Failed anterior cervical foraminotomy

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Hacker, et al., have retrospectively reviewed 23 patients who underwent anterior cervical foraminotomy between 1998 and 2000. Seven (30%) of 23 patients required additional surgery and only 12 patients (53%) experienced a good or excellent outcome. The authors concluded that anterior cervical foraminotomy is not recommended as a stand-alone procedure because of its high reoperation rate. Their experience is quite different from mine. Although other publications following my original report on anterior cervical foraminotomy have shown positive short-term outcomes, I have heard of horrible postoperative complications such as spinal instability requiring extensive fusion and brainstorm stroke due to vertebral artery (VA) injury. The proceeding report is timely in its cautioning of others that anterior cervical foraminotomy performed by an inexperienced surgeon can result in a high rate of serious complications.

In addition to conventional surgical procedures, alternative operative invention for degenerative spinal disorders has branched into two distinct trends: minimally invasive percutaneous surgery; and aggressive radical surgery, implantation of hardware, and bone fusion. Although minimally invasive spinal surgery tends to produce incomplete treatment, radical surgery can be associated with deleterious anatomical and functional effects. Ideally, surgery would not only be a minimally invasive, biologically compliant, effective procedure involving minimal risks but also a cost-effective overall treatment. The original anatomy and function of the human body need to be respected in surgical repair. In light of these ideal criteria, this concept would be termed functional spinal surgery.

The classic procedure for cervical radiculopathy has been anterior cervical discectomy and fusion (ACDF) or posterior foraminotomy. Posterior foraminotomy has been associated with excellent outcomes in the literature. In addition, it does not require sacrifice of a functioning motion unit. It has, however, been less favored than anterior procedures because the pathological process is often located anterior to the nerve root, surgical positioning is difficult, epidural bleeding is burdensome, and postoperative incision-related pain is significant. For a half century ACDF has persisted as a classic therapy. The debate over bone graft–assisted fusion following anterior discectomy has been settled over the years. The ACDF procedure provides good access to the spinal cord canal but not the neural foramen. Thus, discectomy without bone fusion will cause vertical collapse of the neural foramina. Because of the narrow margin between the nerve root and the neural foramen in the cervical spine, placement of an intervertebral bone graft provides significant relief from radiculopathy. In addition, metal constructs have been recently combined with bone graft fusion to confer immediate stability and enhance the subsequent fusion mass. Hardware-augmented bone fusion is a prevailing therapy in spine surgery. The biomedical industry, hospitals, and surgeons all favor this aggressive practice whereas patients and health insurance companies may not. This aggressive intervention has been associated with good fusion-related outcomes in the literature.

Despite the excellent reported outcome, however, poor clinical results related to bone fusion have been our routine findings. As noted in a small number of cases in the proceeding report, the surgery-related outcome is dismal, not to mention the long-term outcome. In four of seven patients the final fusion-related outcome was poor. Surgery-related complications are also apparent in their series. Pseudarthrosis required a second fusion procedure. Anterior fusion resulted in graft extrusion and required additional multiple fusion operations. In three patients with preoperative intractable neck pain, surgery failed to resolve this symptom in all cases. The authors, however, mentioned their good surgery-related results in their cervical spine practice. Perhaps the failed fusion surgery–related outcome in this group is not typical of that achieved in their other patient groups. On the other hand, there may have been no further surgical remedy to prevent these dismal outcomes. Only when a biological remedy or an artificial spine motion unit becomes available might these fusion-related problems become a matter of fact.

Theoretically, it is intuitive that compressive radiculopathy would resolve, if the nerve is not permanently damaged, whenever the compressive vector is eliminated. This hypothesis proved to be correct according to our experience in anterior and posterior procedures to treat cervical radiculopathy. A question arose: could further surgical innovation achieve the treatment benefits of anterior and posterior cervical procedures? That is, could the compressive...
vector be directly eliminated, as it is in an anterior approach, while preserving a motion segment, as is possible in a posterior foraminotomy? The answer arrived in the form of the anterior cervical foraminotomy, which was invented as a functional cervical spine procedure. This method was completely new in concept and technique. The techniques required for anterior cervical microforaminotomy have progressively evolved since my first report in 1996. I have performed more than 700 anterior cervical microforaminotomy operations for various cervical diseases. I have not performed a single fusion procedure in my series, nor have I observed recurrent disc herniation at the treated disc. The reason for the difference between my results and those reported by Hacker, et al., compel me to address the surgical techniques.

In my initial report I mainly explored the concept of surgical treatment of cervical radiculopathy as applied to an early patient series. The concept involved direct removal of the compressive pathological entity while preserving the motion unit. Soon, several technical modifications were made to ensure a precise approach to the various lesions and to preserve the anatomy as much as possible. Resection of the uncovertebral joint does not correctly describe an anterior foraminotomy. The target is a compressive vector at the nerve root, not the uncovertebral joint. Access to the target can be made using several variations. Despite technical variations involved in reaching the target, the integrity of the intervertebral disc and spinal stability should be well maintained. In my original report, the anterior microforaminotomy was performed to treat cervical radiculopathy by removal of the far-lateral portion of the uncovertebral joint (Fig. 1 left).

Although it was intended for application in spinal cord decompression or tumor resection, several variations of this technique soon evolved. In one, the longus colli is split in lieu of the partial transversectomy initially reported.

The first variation of my initially reported technique is a “transuncal approach.” Instead of the originally described mediolateral approach at the uncovertebral joint, a lateromedial approach from the medial margin of the VA is adopted. Although termed the transuncal approach, the uncinate process is not completely excised. The far-lateral margin of the uncinate process (Fig. 1 center) and the medial portion of the transverse foramen of the superior vertebra is trimmed posteriorly toward the posterior longitudinal ligament; the trimmed portion is 1 to 2 mm thick and 4 to 5 mm long. The medial 2 to 3 mm of the transverse foramen is trimmed as well. The medial wall of the uncinate is preserved to keep the disc intact (see Fig. 1 left [arrows] denote the preserved medial wall of the uncinate to the right of the C5–6 disc space in a patient who underwent right-sided C5–6 transuncal anterior foraminotomy). Disc fragments and/or bone spurs are excised via a foraminotomy hole by using specially designed curettes and microdissectors. Surgery requires a high-magnification microscope and precision. Because this entry point often leads to the upper edge of the pedicle posteriorly when the surgical trajectory is made perpendicular to the longitudinal spinal axis, the approach has to be gently inclined cephalad to reach the surgical target precisely posteriorly (“B” in Fig. 2 left indicates a surgical trajectory).

The intervertebral cervical disc in a sagittal plane incides cephalad in an anteroposterior direction. To reach the pathological entity directly, the anterior entry point at the anterolateral spine has to be superior to the actual anterior surface of the uncovertebral joint. Thus, my second variation of anterior microforaminotomy for the treatment of radiculopathy requires the surgeon to make a bone opening at the medial 1- or 2-mm portion of the anterior rim of the transverse foramen and 3- to 4-mm portion of the very-lateral and inferior margin of the upper-level vertebra just superior to the uncinate process tip (Fig. 1 center [entry site A]). This entry hole will lead precisely to the compressive lesion when the bone opening is advanced posteriorly perpendicular to the longitudinal spinal axis because, again, the intervertebral disc interface is inclined cephalad posteriorly (Fig. 2 left [trajectory indicated by A]). I named this second variation an “upper-vertebral-transcorporeal approach” for anterior microforaminotomy. In this second variation unnecessary extension of the cervical spine is avoided in patient positioning. Figure 1 center provides a postoperative anteroposterior (AP) radiograph demonstrating a bone opening in a patient who underwent this operation on the left side of C6–7. Figure 2 right shows a parasagittal T2-weighted magnetic resonance (MR) image demonstrating a surgical tract involved when this technique is used. This second variation is the most common for cervical radiculopathy in my patient series. The anterior foraminotomy technique has to be individually tailored, just as any other surgical approach, to the anatomy surrounding the pathological process.

The third variation is a “lower-vertebral-transcorporeal approach,” which involves anterior bone opening at the base of the uncinate process of the lower vertebra (Fig. 1 center [entry site C]) and a trajectory aimed at the posterior compressive entity (Fig. 2 left [entry site C]). I have occasionally used this variation when treating a higher cervical disc (C3–4) or when a skin incision is inadvertently made too caudal to the level of the disc. Because the trajectory from the skin opening to the final target is performed in a cephalad orientation, the bone opening has to be initiated at the base of the uncinate process of the inferior vertebra. Once the foraminotomy hole is completed, the targeted entity will be reached. I named this a lower-vertebral-transcorporeal approach for anterior microforaminotomy because the trajectory involves the lower vertebral body.

The fourth variation is anterior cervical foraminoplasty, which loosely combines all three variations; however, it maintains the integrity of the intervertebral disc while shaving up excessive bone spurs along the medial wall of the neural foramen to allow reconstruction of the neural foramen. When postoperative radiographs and MR images are obtained, the surgical site will appear as an normal, wide neural foramen. I use this foraminoplasty to treat foraminal stenosis caused by excessive spondylotic bone spurs. I have also modified this foraminotomy technique to treat other disease processes such as spondylotic myelopathy, ossification of the posterior longitudinal ligament, and intradural spinal cord tumors. Surgery-related outcome has been extremely satisfactory in my patient series. Although I still perform endoscopic posterior foraminotomy in selected patients, I have not performed conventional anterior discectomy and fusion for many years. The anterior microforaminotomy procedures have com-