitates the attachment of either side of the hook to the rod. For the seven trauma patients, a 12-hook configuration was used with the construct positioned from three levels above to two levels below the unstable segment. In three patients, complex thoracolumbar and lumbar degenerative deformities were corrected. One or two Danek Crosslinks were employed in all cases (CE Johnston, et al., unpublished data).

Of the seven trauma patients, one had a lateral extracavitary decompression with an accompanying anterior interbody fusion, while six had a simple posterior surgical approach for decompression (if necessary) and fusion. Postoperatively, clinical and radiographic findings were essentially identical to those that have been obtained with traditional, more cumbersome techniques. Correction of the deformity was acceptable in all cases.

Operative Technique

The patient is positioned in either the prone or three-quarter prone position. Following appropriate spinal decompression and posterior subperiosteal exposure of the spine, the hook purchase sites are prepared. The posterior subperiosteal exposure extends from two levels above to two levels below the termini of the planned levels of construct fixation. Thus, the extent of the subperiosteal exposure for the 12-hook technique extends from five levels above to four levels below that of the pathology.

The hook purchase sites for sublaminar placement are prepared by creating generous interlaminar bilateral laminotomies. This is often facilitated by removing the overhanging portions of the rostral spinous processes. Pedicle and transverse process hook placement is performed as previously described.4 The first hook is positioned and the rod attached (medially) by the eyebolt. Before the next hook is secured, the hook/rod complex is held in a safe position by a skilled and knowledgeable assistant. The insertion of the hooks then proceeds from a caudal-to-rostral or a rostral-to-caudal direction. The rod is positioned medially to facilitate the manipulation of the hook insertion site (if necessary) and for hook insertion (Fig. 2 left).

The next hook is then inserted and affixed to the rod after the eyebolt is slid down the rod from the opposite end (Fig. 2 left). Subsequent hook insertions and rod attachments are performed in a sequential manner (Fig. 2 right). Crosslink eyebolts are placed as appropriate. The application of the desired construct forces to the spine is accomplished in an ascending or descending order.

![Fig. 1. A central-post pedicle hook. Note the narrow configuration of the rod attachment site.](image1)

![Fig. 2. Illustrations showing the sequential hook insertion technique. Left: Beginning at the caudal terminus of the system, the first hook has been applied (a sublaminar hook is shown). A second hook is then attached to the rod while the first hook is held in a safe position by manipulation of the rod. Note the room available for hook manipulation, facilitated by the medial positioning of the rod. The eyebolt is slid down the rod, fitted over the hook, and secured. Right: Following compression of the first two hooks together, their eyebolts are tightened and the third hook is inserted in a similar manner. Tightening the hooks as they are inserted enhances the safety of the procedure by allowing each hook to be secured in its desired position in sequence during application.](image2)
The crossed-rod technique of kyphotic deformity correction was used in two cases. This technique provides a similar advantage to that achieved by the Luque rod technique and sequential tightening of wires.\(^3\) The sequential hook insertion crossed-rod technique involves utilizing an ascending sequential insertion technique on one side and a descending one on the other. After one-half of the hooks are inserted on both rods, manipulation of the unattached portions of the rods provides powerful leverage for deformity correction (Fig. 3 left). Following insertion and force application, the Crosslinks are applied (Fig. 3 right).

**Discussion**

**Difficulties With Traditional Techniques**

The complexity of spinal implant systems, combined with an obligatory significant degree of difficulty associated with hook insertion and fixation, considerably prolongs operative time (Fig. 4). Fear of sublaminar hook placement and the potential for its inadvertent manipulation, particularly in the thoracic and thoraco-lumbar region, have appropriately deterred its use. The safety of careful sublaminar hook placement, however, has been established.\(^4-6\) Furthermore, the pedicle and transverse process sites of fixation in the thoracic region are not as secure as sublaminar sites; in the lower thoracic region, transverse process sites are often inadequate. In addition, pedicle (facet) hook placement causes facet joint disruption and, hence, the potential for the development of facet arthropathy.\(^11\)

**Advantages of the Sequential Hook Insertion Technique**

The central-post TSRH system allows for sequentially inserting the hooks, thereby providing the surgeon the ability to affix the hook to the rod immediately following the seating of the hook on the lamina, facet, or transverse process. This advantage alone offers a minimum chance, if any, of neural damage after sublaminar placement and a marked simplification and speed of placement of the instrumentation construct. The security of fixation is substantial, as is the safety of sublaminar hook placement, when applied judiciously.\(^4-6\)

The utilization of transverse process and pedicle sites of fixation does not preclude the use of the sequential hook insertion technique. In fact, the straightforward nature and simplicity of the technique facilitates construct insertion, regardless of the choice of hook position sites.

By inserting and fastening the hooks one at a time, the remaining unattached segment of the rod is unencumbered by other hooks or devices. This greatly improves access to the rod with in situ bending instruments used. In cases in which further contouring is necessary, in situ bending is beneficial in reducing procedure time while providing satisfactory rod contour.

The sequential hook insertion technique offers significant advantages for the correction of scoliotic deformities. With other systems, correction is obtained largely by contouring the rod, securing it, and then rotating the rod to reduce deformity. This so-called "derotation maneuver" provides a somewhat imprecise correction since the exact force applied at each individual spinal level cannot be controlled. This may lead to untoward force applications.\(^1\) With the sequential hook insertion technique, correction of scoliotic deformities proceeds one segment at a time. This allows the surgeon to carefully apply only as much compression or distraction force to each segment as is appropriate. Rotatory deformities can also be corrected by sequentially secur-

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\(^{1}\) E. Benzel, et al.

**FIG. 3.** Illustrations showing the crossed-rod technique of kyphotic deformity correction. *Left:* The system is placed at the rostral end of the construct on the right and the caudal end on the left (first three hooks on each side). The hooks are then sequentially applied in a descending and ascending manner, respectively. This technique allows the hooks to be placed and secured, while leverage applied by the rod is used to sequentially correct the deformity. *Right:* The finished construct with a single Crosslink positioned in the middle of the construct. Two Crosslinks may offer additional stability by providing a quadrilateral frame construct.
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The hooks to an appropriately contoured rod; in situ bending is also occasionally helpful. If necessary, spine derotation can be accomplished with this technique by slightly loosening the hooks that have already been placed and rotating the rod in the usual manner.

Sequential Hook Insertion for Deformity Correction

The crossed-rod technique for kyphotic deformity correction is a very effective approach to the reduction of significant spine deformities. It has been used primarily with the Luque rod technique and sublaminar wire placement, and utilizes sequential wire tightening to achieve deformity correction. The wire tightening proceeds in a rostral-to-caudal direction on one side and simultaneously in a caudal-to-rostral direction on the other.

The crossed-rod technique is very difficult to employ with traditional universal spine instrumentation insertion techniques. The sequential hook insertion technique, however, is easily utilized for this purpose. The rostral-to-caudal order of insertion of the hooks on one side and the caudal-to-rostral insertion on the other, with the gradual correction of the deformity, is easily accomplished (Fig. 3). In order to accomplish construct-facilitated deformity correction with traditional universal spine instrumentation insertion techniques, in situ rod bending or the application of significant force by the surgeon to the construct and the patient’s spine is often necessary, although potentially dangerous.

Conclusions

The sequential hook insertion technique of universal spine instrumentation application simplifies and speeds construct insertion. Furthermore, it is safe and offers a very secure internal splint for thoracic and lumbar instability.

Acknowledgment

The authors recognize and appreciate the expert assistance of Michael F. Norviet, medical illustrator.

References


Manuscript received January 25, 1993. Accepted in final form March 31, 1993.

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