Vascularized Spinous Process Graft Rotated on a Paraspinous Muscle Pedicle for Lumbar Fusion: Technique Description and Early Clinical Experience

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BACKGROUND: **Vascularized bone grafts (VBGs) are described as having superior osteogenicity, osteoconductivity, and osteoinductivity compared with other graft types and have been used in high-risk patients to augment arthrodesis. Pedicled VBGs are rotated on an intact vascular pedicle and therefore maintain all the benefits of VBGs but avoid many of the challenges and additional morbidity of free-tissue transfer. This study describes a novel surgical technique for rotating vascularized spinous process into the posterolateral space for augmenting arthrodesis in patients undergoing posterolateral fusion (PLF).**

METHODS: **A technique is described for rotating the spinous process into the posterolateral space on an intact vascular pedicle of paraspinal muscle. Early clinical and radiographic outcomes are reported for 4 patients who have undergone this procedure.**

RESULTS: **Four patients were treated with a single or 2-level PLF combined with posterior, anterior, or lateral interbody fusion and vascularized spinous process graft. Three-month postoperative computed tomography scans demonstrated a dislodged graft in 1 patient and successful arthrodesis in 3 patients. Additional operative time taken for graft harvest and implantation ranged from 22 minutes for the first patient to 6 minutes for the fourth patient.**

CONCLUSIONS: **Rotation of vascularized spinous process graft for augmentation of posterolateral arthrodesis in the lumbar spine is a potentially safe, effective surgical technique that results in successful arthrodesis in as little as 3 months but requires further study. This technique is expected to add little additional time or morbidity to the traditional lumbar PLF because it requires no separate incision or additional bone removal.**

Instrumented posterolateral fusion (PLF) of the lumbar spine is a commonly used treatment for patients with low back pain and radiographic evidence of spinal instability. Successful arthrodesis after PLF is critical to achieving favorable outcomes, especially regarding avoiding reoperation and recurrence of low back pain. Fusion rates after instrumented PLF alone are approximately 88% (range, 68%–100%) and increase to 95% (range, 93%–100%) if PLF is performed in combination with a posterior lumbar interbody fusion.[1] However, for patients with multiple risk factors, failure rates as high as 50% have been reported.[2-5] These risk factors include poor bone quality; 3-column osteotomy; history of prior failed fusion attempts; infection in the fusion bed; history of irradiation at or near the fusion bed; and numerous other medical, metabolic, or social risk factors known to impede arthrodesis. These high-risk patients generally require a surgical strategy for augmenting arthrodesis.

Vascularized bone grafts (VBGs) are well described in the literature as having superior osteogenicity, osteoconductivity, and osteoinductivity compared with other graft types.[6-13] By maintaining graft vascularity, VBGs heal through a process of primary healing rather than creeping substitution (as non-VBGs do), and furthermore retain greater resistance to infection

Key words
- Arthrodesis
- Autograft
- Degenerative spine disease
- Lumbar fusion
- Lumbar instability
- Novel surgical techniques
- Posterolateral fusion
- Spine reconstruction
- Thoracolumbar deformity
- Vascularized bone graft

Abbreviations and Acronyms
CT: Computed tomography
PLF: Posterolateral fusion
VBG: Vascularized bone graft

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because the bone graft does not rely on the host tissue bed for vascularity. This is important in all patients, and particularly in those with poor host-site tissue quality. VBGs therefore have the potential to decrease the time to fusion, increase the quality of the fusion through quicker bone remodeling, and decrease the risk of grafted bone becoming a sequestrum of infection.

The literature contains numerous case series of free-fibular and rib grafts being used to augment thoracolumbar arthrodesis.[14-20] These studies demonstrate excellent arthrodesis, but the technical challenges of microvascular anastomosis, anatomic challenges of finding suitable host-site vessels, and additional morbidity of free-tissue transfer have precluded the widespread use of VBGs in the posterior lumbar spine.[19-22] An alternative to free-transfer VBGs is pedicled VBGs. Pedicled VBGs are harvested from a site proximal to the spine and rotated into the fusion bed while keeping the graft's native blood supply intact. By maintaining donor-site vascularity, pedicled VBGs retain all the benefits of VBGs, but avoid many of the challenges and additional morbidity of free-tissue transfer. Previous reports have described the use of pedicled VBGs for anterior cervical and posterior thoracic spinal reconstruction, with good operative results.[23-25] The purpose of this study was to describe a novel surgical technique for rotating vascularized spinous process into the posterolateral space to augment arthrodesis after PLF and to report the early clinical and radiographic outcomes of patients who have undergone this novel procedure.

TECHNIQUE DESCRIPTION

A standard midline incision is made over the index levels of the lumbar spine, and dissection is carried down to expose the superficial investing fascia of the paraspinal muscles. A standard subperiosteal dissection is performed on one side of the spinous process and is extended laterally to include the facet joints and transverse processes of the levels to be fused (**Figure 1**). Contralateral to the exposed side, the superficial investing fascia is released, taking care not to disrupt any of the attached paraspinal muscles or their periosteum (**Figure 2**) because these structures carry the vascular supply of the spinous process. The spinous process is then amputated at its base using a high-speed drill, curved osteotome, or both (**Figure 2**). The spinous process is then mobilized laterally to the facet joint, toward the side of the spinous process with intact paraspinal muscle attachments. Retracting on the mobilized spinous process graft provides a standard open posterior view of the lumbar spine, which permits standard pedicle screw insertion, laminectomy, and interbody fusion as indicated (**Figure 3**). After completion of the posterior fixation and decompression, the pedicled spinous process is prepared for arthrodesis. This entails removal of soft tissue and decortication of the exposed surfaces of the spinous process, again taking care not to injure the muscle attachments or periosteum on the contralateral side. The PLF site is also exposed and decorticated. The vascularized spinous process graft is then positioned in the posterolateral space, being sure to obtain contact between the graft and the transverse processes or remaining articular processes of the 2 levels to be fused. It is critical to secure the graft in the posterolateral space using either resorbable sutures or wire cables to ensure the graft does not mobilize out of the posterolateral space or lose contact with the host-site bony surfaces (**Figure 4**). The superficial investing fascia is then closed in the standard fashion (**Figure 5**). **Figures 6A–D** demonstrate the critical steps of the described technique.

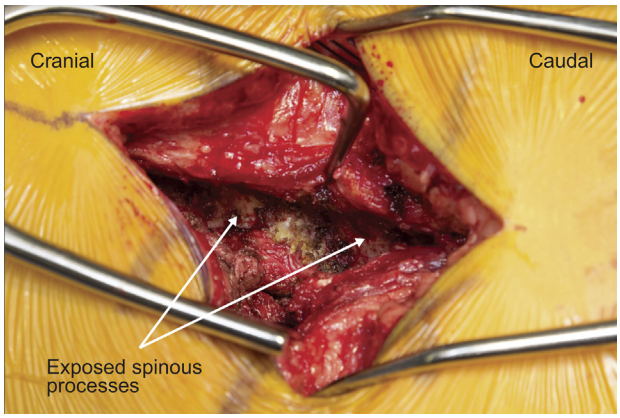

Figure 1. Intraoperative photograph demonstrating the unilateral open lumbar exposure; the paraspinal muscle attachments to the spinous processes are kept intact on the contralateral side. (Used with permission from Barrow Neurological Institute, Phoenix, Arizona.)

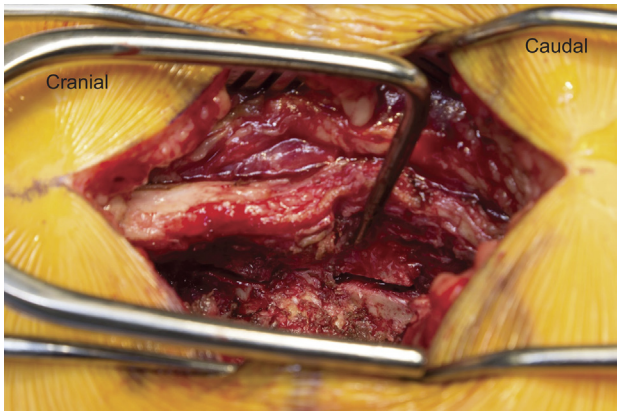

Figure 2. Intraoperative photograph after the exposed surfaces of the spinous processes have been amputated with a curved osteotomy. Note that the investing fascia of the paraspinal muscles on the contralateral side has been released without injuring the paraspinal muscle attachments or periosteum on that side of the spinous process. This is critical for maintaining vascularity to the spinous process. (Used with permission from Barrow Neurological Institute, Phoenix, Arizona.)

CASE SERIES

Four patients with a mean age of 66.5 years (range, 62–73 years) were treated with a single or 2-level combined PLF and posterior, anterior, or lateral interbody fusion. All 4 patients were being treated for spinal stenosis and low-grade spondylolisthesis. Each patient furthermore had 2 or more risk factors for pseudarthrosis, including osteopenia, osteoporosis, active