An anterior cervical retractor utilizing a novel principle

Technical note

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The alarmingly high soft-tissue complication rates after anterior cervical surgery suggests that the design of current retractors is inadequate. A review of retractor design and consideration of new designs is worthwhile. The author reviewed the literature and the 7 described devices (Cloward, Caspar, Thompson-Farley, Tresserras, Ozer, Takayasu, and Oh devices). With the exception of Cloward/Caspar and Thomson-Farley systems, the author's search of the literature failed to disclose any independent review or investigations of the other retractors, suggesting that the use of these devices is limited. The Cloward/Caspar-style retractors depend for stability on small teeth at the ends of the blades that impale and stretch the longus colli muscle. For stability this self-retaining design requires equal tissue counterpressure. These devices are thus ill suited for a wound with substantially greater pressure from the medial structures and are prone to migration. The Thomson-Farley type of systems use arms with mechanical joints fixed to a table-mounted frame. The releasable joints allow adjustability and independent relaxation. Their limitations include bulk causing obstruction to the surgeons and radiographs, increased setup time, and ease with which excessive force can be applied.

The author describes a new anterior cervical retractor that is based on a novel principle. The principle is that bone fixation can be used to provide the retractor blade an axis of rotation inside the wound. This gives improved retractor blade stability with the mechanical advantage of a lever. The stable rotation produced allows adjustable retraction and tissue relaxation without compromise in stability. To the author's knowledge, there are no previously described retractors with this ability.

The system consists of a small 2-piece sliding frame fixed to the spine with the distraction screws. Bone fixation is preferable to sharp teeth and longus colli dissection because it works better and heals without scarring. Surgery is carried out through the frame, which slides during distraction. Independent retractor blades are attached to the sides of the frame, which provides a stable craniocaudal axis inside the wound. The blades rotate to provide retraction or relaxation as required. Intermittent relaxation of tissues under retractors has been shown to be beneficial. Another advantage, compared with systems that maintain wounds with vertical sides, is the ease with which an oblique approach can be used. The mechanical advantage has 3 benefits. First, bulky external mechanisms for retraction are avoided, which improves access. Second, numerous blade lengths are unnecessary, reducing inventory. Third, radiolucent polymers can be used with "snap-fit" properties. The improved stability over conventional systems reduces the need for skilled assistance and avoids surgeon frustration after retraction migration.

Over a 3-year period, 100 anterior cervical operations have been performed. Anecdotally, operations are quicker mainly because the retractors do not slip. Prospective clinical studies with independent evaluation are underway. *(DOI: 10.3171/2009.9.SPINE0955)*

KEY WORDS • anterior cervical surgery • retractor • dysphagia • hoarseness

ANTERIOR cervical surgery commonly produces both short- and long-term complications. Dysphagia occurs in 50% of patients at 1 month and 12% at 1 year;[4,20] recurrent laryngeal nerve injury occurs in 15–23% and produces hoarseness in one-third of patients;[3,18] and a sore throat occurs in up to 70% of cases.[26] Rarer but more serious complications are esophageal perforation in 0.25%,[13] airway complications in 6%,[28] and cerebral ischemia in 0.13%.[12,25,27] The use of retractors has been implicated in all of these complications, although the mechanisms are unclear for some.[2,3,8,16,17,21,24,25,32] The frequency of these complications may be inevitable with current retractors, suggesting that consideration of new designs is worthwhile.

Current Anterior Cervical Retractor Systems

Excluding handheld retractors, a review of the literature identified 7 different designs of anterior cervical retractors that have been used clinically: Cloward, Caspar, Thompson-Farley, Tresserras, Ozer, Takayasu, and Oh devices.[5,6,9,14,22,23,29,30,33]

The aforementioned systems are popular because, without them, handheld retractors have to be held stable for a long time by an assistant, who usually cannot see the field properly. For the operation he popularized, Cloward[7,10] developed a twin-bladed retractor for medial and lateral retraction, which pivoted about a hinge. Caspar's device is similar, but the blades slide in parallel along a ratcheting bar.[8,14] These self-retaining types of retractors depend for stability on teeth at the ends of the blade impaling and stretching the longus colli muscle. It is a general feature of this self-retaining design that stability requires equal tissue counterpressure. However all anterior approaches to the spine create asymmetrical wounds, and in the neck the medial structures (thyroid, laryngopharynx, trachea, endotracheal tube, and esophagus) push the retractor laterally, causing it to pivot on the lateral blade's engagement under the longus colli and causing the now loosened medial blades to elevate, thus bringing the teeth dangerously close to the esophagus. This action is countered by depressing the medial side of the retractor with weights, towel clips, sutures, hands, and so on. If the longus colli muscle stretches or tears, increased separation of the blades is required for restabilization, creating a vicious cycle. Informal inquiries in the United Kingdom, Australia, and India suggest that these are the most commonly used retractor systems. Modern versions of these designs, such as the Shadowline, Trimline, and Koros Black Belt, represent improvements in blade connectivity, but have not addressed the inherent instability.

A search of the literature found independent reviews or investigations for the Cloward/Caspar and Thompson-Farley systems only, suggesting that the use of others was or is limited.

A Novel Principle for Retractor Design

The novel principle is that bone fixation can be used to provide the retractor blade with an axis of rotation inside the wound. This gives improved retractor blade stability with the mechanical advantage of a lever. The stable rotation produced allows adjustable retraction and tissue relaxation without compromising stability. To the author's knowledge, there are no previously described retractors with this ability.

The 2 elements of bone fixation and rotation have been used before but separately. Fixing retractors to the spine occurs when retractor blades, with integral channels are screwed or pinned to bone. Rotation of retractor blades about a vertical axis—that is, parallel to the long axis of the blade—is used widely in surgery because it allows the retractor blade to conform to the tissue pressure. Most table-mounted ring or frame retractor systems allow such blade rotation, and some also allow the blades to rotate about a horizontal axis lying outside the wound, so-called toeing in. Rotation about an internal axis is used in the Taylor device[31] and in others of similar style, which lever the soft tissues by using the bone as a fulcrum. This improves stability and mechanical advantage compared with handheld retractors. To improve stability further Taylor-style retractors can be impacted into the bone. In
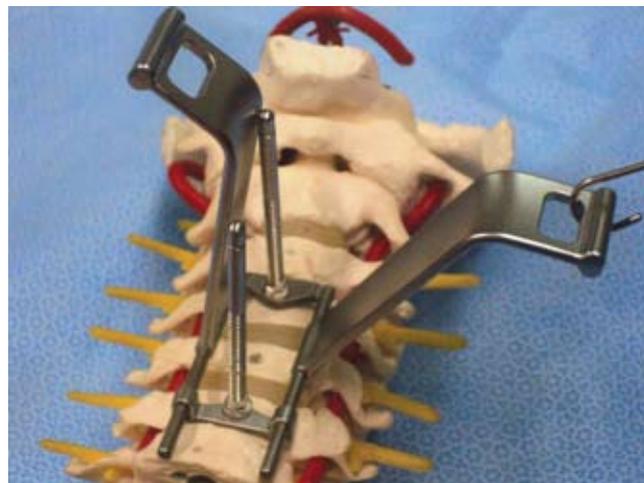

FIG. 1. The 2-piece sliding metal frame, on a model, showing rotation of blades.

this case, attempted rotation requires that they bend or the impacted tip tears the bone and thus loosens it. Retractor rotation, however, is desirable because it allows tissue relaxation, which has been shown to reduce spinal muscle injury and pain as well as being beneficial to neural tissue.[1,11,15,19] The authors of a recent study found differences in a calculated index of recurrent laryngeal irritation during anterior cervical discectomy and fusion that favored periodic release of handheld retractors as opposed to conventional retractors.[11] Conventional retractors, after release to allow for tissue relaxation, cannot always be easily or safely relocated. This discourages surgeons from relaxing the retractors.

Description of the New Anterior Cervical Retractor

The device is the first to use bone fixation as a means of providing an axis of rotation for the retractor blade inside the wound. This gives improved retractor blade stability with the mechanical advantage of a lever. The

FIG. 2. The 1-piece polymer set, 3 frames, 2 lengths of blade, screw marker, distraction screws, and driver.
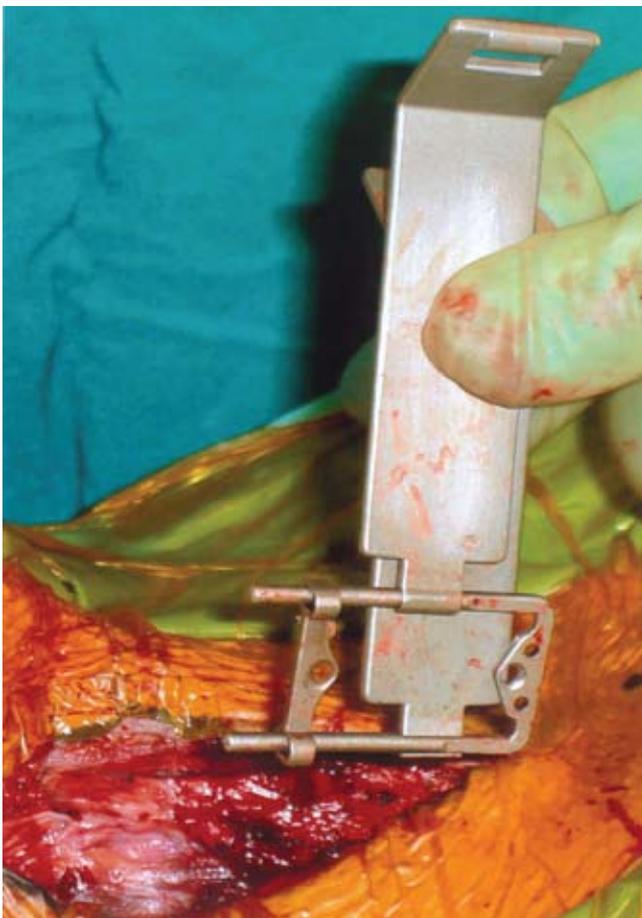
Fig. 3. Flat-packed frame about to be inserted through oblique incision. Photo courtesy of Dr. P. Moloney.

Fig. 4. Intraoperative photograph obtained after discectomy with polymer blades and Caspar distractor.

stable rotation that is produced allows adjustable retraction and tissue relaxation.

The first device used in clinical practice consisted of a small 2-piece sliding frame fixed to the spine with the standard distraction screws (Fig. 1). Lateral blades of metal were hooked to the frame. Subsequent use of polymer blades has improved the connection, allowing them reversibly to clip to the sides of the frame. The latest device is a simpler 1-piece polymer frame (Fig. 2). Despite numerous changes to manage distraction or adjust size, the principles and mechanism of retraction have remained unchanged from the outset, and it is these that have the most originality and justify broader consideration.

Technique of Insertion and Use

The conventional anteromedial approach is performed using handheld retractors. The prevertebral fascia is opened widely using a pledget. This creates a large space beneath the fascia that contains the sympathetic chain anterolaterally. Localizing radiography, for level and midline, is conducted with a marker. A superficial discectomy is performed to identify the disc space endplates and angle. Large osteophytes are best removed at this point. The frame is then placed into the prevertebral space under the fascia, either on its own or "flatpacked"

with the blades already attached (Fig. 3). Insertion into the wound is most easily done using a finger to sweep the tissues around the frame. The frame is positioned centrally over the disc space and on top of the longus colli muscle. The first distraction screw is inserted through the frame into the vertebral body parallel to the endplates. Marking the midline initially helps ensure that the frame position is central. The more easily accessible end is done first. If using the 2-piece frame (Fig. 1), the mobile spar is then positioned over the other vertebral body and the second screw inserted through this. If the 1-piece frame (Fig. 2) is used, the screw is inserted but not tightly. Bone is a preferable choice for retractor fixation because, unlike soft tissue, it heals without scarring. If plating is required, screws need to be in the outer third of the body to allow room for plate fixation inside the frame. If blades are not already attached, they can now be clipped on. The longus colli muscle covering the disc space is resected and surgery is performed through the gap in the frame (Fig. 4). The conventional Caspar distraction system works normally. With the 2-piece frame, the mobile spar slides during distraction, while with the one-piece frame the screw slides within the frame. The oval ends of the mobile spars accommodate physiological or induced lordosis or small osteophytes. The polymer 1-piece frame can flex. Most prostheses, grafts, or plates can be placed through the frame (Fig. 5), but plate insertion requires careful initial screw insertion or frame removal. For 2-level procedures a single-level frame can be used and repositioned or a 2-level frame can be used with the blades sliding between levels (Fig. 6).

The independent blades can rotate to retract or relax (Fig. 1). A Babcock forceps is attached to the hole at the end of the blade as a rotating handle, although an assistant's finger or a hook with weights also works satisfactorily. Intermittent resting of the tissues is performed. The system is particularly helpful when decompressing the contralateral foramen because blade rotation creates a more oblique angle of approach and more lines of sight around the drill or instruments. This obliquity also minimizes medial tissue retraction. The mechanical efficiency
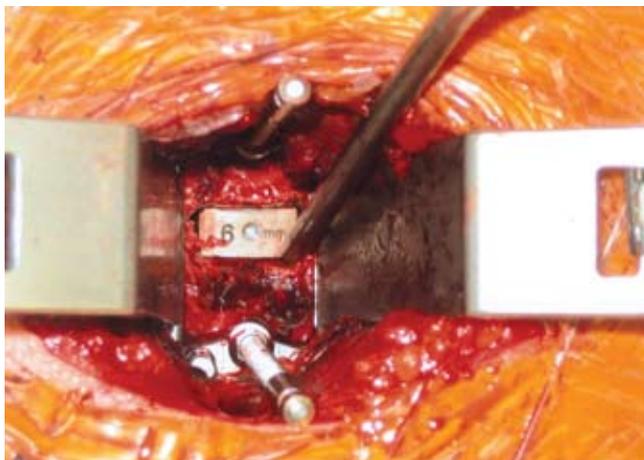
FIG. 5. Intraoperative photograph acquired after placement of a single-level cage inside the frame.

FIG. 6. Intraoperative photograph obtained after placement of a 2-level plate inside the frame.

resulting from the internal fulcrum reduces the retraction force required, and this means that strong external mechanisms for retraction are avoided, numerous blade lengths are unnecessary, and weaker radiolucent polymers can be used with snap-fit properties. The improved stability avoids surgeon frustration due to retractor migration midprocedure.

Limitations of the Device

The problems with screw fixation are the same as those of a screw-based distraction system—namely, screw loosening during distraction if the bone is weak. This has occurred but has not affected frame function. Bone density measurements could be performed but have not been considered necessary to date. It is possible to insert plates through the frame, but careful craniocaudal screw positioning is required and sometimes the frame needs to be removed and the plate inserted using handheld retractors alone. This is preferable to placing screws into the adjacent disc. Intervertebral spreaders can be used for distraction, but the frame restricts their lateral placement. Very large anterior osteophytes may need to be removed before frame fixation, both for frame positioning and for bone preparation prior to plating. Longer screws than usual (usually 16 mm) are required to accommodate the depth of the frame at 3 mm. Inserting the frame smoothly has a learning curve and requires care.

Personal Clinical Experience

The device and its modifications have been used by the author and a few colleagues since 2005. Over 100 cases to date have been undertaken. These have included discectomies, corpectomies, bone grafts, cages, plates, and artificial discs. Multilevel surgery can be done by moving the single-level frame or using longer frames. This anecdotal experience has shown no serious or long-term soft-tissue complications to date, although early dysphagia has not been prevented. As several different devices have been used during development, no detailed clinical series is offered here.
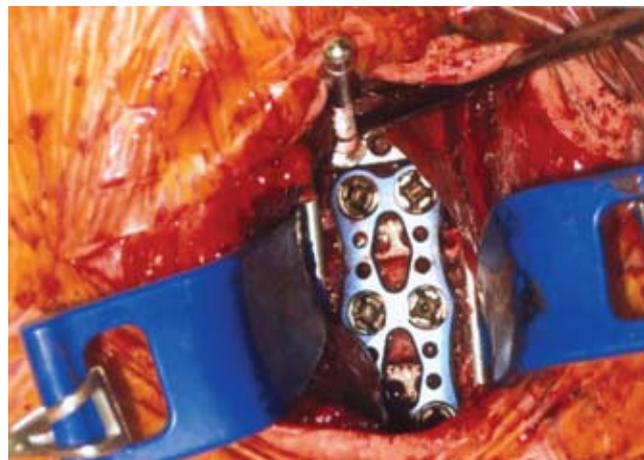
The key clinical questions about whether this type of system can reduce soft-tissue complications have yet to be determined and require unbiased investigation.

A prospective randomized study involving the system is nearing completion (http://www.anzctr.org.au/trial_view.aspx?ID=82849).

Summary

A new system for anterior spinal retraction is presented and its novel principles described.

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