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Minimally Invasive Cervical Elastic Laminoplasty - Principles and Surgical Technique

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Abstract

Purpose Of The Study

To present a new technique of minimally invasive decompression of the cervical spinal canal using elastic and plastic deformation of the laminae.

Material And Methods

Short midline vertical incision provides an access to the superior aspect of the target spinous processes. Cranial edge of the lamina is located by a midline, muscle-sparing interspinous dissection. The spinous process is cut in mid-sagittal plane using a thin blade of an ultrasonic bone scalpel down to epidural space. The created sagittal cleavage of the spinous process is subjected to tension and elastic distraction by a custom-designed distractor (Aesculap, Germany). Gradual increase of the distraction force leads to a significant plastic deformation. This reduces the distraction force and allows for a wider exposure which, in turn, facilitates dural visualization, resection of the yellow ligament and undercutting of approximately a half of the adjacent intact laminae. After completion of decompression, the plastic arch expansion can be maintained either by interposed bone-graft or appropriately shaped cage secured by a circumferential suture to the spinous process. Soft tissue resection and permanent expansion of the laminae provide sufficient decompression of the cervical spinal cord. In multilevel stenosis, the desired laminae can be expanded using this technique. To achieve the same degree of canal expansion as that by a classic laminoplasty (C3-7), a skip technique can be utilized. This involves combining expansive laminoplasty of C4 and C6 with bilateral undercutting of C5 and partial undercutting of C3 and C7. This can be achieved through two short vertical incisions. Based on data and experience gained from testing on 11 cadavers, we applied this method in 7 patients requiring posterior cervical decompression.

Results

The spinous process or laminae fractured during expansion in the initial 4 patients and the procedure required conversion to a minimally invasive laminectomy. Further modification of the distractor and spinous process splitting technique resulted in elimination of this complication in subsequent cases. In all remaining patients, sufficient canal expansion was achieved by soft tissue resection and distraction of laminae, typically reaching 5 - 8 mm. Minimally-invasive muscle-sparing midline approach provided very positive functional results in terms of postoperative pain and range of motion allowing for immediate mobilization without external bracing.

Conclusion

Minimally invasive, muscle sparing, expansive laminoplasty provides adequate spinal canal expansion. Use of this technique and its muscle-sparing nature potentially result in improvement of early functional outcomes when compared to standard laminoplasty techniques requiring lateral lamina-facet border exposure. However, the theoretical superiority of this technique will need to be clinically scrutinized in a well designed surgical outcome study.
Laboratory Study: Safety and Efficacy of a Novel Ultrasonic Osteotome Device in an Ovine model

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Abstract

The use of ultrasonic technology for bone removal offers the potential advantages over the use of traditional hand instruments or cutting burrs of more precise bone resection and reduced soft-tissue injury. While the use of modified ultrasonic aspirators has been described for bone removal in spinal surgery, none of these instruments has been systematically examined to evaluate safety and efficacy. Thus, we compared laminectomies using traditional instruments, and traditional instruments with an ultrasonic osteotome, in an ovine model. We used a combination of clinical examination, intra-operative and post-operative neuromonitoring and histological analysis to evaluate safety. The secondary endpoint of efficiency was assessed by examining operative times. No significant difference was found between groups in neurophysiology or the Tarlov clinical rating scale. Histology revealed inflammatory or reparative changes in 6/8 experimental animals and 2/4 control animals with a single section in an experimental animal revealing focal nerve root disruption and mild axonal loss. A single durotomy was noted in both the control and experimental groups. Operative time for the experimental group was significantly shorter than the operative time for the control group.
Use of Ultrasonic BoneScalpel in Spine Surgeries: Experience from the First 58 Patients

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19th International Meeting on Advanced Spine Techniques (IMAST), Istanbul, Turkey, July, 2012

Abstract

Summary
We retrospective reviewed 58 consecutive patients who underwent spine surgeries with the use of the ultrasonic BoneScalpel. The operation time, blood loss and intraoperative complications were recorded. In all instances the BoneScalpel was able to efficiently create the needed osteotomies to facilitate the surgical procedure without any percussion on the spinal column or injury to the underlying nerves.

Introduction
The ultrasonic BoneScalpel is a tissue specific device that allows the surgeon to make precise osteotomies while protecting collateral or adjacent soft tissue structures. The device is comprised of a blunt ultrasonic blade that oscillates at over 23,000 cycles per second with an imperceptible microscopic amplitude. The recurring impacts pulverize the non compliant crystalline structure resulting in a precise cut. The more compliant adjacent soft tissue is not affected by the ultrasonic oscillation.

Methods
Data were retrospectively collected following each surgery in which the BoneScalpel was used to perform any manner of osteotomy (facetectomy, laminotomy, etc.). The majority of patients had degenerative or adolescent scoliosis, kyphosis, spinal stenosis and spondylolisthesis.

Results
There were 35 females and 23 males with average age of 61 years (range 14-85). Forty two patients (72%) had previous spine surgery and/or spinal deformity. The ultrasonic BoneScalpel was used at all levels of the spine and the average operated levels were 5. The mean operation time was 4 hours and the mean blood loss was 360 ml. In all instances the BoneScalpel was able to efficiently create the needed osteotomies to facilitate the surgical procedure without any percussion on the spinal column or injury to the underlying nerves. There was a noticeable absence of bleeding from the cut end of the bone consistent with the ultrasonic application. There was one instance of a 3 mm dural thermal injury which resulted from the overheating of the local tissue by the BoneScalpel blade sitting in one position. This was over sewn in a water tight closure. No other intra-operative complications directly related to the BoneScalpel were encountered. With increasing experience, more complex osteotomies were successfully created.

Conclusions
The BoneScalpel is a safe and effective ultrasonic bone cutting device that can be used to facilitate osteotomies in a variety of spine surgeries. This device may obviate the risk associated with the use of high speed burrs and oscillating saws during spine surgery.
Novel Technique: Piezoelectric BoneScalpel™ Osteotomies for Harvesting Osteocutaneous Free Flaps

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Combined Otolaryngology Spring Meeting, San Diego, CA, April, 2012

Abstract

Objectives
To present a novel utilization for a piezoelectric device in the harvesting of osteocutaneous free flaps.

Method
Nonrandomized case series assessing a new osteotomy device, the Misonix BoneScalpel™ Ultrasonic Osteotome. Five patients underwent mandibular resections related to oncologic disease of the head and neck at University Hospitals Case Medical Center. The mandibular defects were reconstructed with osteocutaneous free flaps: three fibular, one radial forearm, and one scapular. Patients were managed per institutional protocol for head and neck free flaps. The BoneScalpel™ was used for all harvesting and reconstructive osteotomies. The two lead surgeons recorded subjective operative feedback.

Results
All osteotomies were successfully created the BoneScalpel™. The lead surgeons (R.P.R and C.A.Z.) report improved tactile control, precise osteotomies, minimal learning curve, and similar operative time compared to traditional oscillating and reciprocating saws. Vascular pedicles and adjacent soft tissue were not damaged. Bony unions appeared intact at 7-month follow-up.

Conclusion
The BoneScalpel™ Ultrasonic Osteotome offers a safe and efficient method to create osteotomies during the harvest of osteocutaneous free flaps. Primary advantages include better tactile control, minimal learning curve, and theoretic protection of vital soft tissue structures. Future studies with objective data are needed to further support this novel technique in head and neck reconstruction.
Use of a Novel Ultrasonic Bone Scalpel for Osteoplastic Laminoplasty in the Resection of Intradural Spinal Cord Pathology

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Department of Neurosurgery, The Cleveland Clinic, Cleveland, OH

27th Annual Meeting of the AANS/CNS Section on Disorders and Peripheral Nerves, Phoenix, AZ, March 2011

Abstract

Introduction

Osteoplastic laminoplasty is a well described alternative to laminectomy in the treatment of spinal pathology. Recent studies have shown that laminoplasty may decrease the incidence of progressive kyphotic deformity when used in the setting of intradural spinal cord tumor resection, especially in the pediatric population. A novel device, the BoneScalpel™ by Aesculap, is an ultrasonic osteotome that precisely cuts bone while preserving the underlying soft tissues. In the case of laminoplasty, this potentially reduces the risk of dural laceration. In addition, the device allows for fine osteotomies as narrow as 0.5 mm, which may facilitate better post-operative bone healing.

Methods

We present our experience with 11 patients who underwent osteoplastic laminoplasty using the BoneScalpel™ in the setting of intradural pathology between January 2009 and September 2010. Following lesion resection, titanium plates were used to reconstruct the lamina. The technical advantages and procedure-related complications of using an ultrasonic bone osteotome in the resection of intradural spinal cord lesions were analyzed.

Results

Successful laminoplasty was carried out in all 11 cases. One case of incidental durotomy was noted following use of the device, which was repaired primarily without neurological or clinical sequelae. There were no cases of peri-operative complications such as wound infection or CSF leak. There was also no incidence of immediate post-operative spinal instability.

Conclusions

The BoneScalpel™ by Aesculap is a safe and technically feasible device for performing osteoplastic laminoplasty. It allows for a narrower laminar trough to be created than conventional drilling, which may lead to improved laminar healing and prevent delayed post-laminectomy kyphosis. Further studies and longer clinical follow-up are needed to delineate the true role of this device in the treatment of spinal cord pathology.

Note: The Misonix BoneScalpel™ is manufactured and distributed worldwide, including the U.S.A., by Misonix, Inc. An OEM version of the device is manufactured for Aesculap, Inc., who distributes the product non-exclusively in the U.S.A. for bone fragmentation in spinal and cranial applications.
Complex Facial Reconstruction by Osteoinduction: The First Ever Clinical Application of the Vastus Intermedius Perforator Periosteal Flap (VIPP) and Facial Skeletal Transplantation Without Immunosuppression

Rian Adam Maercks, MD and Eric SantaMaria
2nd Biannual Meeting of the American Society for Reconstructive Transplantation, Chicago, IL, November 2010.

Abstract

Background

The published Vastus Intermedius Periosteal Flap (VIPP) includes the entire periosteum of the femur dependent on the descending branch of the lateral circumflex femoral artery. A less bulky flap with reduced dissection can be harvested based on consistent musculoperiosteal perforators at the junction of the middle and distal thirds of the thigh. We report the first clinical application of the Vastus Intermedius Periosteal (VIPP) flap and provide video documentation of its vascularity.

Methods

A patient bone loss of the superior orbital bar, frontal region and temporal process of the zygoma was treated with the VIPP flap. An ALT skin paddle was dissected, four musculoperiosteal perforators were identified and dissected to periosteum and 80% of the circumference of the femoral periosteum was harvested. A thin 8 x 2 cm piece of femoral cortex was included. The vascularized bony frame replaced the orbital rim and the vascularized periosteum was placed over the remainder of the bony defect. A vascular anastomosis was performed between the pedicle and the superficial temporal vessels.

Results

The first ever VIPP flap was confirmed to have a robust vascularity. Its chimeric nature allowed easy monitoring of the skin paddle. Video documentation demonstrates that skin, muscle, periosteum and cortical bone bleed briskly when elevated with the pedicle. The flap suffered two hematomas on days 2 and 5 which required evacuation and evaluation in the operating room. On day 7 the skin paddle was excised. Periosteal flap and osseous construct were left in place.

Conclusions

We confirm vascularity of the VIPP flap for osteoinduction. Computed tomography evaluation of osteogenesis is shortly pending. This flap allows consideration of a new technique of reconstructive transplantation, osseous transplant without immunosuppression. Long bone periosteum is osteoinductive and capable of replacing large masses of bone. Using a VIPP flap, a processed cadaveric segment of facial skeleton can precisely restore human form with the patient’s own cellular machinery. This technique may be the ultimate answer to complex facial skeletal reconstructions until the science and art of facial transplantation becomes widely applicable. We are initiating a series of reconstructions with specific facial skeletal allograft and VIPP flap.

Note: A novel ultrasonic osteotome (Misonix BoneScalpel) was used to resect the femoral periosteum of the VIPP flap.
Use Of Ultrasonic Bone Scalpel In Orthognatic Surgery

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Abstract

Purpose
In this preliminary study we evaluated the feasibility of orthognatic osteotomies with a new ultrasonic osteotome. By adapting its ultrasonic blade for dual action and introducing a soft protective element we have hence modified a powerful ultrasonic device that was originally developed for spinal osteotomies and nerve decompression (Misonix BoneScalpel™).

Materials and Methods
28 patients underwent orthognatic surgery with the ultrasonic osteotome. All procedures within this study group were solely being performed ultrasonically and without use of reciprocating saws or rotary burrs. Effects on operation time, peri-operative bleeding, post-operative edema, nerve lesion and osseous consolidation were assessed.

Results and Conclusion
A significant reduction of nerve impairment was observed as well as reductions in swelling, hematoma, operative time and hospital stay. Improved safety in the pterygomaxillary zone facilitates the down-fracture and the sagittal split is eased by propagation of the ultrasonic wave into the cancellous layer. The osseous cutting itself is more precise and allows for an improved adaption to the anatomy. Osseous consolidation was assessed as normal and complete.
Technical Note: A Novel Bone-Cutting Instrument, the BoneScalpel™, May be Useful in Performing Osteoplastic Laminoplasty

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Department of Neurosurgery, The Johns Hopkins University School of Medicine, Baltimore, Maryland
AANS/CNS Section on Pediatric Neurological Surgery Annual Meeting, Boston, MA, December 2009.

Abstract

Introduction
Laminoplasty is a well described alternative to laminectomy in the treatment of spinal pathology. Recent studies have shown that laminoplasty used for pediatric intramedullary spinal cord tumor resection may decrease the incidence of progressive spinal deformity. A novel device, the BoneScalpel™ by Aesculap, is an ultrasonic osteotome that allows the surgeon to cut the bone while preserving the underlying soft tissue, potentially reducing the risk of dural laceration. In addition, it allows for very fine cuts as narrow as 0.5 mm. We used the BoneScalpel™ to perform osteoplastic laminoplasties in 2 patients undergoing surgery for spinal cord tumors and describe our preliminary findings.

Methods
Two patients who were undergoing planned laminoplasty for spinal cord tumors were brought to the OR and standard exposure of the appropriate lamina was carried out. In order to perform the laminoplasty, the BoneScalpel™, was used to cut troughs on either side of the lamina. The cut lamina were then disconnected rostrally and caudally from the posterior spinal ligament, and removed as one unit. Once the tumor resection was completed and dura closed, the bone was replaced with small bone plating systems.

Results
Successful laminoplasty was carried out in both cases. No known damage to the underlying soft tissue, dura or neural elements was identified.

Conclusions
The BoneScalpel™ by Aesculap is a potentially useful and safe device in performing osteoplastic laminoplasty. As it allows for a more narrow trough than conventional drilling, less bone is ultimately removed. This could be especially useful in the pediatric population where the smaller defect in the approximated bone may lead to improved healing. Further studies should be carried out to explore this as a potential option.

Note: The Misonix BoneScalpel™ is manufactured and distributed worldwide, including the U.S.A., by Misonix, Inc. An OEM version of the device is manufactured for Aesculap, Inc., who distributes the product non-exclusively in the U.S.A. for bone fragmentation in spinal and cranial applications.
**BoneScalpel™ Ultrasonic Osteotome**

The BoneScalpel is manufactured and distributed by Misonix, Inc., Farmingdale, NY, USA.

**Indications**

The BoneScalpel system is indicated for use in the fragmentation and aspiration of both soft and hard (e.g.: bone) tissue as used in the following surgical specialties:

- Orthopedic Surgery
- Plastic and Reconstructive Surgery
- Neurosurgery
- Thoracic Surgery
- Wound Care
- General Surgery

It is also indicated for use in debridement of wounds, such as, but not limited to burn wounds, diabetic ulcers, bedsores and vaginal ulcers, soft tissue debridement and cleansing of the surgical site in application, in which, in the physician’s judgment would require the use of an ultrasonic aspirator with sharp debridement.

**CAUTION:** Federal law restricts this device to sale by or on the order of a licensed healthcare practitioner

**Contra Indications**

The BoneScalpel system is contra indicated for cardiac surgery and any procedure in the proximity of the heart.

The irrigation pump is contra indicated for the administration of parenteral fluids, infusion of drugs or for any life sustaining purposes

**Trademark Information**

Misonix® is a registered trademark of Misonix, Inc., Farmingdale, NY
BoneScalpe™ is a pending trademark of Misonix, Inc., Farmingdale, NY