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Case Report

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Titanium Mesh in Spinal Fusion: A Case Series

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Abstract

Background: Maxillofacial titanium mesh is most commonly used in reconstructive surgery for its versatility, stability, affordability, tissue tolerance, and compatibility with multiple imaging modalities. Here we describe the novel use of maxillofacial titanium mesh for spinal fusion surgery in a case series. **Methods:** We present three cases requiring instrumented spinal fusion. A 95-year-old women with one-month history of falls and back pain was found to have a spinal canal mass at T2-T3 and T11 burst fracture. A 32-year-old male had a L4 burst fracture following a motor vehicle accident. A 66-year-old female with one-year history of lumbar pain was diagnosed with thoracolumbar kyphosis, secondary hyperlordosis of the lumbar spine, stenosis at L4-L5, and L2-L5 spondylolisthesis. **Results:** Instrumented spinal fusion was carried out and maxillofacial titanium mesh was cut and contoured appropriately prior to being precisely placed over the dura mater. Post-operative imaging demonstrated adequate fixation for all cases. No intraoperative or postoperative complications occurred. **Conclusions:** Maxillofacial titanium mesh has long been used in maxillofacial reconstructive surgery for a variety of reasons including malleability, strength, and the distinct biocompatibility of titanium. However, titanium mesh may also be used to augment spinal fusion for tumor, trauma, and degenerative conditions without complication. Titanium mesh can offer the spine surgeon a safe, cost-effective and efficacious tool when used in spinal fusion. Future randomized controlled trials are needed to validate these findings in large sample sizes. Level of Evidence: 4.

Keywords: Titanium mesh, Oromaxillofacial titanium mesh, Spinal fusion, Instrumented spinal fusion, Case series.

INTRODUCTION

Maxillofacial titanium mesh has traditionally been used by surgeons to aid in maxillofacial reconstruction and soft tissue augmentation, and is known for its versatility stemming from its malleability and ease of use [1]. This allows for quick placement and high adaptability. Despite this flexibility, it has been shown to provide stable fixation and stabilization — especially in comminuted fractures [2]. Additionally, poor tissue tolerance to the mesh is rarely observed [1]. Titanium, in general, has a great deal of utility in the surgical field, and is known to be mechanically stable, compatible with CT and MRI and is very affordable [3]. It is also inert, non-carcinogenic, non-allergenic, and has been shown to be associated with a low risk of infection [4].

The number of surgical applications that can be addressed with titanium mesh continue to expand. In the spine arena, the titanium mesh cage was recently introduced to provide anterior structural support and interbody fusion while obviating the need for iliac crest bone grafting [5]. Multiple reports have shown high rates of fusion and positive clinical outcomes in lumbar fusions undergone with titanium mesh cages along with relatively low rate of complications from the titanium mesh [6]. However, these cages are difficult to physically manipulate and are more expensive than the maxillofacial titanium mesh, which we feel can now be considered a more cost effective and operator-friendly option to achieve spinal fusion. This is the first series to describe the application of oral-maxillofacial titanium mesh in spinal fusion surgery.

CASE PRESENTATIONS

All cases took place at a large, level-1 trauma center in southern California; surgeries performed by a single spine surgeon unless otherwise noted. Figure 1 demonstrates representative images of the placement of the titanium mesh intra-operatively. Maxillofacial titanium mesh was manufactured by Stryker (Kalamazoo, MI, USA).

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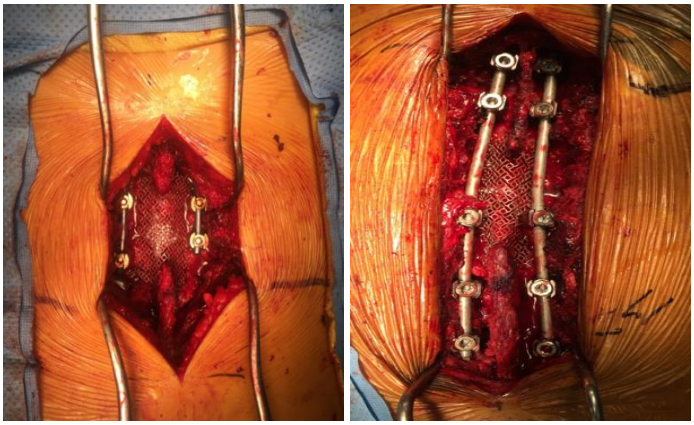

Figure 1: (A-B) Intra-operative photographs of maxillofacial titanium mesh placement prior to bone graft placement

Case 1

A 95-year-old, otherwise healthy, female initially presented to the emergency department at our institution with a one-month history of back pain and falls. In the previous week, she experienced increased lower extremity weakness, worsening back pain, and inability to ambulate. After a comprehensive medical workup, CT and MRI demonstrated a spinal canal mass at T2-T3 as well as a burst fracture at T11 resulting in secondary kyphosis and stenosis. Myelomalacia changes were also noted at the spinal cord adjacent to the T11 vertebral body fracture. Following discussion with the patient and consulting neurosurgery team, and it was determined that the intradural mass at the upper thoracic spine was the more pressing cause of her rapidly progressing weakness rather than the myelomalacia at the level of T11 burst fracture. Therefore, the decision was made to resect the mass, with subsequent posterior fusion.

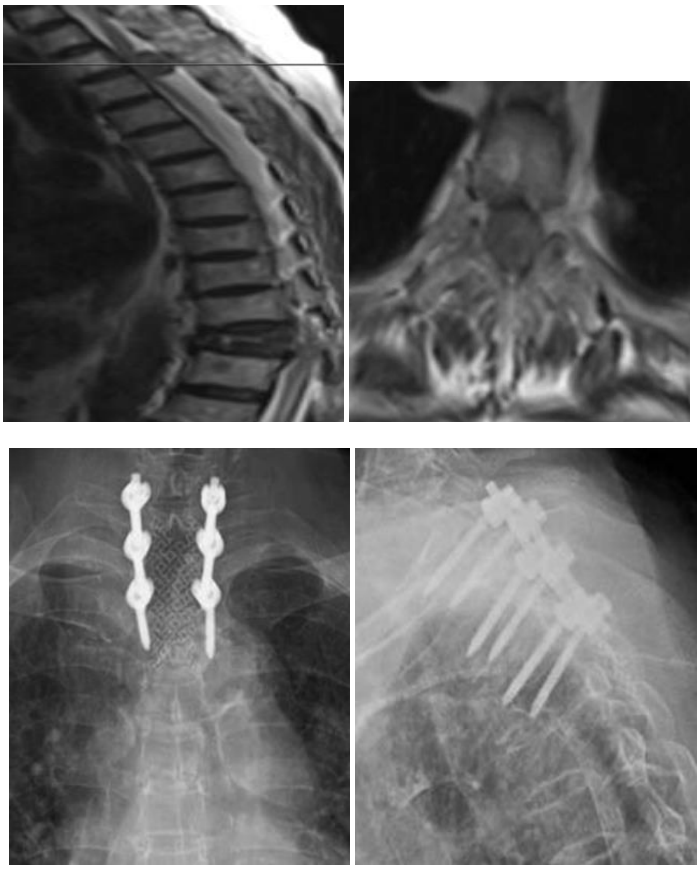

Figure 2: (A-D) Case 1. Sagittal and axial MRI images of large intra-dural mass at the T2-T3 level and burst fracture at T11

An initial incision was made over T1-T3, followed by posterior exposure, and bilateral pedicle screw placement of T1-T3. Laminectomies of the aforementioned spinal levels were completed, followed by the tumor resection portion of the case that was performed by neurosurgery. The dura was then carefully repaired and covered with fibrin glue to aid with sealing. We then proceeded to cut a correspondingly-sized titanium mesh and contoured it to be slightly convex, and then removed notches at the ends of the mesh such that they would fit securely over the superior and inferior spinous processes. The mesh was cut in a fashion to fit between the previously placed pedicle screws. It was placed posterior to the fibrin glue, and was carefully confirmed not to add any pressure onto the underlying contents of the spinal canal. Decortication of the bilateral T1-T3 facets was completed, and then rods were placed and torqued. We then applied 30cc of crushed cancellous allograft bone over the titanium mesh, as well as over the lateral elements in order to facilitate fusion. There were no complications and the estimated blood loss was noted to be 250cc with a total operative time of just over 5 hours. Pre-operative MRI and post-operative X-Rays can be found in Figure 2.

Case 2

A 32-year-old, previously healthy, male presented as a level-1 trauma activation following a motor-vehicle accident, sustaining an infrarenal aortic injury requiring emergency vascular repair, multiple extremity fractures, as well as a severely comminuted burst fracture of the L4 vertebral body with significant left foraminal stenosis. Throughout his initial stay, the patient was medically stabilized but remained in a coma. Given the severity of the fracture with significant foraminal stenosis, the decision was made with the patient's family to proceed with a posterior decompression and lumbar fusion.

Dissection was carried down in the usual fashion, exposing the bilateral lamina from L2 to S1. Pedicle screws were placed bilaterally from L3 to S1, skipping the fractured L4 level. During laminectomy of L4, it was noted that there were multiple nerve roots exposed, and it was determined that the dura had been traumatically stripped away. An attempt was made to try to free the rootlets from their scarred position to reinsert them within the dura, but ultimately the expansive amount of trauma in the arachnoid made determining where to put each root unfeasible. We then covered this area with DuraGen Matrix (Integra LifeSciences, Plainsboro, NJ, USA) and proceeded to cut and contoured the maxillofacial mesh to precisely cover the posterior dura and DuraGen. Decortication of L3, L5 and S1 was then performed, and 60cc of crushed cancellous bone was placed into the wound to prepare the fusion. There were no complications, and estimated blood loss was noted to be 800cc with a total operative time of 7 hours. Pre-operative and post-operative CT imaging can be found in in Figure 3.

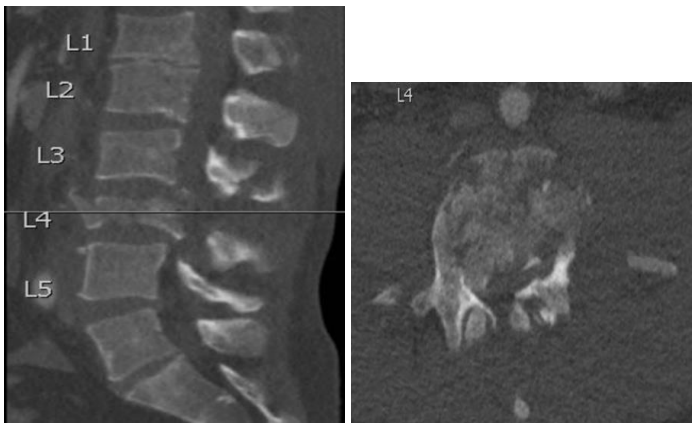

Figure 3: (A-B) Case 1. Post-operative X-rays demonstrating spinal fusion augmented by maxillofacial titanium mesh

Case 3

A 66-year-old, otherwise healthy, female presented to our outpatient clinic with 1 year history of atraumatic lower back pain radiating down bilateral lower extremities. Pre-operative imaging demonstrated thoracolumbar kyphosis with secondary hyperlordosis of the lumbar spine. She was noted to have rotational instability with complete collapse at L3-L4, and secondary collapse at L2-L3, both on the left side. She also had severe lumbar spinal stenosis particularly at L4-L5, as well as grade 1-2 spondylolisthesis at L2-L3, L3-L4, and L4-L5. After an unsuccessful trial of physical therapy and epidural injections, the decision was made to proceed with posterior decompression and fusion.

Incision was made to expose the level of L1 to S1 in the usual fashion, and pedicle screws placed bilaterally from L2-S1 with the exception of L4. Once this was completed, laminectomies from L2-L4 was performed and then a transfacet decompression completed at L2-L3 on the left. This disc space was then prepared and a titanium cage (SpineArt USA, Irvine, CA, USA) was placed using fluoroscopic assistance. Transfacet decompression was then completed at L3-L4. At this point, the left L4 pedicle screw was inserted, however, the right pedicle screw could not be placed due to irritability of the nerve root on intra-operative monitoring after decompression. Laminectomy was then completed from L2 to L5. Maxillofacial titanium mesh was measured, appropriately cut, and countered to place it over the dura from L2 to S1. The facets were then decorticated and autograft, as well as morcelized fresh frozen femoral head allograft, were then placed in the posterolateral gutters and the remainder placed centrally over the mesh. Appropriately sized rods were placed and torqued. L1 was included in the fusion without instrumentation in order to decrease the possibility of proximal junctional kyphosis. Given the complexity of this case, the estimated blood loss was 1,200cc and duration just over 7 hours. Pre-operative and post-operative X-Rays, as well as post-operative CT can be found in Figure 4.

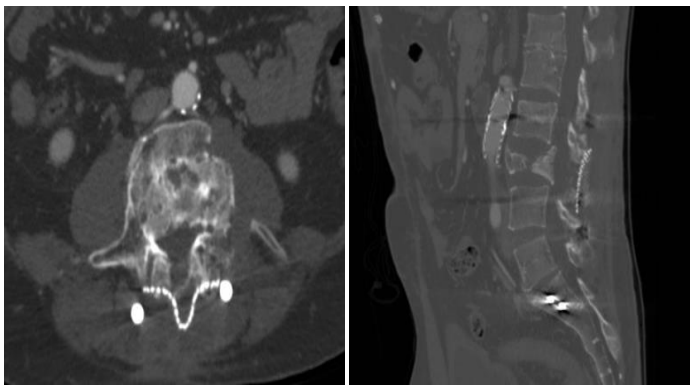

Figure 4: (A-B) Case 2. CT images of L4 burst fracture and left foraminal stenosis

All patients had regular follow-up in our outpatient clinic. There were no complications in the post-operative period, and CT imaging at the 6 month follow-up visit demonstrated stable fusion and alignment without hardware pullout or complication.

DISCUSSION

Titanium has long been administered safely and effectively in spinal operations. Ebraheim *et al*. employed titanium pedicle screws and plates to augment thoracic and lumbar spinal fusion [7]. Ray reported successful patient outcomes following application of threaded titanium cages in lumbar interbody spinal fusion [8]. Lilijenqvist *et al*. later used titanium cages in the surgical treatment of vertebral osteomyelitis [9]. The expanded use of titanium mesh cages as vertebral body replacers, inter-body spacers, concave mechanical supporters, laminar replacements, and interlaminar spacers was discussed by Grob *et al* [10]. Furthermore, titanium rods are considered the standard for spine surgery with titanium anterior plates and interbody spacers being the most widely used [11].

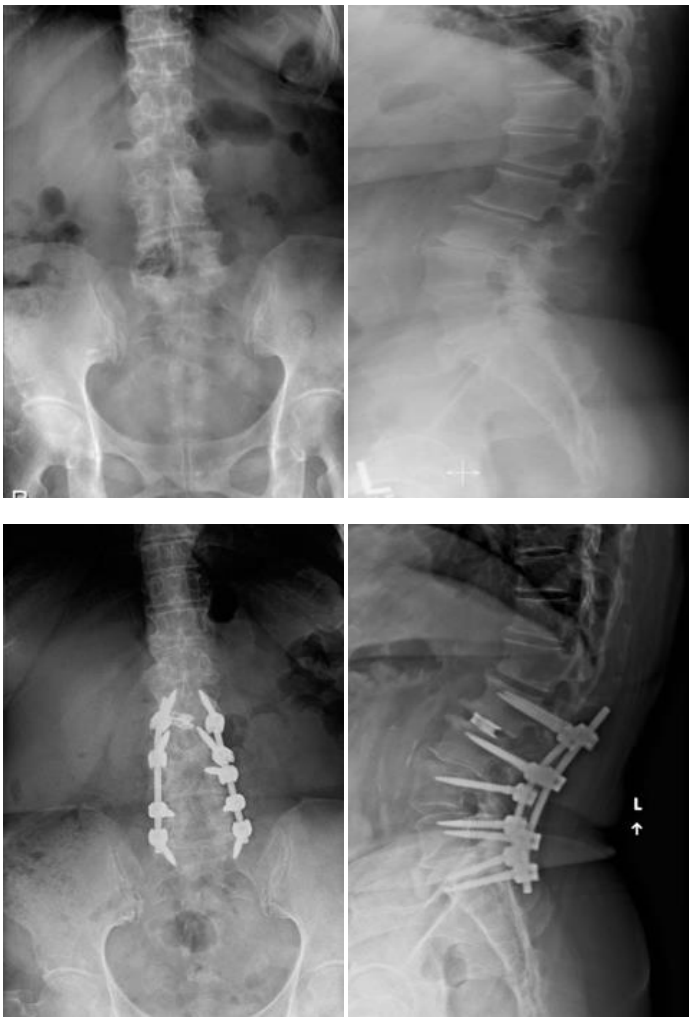

Figure 5: (A-D) Case 2. Post-operative X-rays indicating spinal fusion augmented by maxillofacial titanium mesh

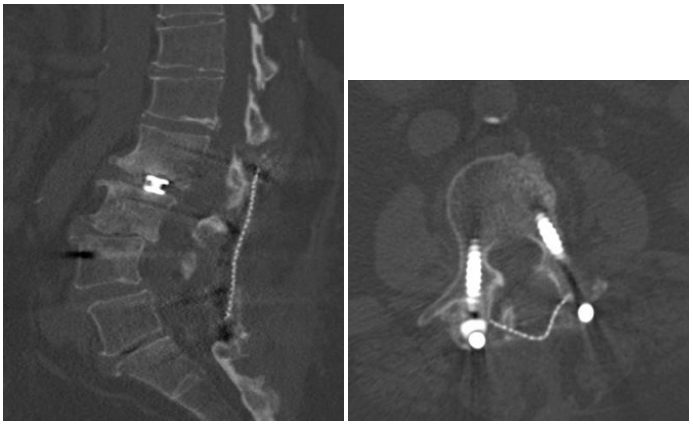

Figure 6: (A-B) Case 3. Pre- and post-operative X-rays demonstrating spinal fusion

Post-operatively, the use of titanium in spine surgery has been linked to favorable outcomes. When compared to infection rates of stainless steel implants, infection rates associated were titanium implants were lower 1-7 years post-operatively, according to Soultanis *et al* [12]. Also, patients that achieved solid fusion have exhibited negligible levels of metal debris in surrounding tissues [13]. Also, titanium spinal implants are considered "MRI-friendly" because they do not produce the image distortion that is characteristic of other metal implants [14,15]. More recently, titanium has

been incorporating in 3D printing as a surgical guide and even as a customized spinal implant [16]. These numerous clinical applications of titanium spinal implants suggest that the metal is safe and effective for spine surgery.

However, the use of maxillofacial titanium mesh for the purpose of performing posterior spinal fusion is a novel modality that we believe provides multiple benefits over alternative materials. First, the malleability of the mesh allows it to be quickly and easily modified to seamlessly conform to a patient's anatomy. The combination of the strength and flexibility of titanium mesh has made it the gold standard for maxillofacial reconstruction, and we believe these same properties make it suitable for incorporation in spinal fusion [17].

Use of maxillofacial titanium mesh also does not require any posterior-lateral exposure for additional instrumentation, which we postulate will allow for shorter operative times, more cost-effective operations, fewer complications and ultimately better outcomes. This also specifically makes this modality a good option for poorer surgical candidates who may not be able to tolerate extensive operations with longer time under anesthesia and greater intra-operative blood loss.

Furthermore, in instances where revision spinal fusion surgery is indicated, the mesh can be easily adjusted by simple manipulation. According to the National Inpatient Sample database, there were 22,128 discharges linked to revision spinal fusion between 2002 and 2009, which constitutes a 51.0% increase over that period [18]. From 2001 to 2010, revision surgery was linked to longer hospital stays, greater intraoperative blood loss, surgical site infections, and other complications [19]. To date, we have used maxillofacial titanium mesh on ten patients. Although none have required revision surgery, we postulate that revising a fusion with titanium mesh would be much easier than other fusion modalities, allowing for shorter surgeries with fewer complications.

CONCLUSION

Ultimately, this case series describes the successful application of maxillofacial titanium mesh to spinal fusion in the cases of surgery for tumor excision, trauma, and degenerative spondylolisthesis. This novel use of titanium mesh offers safety, ease of application, malleability, additional protection of the underlying dura mater, reduced exposure to the posterolateral facets, improved tolerance to spinal fusion, and ease of manipulation should revision surgery be required. Future studies are needed to determine further applicability of titanium mesh in spine surgery. In addition, high-quality randomized trials are needed to confirm these findings in large sample sizes.

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Conflicts of interest

The authors declare no conflicts of interest.

Source of funding

None.

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