Pneumatic Powered Kerrison Rongeur in Spine Surgery Can Benefit Patient and Surgeon

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Abstract: Spinal deformity surgeons are at increased risk of overuse injuries. The use of power instruments has been incorporated to reduce the rate of occupational injuries and increase efficiency of surgery without increasing risk to the patient. The pneumatic powered Kerrison rongeur minimizes the force a surgeon must apply and theoretically may increase precision. The purpose of this paper is to review the technique and safety of the pneumatic Kerrison in pediatric spine deformity surgery.

Key Concepts:

- Surgeons are at risk for overuse injuries; power surgical instruments help minimize muscular force exerted by the surgeon compared to manual instruments.
- The excursion and force of the pneumatic Kerrison is easily controlled by surgeons' fine muscle control with a finger trigger with increased precision and less fatigue compared to a manual Kerrison, especially when significant biting force is required.
- In our experience, we have not had intraoperative or postoperative complications associated with the pneumatic Kerrison.

Introduction

Orthopaedic surgery is a physically challenging profession that is associated with various occupational injuries. Surgeons are situated in nonergonomic positions for prolonged periods of time while using physically demanding tools. Subsequently, as many as 66% of orthopaedic surgeons experience pain while operating, with 40% attributing the pain to operating instruments.[1] Auerbach et al. surveyed the Scoliosis Research Society and found that spine surgeons with greater caseloads and a higher number of deformity surgeries had increased prevalence of back and upper extremity pain, respectively.[2] Spine surgeons also exhibit higher rates of lateral epicondylitis compared to the general population, and with rates similar to workers performing repetitive manual tasks.[2,3] Surgeons are at three times greater risk of developing occupational injuries such as carpal tunnel syndrome.[4]

One of the workhorse instruments in spine surgery is the Kerrison rongeur, which is used for removal of ligaments/bone adjacent to neural elements. In pediatric spine surgery, a Kerrison rongeur is often used for posterior column osteotomies and neural decompression.

Power instrumentation has been incorporated in adult and pediatric orthopaedic surgery to reduce the high rate of occupational injuries in surgeons and increase efficiency of the surgery without increasing risk to the pa-

tient.[5,6] Recently, the pneumatic-powered Kerrison rongeur has been reported to help alleviate the manual fatigue and soreness surgeons face while performing spine surgery.[7] Components of the pneumatic Kerrison are shafts of variable length (235 or 285mm) and biting blades of various widths (2-6mm), single-use tubes for compressed air, and a pressure regulator. The pneumatic Kerrison is equipped with a finger trigger that causes biting of the blade in response to changes in force and speed of compression.[7,8] Importantly, the surgeon utilizes fine motor control (little force) to operate a pneumatic compared to a manual design, with power amplifying this force to the biting end. Thus, large muscles are not recruited which minimizes surgeon muscular fatigue and effort, while maximizing control and precision. A good analogy is surgeons trained in micro-surgery are taught to rest their forearms on pads, to help ensure the larger arm muscles are relaxed, so only the finely controlled muscles of the hand are used. This minimizes jerky or forceful movements, which can be catastrophic around neural elements.

Description of the Method

To set up the pneumatic Kerrison system, connect an airhose to a central compressed air supply with pressure set according to recommendations from the manufacturer (Figure 1).

Figure 1. *OR wall gas (nitrogen) outlet. (Used with permission from the Children's Orthopaedic Center, Los Angeles)*

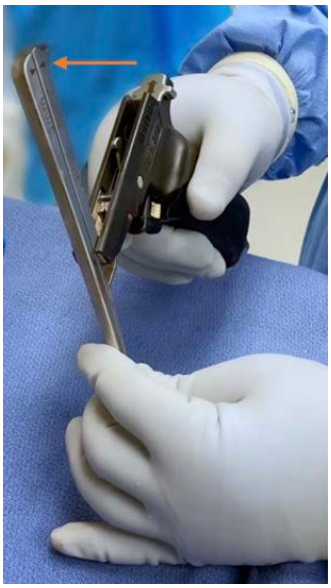
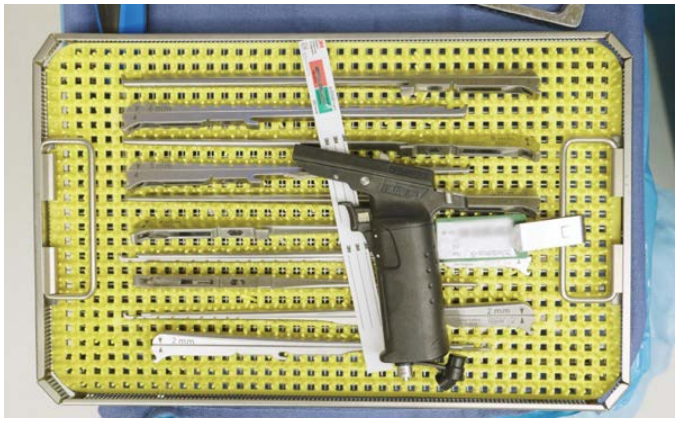


Figure 2 (left). *Placing a shaft/biting blade onto the handpiece. Ensure arrows on the shafts are properly aligned (orange arrow). (Used with permission from the Children's Orthopaedic Center, Los Angeles)*

Figure 3 (below). *Kerrison in its tray showing biting blades of various widths (2-6mm). (Used with permission from the Children's Orthopaedic Center, Los Angeles)*



A tube is then connected to the Kerrison. Various sized shafts/biting blades can be inserted onto the handpiece (Figure 2).

The pneumatic Kerrison rongeur is equipped with handles and shafts of different lengths and widths to accommodate variation in resection (Figure 3).

The mechanical safety lever and on/off switch can be used to prevent unintended activation of the Kerrison.

Pulling the trigger until resistance is first met grasps the intended tissue with 5kg of force. Decompression of the trigger upon meeting initial resistance releases the tissue. A complete pull of the trigger cuts the tissue with a maximum force of 70kg. We have found maximum control can be obtained while holding the end of the shaft near

Figure 4. *Wide shot of the Kerrison demonstrating the surgeon's fingers that stabilize the shaft near the cutting end, with the hand/forearm stabilized on the patient's body. Care is taken not to grasp the non-mobile superior half of the shaft preferentially (see below). (Used with permission from the Children's Orthopaedic Center, Los Angeles)*

the cutting end while this hand is stabilized on the body (Figure 4). This is analogous to a micro-surgeon stabilizing hands and forearms.

The upper half of the shaft moves back and forth, and the lower half is non-mobile, rigidly attached to the main portion of the Kerrison. The surgeon holds the lower shaft to maintain positioning while the upper half of the Kerrison moves to perform the "biting" (Figure 5). If a surgeon incorrectly holds only the upper mobile half of the shaft, when the rongeur opens, the bottom half of the shaft moves forward relative to the top half **which could potentially injure neural structures.** As long as the surgeon pulls upward, away from the spinal cord like would be done with any Kerrison, there should not be a problem.

We have found any procedure that is typically done with a manual Kerrison can be performed with the pneumatic Kerrison, including laminectomies, neural decompression, and osteotomies. For the purposes of illustration, the authors will describe the use during posterior column osteotomies during deformity correction. The spinous processes are removed as needed, and bilateral inferior facetectomies are performed with an ultrasonic bone cutting tool. For large deformities or areas of significant

Figure 5. *Proper technique of holding the bottom shaft, which is non-mobile and rigidly attached to the body of the Kerrison. (Used with permission from the Children's Orthopaedic Center, Los Angeles)*

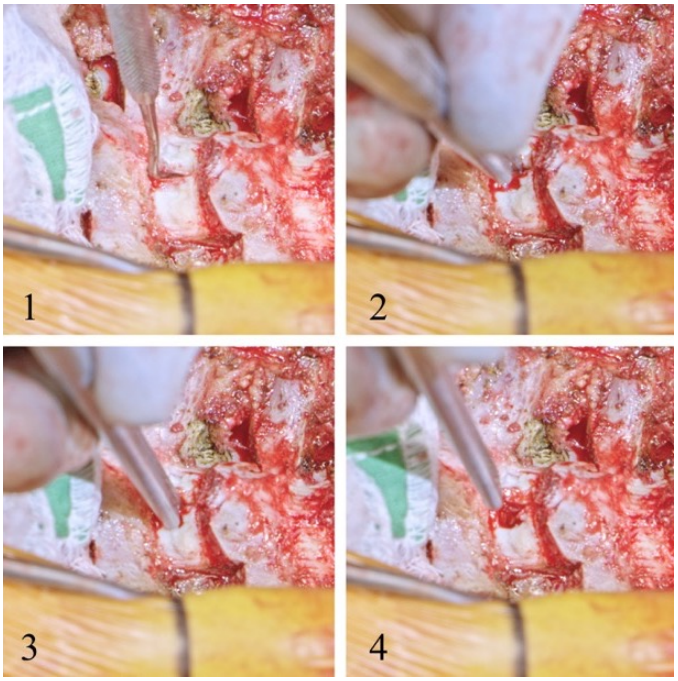


Figure 6. *A dental tool may be used to confirm access to midline epidural space (1), and ligamentum flavum may be removed laterally towards superior articular process (2-4). (Used with permission from the Children's Orthopaedic Center, Los Angeles)*

rigidity, posterior column osteotomies are performed. A large manual rongeur is used to remove the remaining interspinous ligament and the majority of the ligamentum flavum until the midline raphe to the epidural space is visible. A dental tool or Woodson elevator can be used to confirm access to the midline epidural space (Figure 6). The pneumatic Kerrison is inserted into the midline

epidural space, and the ligamentum flavum is removed medial to lateral.

The remaining superior articular process is removed in order to provide increased flexibility of the posterior spine (Figure 7). An alternative approach to cutting the superior articular facet is with an ultrasonic bone cutter. In cases in which we do not need to bring the spine into more kyphosis, we may leave the majority of the ligamentum intact to protect inadvertent entrance into the canal. An osteotomy is not considered complete until motion is clearly demonstrated between vertebrae. Use of a lamina spreader between vertebrae can not only demonstrate motion, but also break any remaining connections.

Comparison to Other Methods

The most important benefit we find with the pneumatic Kerrison is greater precision and control, as one can utilize the very significant force while using only fine motor control with our hands. The decreased manual work of the surgeon compared to a manual Kerrison offers hope of reducing risk of occupational injury. Additionally, the Kerrison may provide relief to surgeons who may already suffer from pain and overuse injury. Since adopting the pneumatic Kerrison in 2016, the authors have reported less fatigue from repetitive trigger squeezes compared to the greater degree of effort required by the manual Kerrison. There were no intraoperative or postoperative complications associated with the pneumatic Kerrison during all 123 procedures performed at the authors' institution from 2016 to 2018.

Use of the pneumatic Kerrison requires air supply tubing, which did not seem onerous to the operating team. The mechanical safety lever functions well; there were no instances noted of unintended activation of the pneumatic Kerrison.

Summary

The pneumatic Kerrison offers increased precision and control, with less manual force on the part of the surgeon compared to a manual Kerrison. Patient safety is not compromised and, in fact, may be improved as less force is exerted on the part of the surgeon. Use of the pneumatic Kerrison will decrease the occupational manual demands on the surgeon and will hopefully minimize overuse injuries.

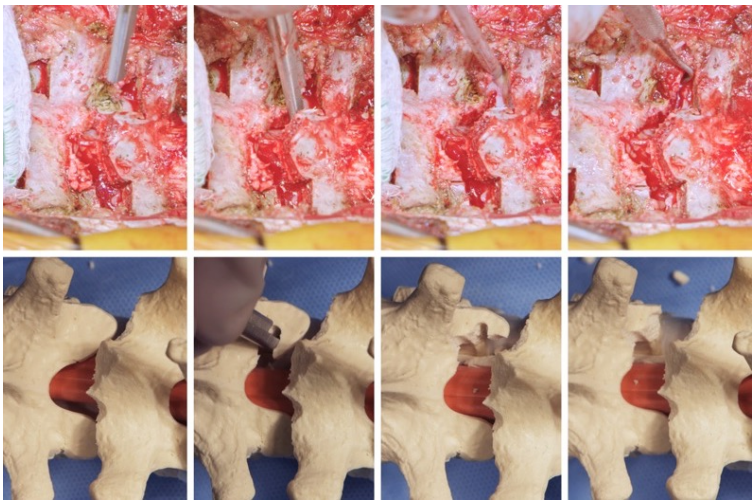


Figure 7. *The inferior articular facet has been removed with an ultrasonic bone cutting tool. The osteotomy is completed with a Kerrison by cutting through the superior articular facet, in vivo (top) and in a model (bottom). (Used with permission from the Children's Orthopaedic Center, Los Angeles)*

Additional Links

Description of the technique and safety of the pneumatic Kerrison in 125 adults undergoing spine surgery: Maroon JC, El-Kadi M, Bost J. Pneumatic Kerrison rongeur: technical note. *Surg Neurol*. 2009;71(4):466-468. doi:10.1016/j.surneu.2008.10.008

Pneumatic Kerrison instructions published by Aesculap: https://www.aesculapusaifus.com/sites/default/files/ifus/Kairison%20Pneumatic%20Bone%20Punch%20SOP-AIC-5000593%20%28TA011795%29.pdf

Pneumatic Kerrison brochure published by Aesculap: https://www.aesculapusa.com/content/dam/aesculap-us/us/website/aesculap-inc/healthcareprofessionals/orsoultions/pdfs/DOC763RevA-PneumaticKerrisonBrochure.pdf

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