

A Modified Footplate for the Kerrison Rongeur

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ABSTRACT

Background

Use of the Kerrison rongeur for bone removal in spinal surgery is associated with dural tears and cerebrospinal fluid leaks. We report a modification of the Kerrison rongeur footplate designed to reduce the risk of dural tears.

Method of Approach

A novel footplate was designed by incorporating the following parameters: 1) tapering the footplate to deflect soft tissue downward during positioning of the rongeur underneath the bone and 2) making the footplate longer and wider than the cutting element to prevent soft tissue from seeping into the cutting surface. Stereolithography models of the modified footplate were made and tested in a cadaver. The modified footplate was then incorporated into an existing Kerrison rongeur as a working prototype, and tested in 20 laminectomy cases to clinically validate its design.

Results

The modified footplate prevented soft tissue from entering the cutting surface of the Kerrison rongeur in the manner intended by its design. No dural tears or CSF leaks were encountered in any instance. Potential soft tissue compression caused by an increase in footplate dimensions was not a significant issue in the rongeur size tested. This modification, however, might not be practical in rongeurs larger than 3mm.

Conclusions

The risk of dural tears and cerebrospinal fluid leaks in spinal surgery may be reduced by this footplate modification of the Kerrison rongeur. Soft tissue compression may limit the incorporation of this modification to rongeurs 3mm or smaller.

Keywords: Intraoperative complication, laminectomy, spinal stenosis, spine surgery, surgical instruments

BACKGROUND

Unintended durotomies are common and have been reported to occur in 4-16% [Epstein,13,14] of lumbar spine operations. Since lumbar laminectomies and discectomies are among the most common procedures performed in hospitals (excluding those related to pregnancy and childbirth) [6], incidental durotomy is a problem of significant epidemiological importance. Sequelae include headache, tinnitus, vertigo, nerve palsies, pseudomeningocele, durocutaneous fistulas, intracranial hemorrhage, meningitis, arachnoiditis, and epidural abscess [10]. Although some authors have advocated early mobilization [4,8], incidental durotomy frequently results in extended periods of bed rest or CSF diversion [5,15] and may require reoperation for repair [4,8]. While some authors have found no significant long-term effects at 2 years [1,7], others have found it to adversely affect outcome 10 years postoperatively [11]. In addition to the clinical implications, incidental durotomy is the second most common cause of litigation in spine surgery [3], itself the dominant source of malpractice claims in Neurosurgery [2].

In lumbar surgery, dural tears are most often associated with use of the Kerrison rongeur [13]. This can occur while tearing ligament or scar tissue adherent to dura, or if a fold of dura inadvertently is caught into the cutting surface. Although many different proprietary versions of the Kerrison rongeur exist, few modifications have been previously reported, and none specifically address its safety [9,12]. Here, we report a useful modification of the rongeur footplate intended to prevent dural tears.

METHOD OF APPROACH

Technical Description

It is believed that the current design of the Kerrison rongeur does little to prevent the occurrence of dural tears during use. A number of modification strategies were studied including an active retractable metal barrier, a jet of pressurized air, altering the closure force and altering the size and shape of the footplate and shaft. The simplest and least cumbersome modification involved altering the footplate so that it deliberately keeps soft tissue away from the cutting surface. Two specific design parameters were employed to accomplish this goal: 1) the footplate was tapered to deflect soft tissue downward during positioning of the rongeur underneath the bone and 2) the footplate was made both longer and wider than the cutting element to prevent soft tissue from seeping between opposing surfaces during instrument occlusion. The tapered end of the rongeur reduces the amount of material at the tip of the footplate, resulting in less underlying soft tissue compression. Meanwhile, the strength of the cantilever design is maintained since the force on the footplate is concentrated at its root, and perhaps improved due to the introduction of a flange [Fig. 1].

Initially, plastic stereolithography (SLA) models of the footplate were designed using computer-aided design software (SolidWorks Corporation, Concord, MA) and produced as snap-on additions to an existing 3 mm Kerrison rongeur. Two of these models with different sizes of overhang (0.5 and 1 mm) were made then tested in a cadaveric model [Fig. 2].

RESULTS

Laboratory Testing

While some improvement over the current design was noted with the 0.5 mm addition, dural tears were still possible. The 1 mm addition, however, effectively prevented soft tissue from entering the cutting surface, and resulted in little additional interference while manipulating the footplate of the rongeur underneath the bone.

Clinical Experience

A prototype with 1 mm of additional length and width of footplate was produced by machining and microwelding an addition of surgical grade stainless steel onto an existing 3 mm Kerrison rongeur [Fig. 3]. We documented the effectiveness of this footplate in clinical applications by testing it on 20 patients undergoing surgical treatment of spinal stenosis and we continue to use it routinely in spine cases. Despite its tapered end, the footplate retained its strength. We found that the modified footplate prevents soft tissue from entering the cutting surface of the Kerrison rongeur in the manner intended by its design, and no dural tears or CSF leaks have been encountered to date. Thus the modified Kerrison appears effective at preventing incidental durotomy.

DISCUSSION

Use of the Kerrison rongeur may be associated with tearing of the dura by nature of its design. The lack of direct visualization, along with the absence of inherent active or passive mechanisms to exclude soft tissue from the instrument's cutting surface, places

adjacent structures at risk. In this paper, we describe a modification intended to improve the safety of the Kerrison rongeur and to prevent potential morbidities associated with dural tears. Since incidental durotomies are frequent [13,14] and are associated with added morbidity [11], trying to reduce the occurrence of this common complication is important.

Specifically, our design involved two passive modules: 1) tapering the undersurface in order to deflect tissue downward during positioning of the footplate underneath the bone and 2) increasing the dimensions of the footplate at its forward and lateral aspects to keep soft tissue away from the opposing surfaces of the instrument [Fig. 3]. The modification was first designed as a snap-on addition to an existing rongeur and various sizes of the footplate were tested on cadaveric models. A fully functional prototype of the footplate was then produced by a machining process, followed by microwelding of the addition onto an existing Kerrison rongeur. This prototype proved to be effective in 20 laminectomy cases and did not cause any adverse effects.

There are two disadvantages to this modification. Since the footplate size has been increased, one effectively loses cutting width with each bite. The prototype tested was built into an existing 3 mm rongeur, and the size of the modified footplate added 1 mm of length at the forward aspect and 1 mm of width on each side. It is likely that similar modifications on 4 and 5 mm rongeurs will be impractical due to the excessive width of the resulting footplate and difficulty inserting and positioning the instrument. Additionally, since the cutting surface does not come right up to the edge of the

instrument, there are situations in which the instrument is ill-suited, such as removing small bone spicules from the cut edge of a laminectomy for example. The modified instrument however is ideal for central canal decompression, especially when the dura is patulous or when working in a lordotic region of the spine, such as the L5-S1 junction, where the dura can abut the leading edge of the instrument.

Our modification is not intended to eliminate the usual epidural dissection, especially for reoperations. Cerebrospinal fluid leaks are still possible if one tears tissue adherent to dura, as may occur with dull instruments. The usual preparatory practice of detaching any dural adhesions from the overlying bone or ligament is still required, although the leading edge of the instrument itself can function as a dissecting tool. In this regard, this footplate design appears to confer an advantage in terms of preventing dural tears caused by the simultaneous inclusion of bone and soft tissue inside the cutting surface of the instrument.

CONCLUSIONS

We modified the footplate of a Kerrison rongeur in an effort to reduce the incidence of CSF leaks in spinal surgery. The instrument bears a wider, more tapered footplate that effectively counteracts the tendency of soft tissue to enter the cutting surfaces. The modified Kerrison rongeur has been used effectively, and has not been associated with unintended durotomies in 20 patients.

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FIGURE LEGENDS

1. A novel footplate design was created for the Kerrison rongeur that features a tapered bottom as well as a top surface that is wider and longer than the cutting shaft. This geometry was intended to deflect surrounding soft tissue from the cutting area. **A**, Angled view, **B**, side view.
2. Stereolithography (SLA) was used to create a model of the modified footplate as a snap-on addition to an existing Kerrison rongeur. Here, the model (1 mm of overhang) is being tested in a cadaver spine to assess for potential risks and benefits prior to intraoperative use. The footplate design allows for clearance of dura away from the cutting surface.
3. A prototype of the modified Kerrison rongeur was made by microwelding an addition of surgical grade stainless steel onto an existing Kerrison rongeur. **A**, Side view showing tapered footplate. **B**, Front view showing flange. **C**, Top view showing the wider footplate dimensions relative to the shaft. **D**, Top view with instrument in occlusion.

FIGURE 1

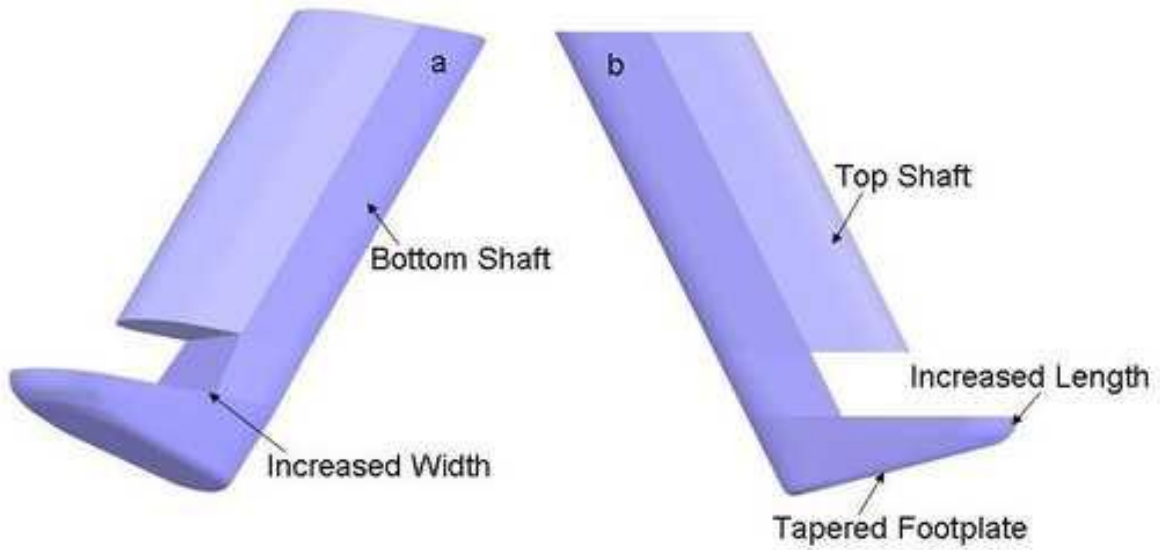


FIGURE 2

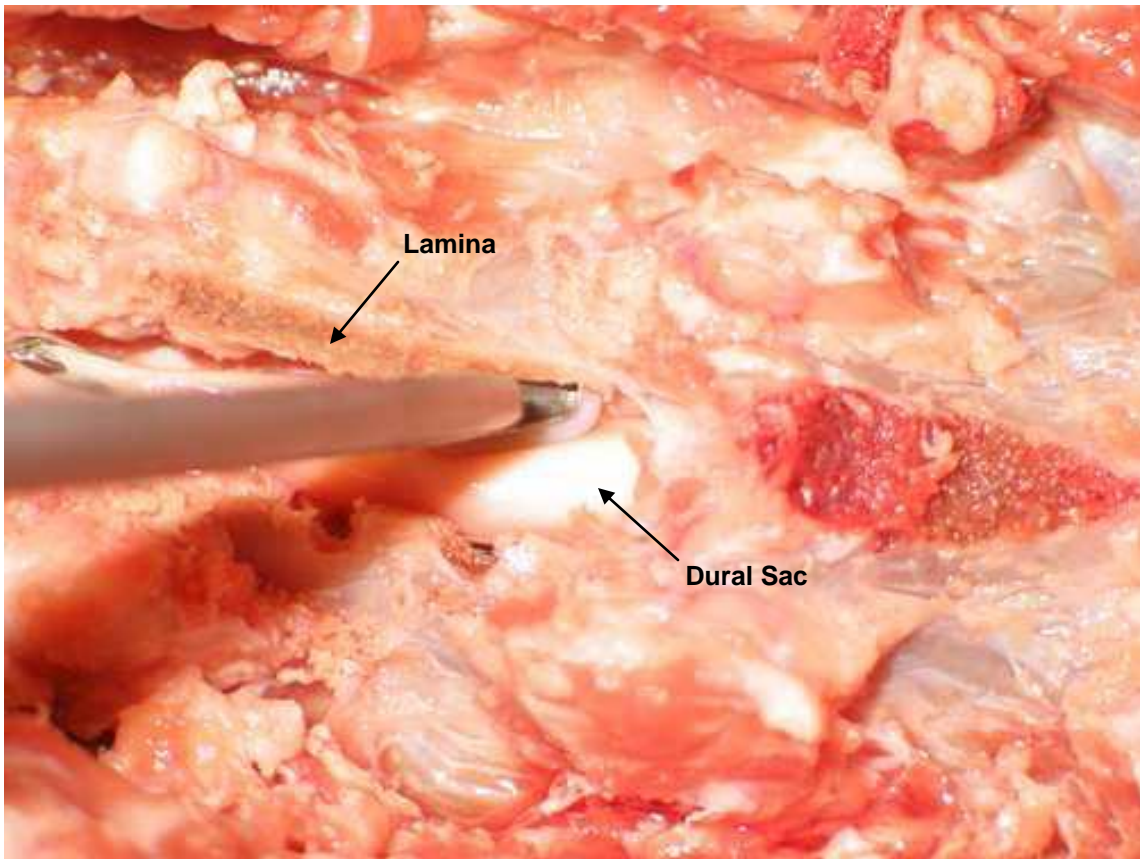


FIGURE 3A

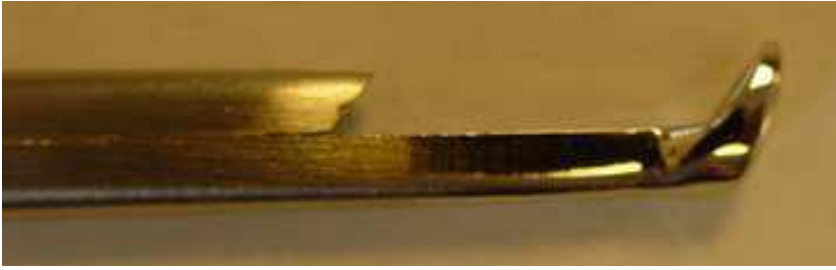


FIGURE 3B



FIGURE 3C



FIGURE 3D

Modified Footplate for the Kerrison Rongeur

