



## Technical Note

# Unique Bone Suture Anchor Repair of Complex Lumbar Cerebrospinal Fluid Fistulas

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## ABSTRACT

**Background:** Spine surgeons encounter occasional complex cerebrospinal fluid fistulas/dural tears (CSF/DT) during lumbar spinal surgery. In some cases, these leaks are found during the index procedure, but others may appear postoperatively, or in the course of successive procedures. Here we asked, whether these complex CSF fistulas/DT could be more readily repaired utilizing a “bone suture anchor” technique, particularly where there is no residual dural margin/remnant.

**Methods:** With the combined expertise of the orthopedist and neurosurgeon, mini/micro bone suture anchors, largely developed for hand surgery, facilitated repair of complex DT occurring during lumbar spine surgery. This technique was utilized to suture in place fascia, periosteal, or muscle grafts, and was followed by the application of microfibrillar collagen, and a fibrin sealant.

**Results:** This mini/micro suture anchor technique has now been utilized to repair multiple significant intraoperative and/or postoperative recurrent DT, largely avoiding the need to place lumbar drains and/or lumbo-peritoneal shunts.

**Conclusions:** Here, we reviewed how to directly suture dural grafts utilizing a mini/micro bone suture anchor technique to repair complex intraoperative primary/recurrent DT occurring during lumbar spine surgery. The major advantages of this technique, in addition to obtaining definitive occlusion of the DT, largely avoids the need to place lumbar drains and/or lumbo-peritoneal shunts with their attendant risks and complications.

**Key words:** Massive, Dural Leak, Lumbar, Suture Anchors, Patch Grafts, Complex Repair

## INTRODUCTION

Dealing with major primary and/or recurrent cerebrospinal fluid fistulas/dural tears (CSF/DT) occurring during complex lumbar surgery may be problematic. For primary cases or revision surgery (i.e. with significant postoperative scarring), there may be insufficient to no lateral dura present to “sew to”, precluding attaining a “water-tight” dural closure. In these situations, where it is optimal to fully close the dura, by applying fascia, sheep pericardium, muscle patch/other dural grafts (“graft material”), the surgeon should be able to close the dura utilizing mini/micro bone suture anchors, typically employed in hand surgery [Table 1 and Figures 1 and 2].<sup>[1,3,4]</sup> By placing the screw portion of the mini/micro suture anchors into the available bony margins surrounding the laminotomy, laminectomy and/or bony decompression defect, the accompanying sutures can be placed sequentially into the “graft”

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to attain a “water-tight” closure. This, in combination with the application of microfibrillar collagen and fibrin sealant, can be used to increase the strength, and durability of the closure.

### Bone Suture Anchor Techniques in Orthopedics

#### Composition of Mimi/Micro Bone Suture

Bone Suture Anchors are utilized in orthopedics typically for affixing tendons and ligaments to bone [Table 1 and Figures 1 and 2].<sup>[1,3,4]</sup> The anchor itself is inserted into the bone, and the accompanying suture is attached to the anchor utilizing the anchor’s eyelet. Materials, including the screws and sutures, may be either non-absorbable or absorbable. Screw anchors have a high load to failure ratio, with the metal anchors previously demonstrating greater strength vs. biodegradable alternatives. Nevertheless, there are now more bioabsorbable anchors (poly-L-lactic acid, poly-D, L lactic acid, polydioxanone, polyglycolic acid and their copolymers) and other newer products that increasingly offer comparable pullout strengths when compared to non-absorbable constructs (e.g. metal anchors), some with lower complications rates.

#### Sutures Utilized with the Bone Suture Anchors

The sutures themselves, which may or may not come preloaded, consist of braided polyester sutures or ultrahigh molecular weight polyethylene [Table 1 and Figures 1 and 2].<sup>[1,3,4]</sup> Some bone suture anchors offer a large single eyelet through which one can pass up to two suture strands at a time, while other sutures are attached to the anchor through separate eyelets or slots. The major weakness

of these constructs is that the suture may break at the margins of the eyelet affixed to the screw.

### Bone Suture Anchor Repairs in Hand Surgery

In hand surgery, mini and/or micro bone suture anchor (BSA) techniques have been utilized for decades [Table 1].<sup>[1,4]</sup> In 1995, Skoff *et al.* studied the strength of BSA utilized to reinsert Flexor Digitorum Profundis (FDP) tendons in 16 paired fingers from 8 cadavers; the BSA technique was relatively simple to use, and required both less dissection, and surgical time.<sup>[4]</sup> In



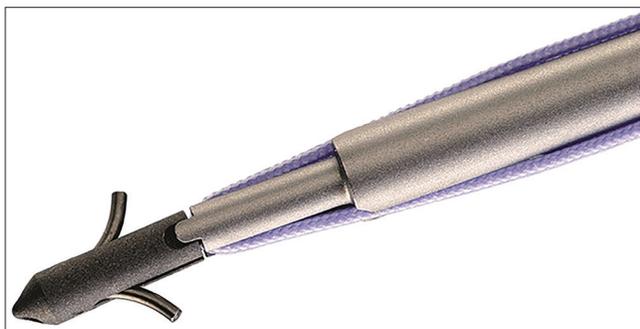
**Figure 1:** Biotek Titanium Mini-Vim-Suture-Anchor (Arthroscopic Implants). This mini-Vim-Suture-Anchor-with-Needle is produced by Biotek and the anchor portion is made of Titanium. It is 2.8 mm to 3.5 mm in diameter, and 2.8 mm wide. They come preloaded with USP #2 BioFiber suture. In most cases it can be inserted without the need for a drill, although one is available.

**Table 1:** Bone Suture Anchor Techniques in Hand and Maxillofacial Surgery.

| Author Ref Year                                      | Type of Surgery   | Study Design  | Method  | Findings   | Conclusions  |
|--|---|---|---|--|--|
| Skoff <sup>[4]</sup><br>J Hand Surg Br 1995          | BSA in hand surgery   | 16 Paired fingers from 8 Cadavers                       | Reinsertion<br>Strength of FDP Tendons                                  | BSA simple to insert<br><u>Required</u><br>< dissection<br>< surgery time          | BSA simple to insert                                 |
| Fields <sup>[3]</sup><br>J Oral Maxillofac Surg 1997 | Pullout Force Mini vs Micro BSA for test pullout strength from posterior condyles | 22 Cadaver Human Mandibular Condyles                    | <u>Pullout testing</u><br>Micro broke 25% vs. Larger Mini 10%           | Significantly Greater Pullout Force Mini vs. Micro BSA                             | Mitek Mini BSA Greater Pullout Force vs. Micro BSA   |
| Brustein <sup>[1]</sup><br>J Hand Surg Am 2001       | BSA Vs. PB for Distal Profundis Tendon Injuries                                   | Compared Micro vs. Mini BSA<br>9 Human Cadaveric Hands- | Test FDP<br>ABS Mini vs. Micro vs. PB to reattach FDP to distal phalanx | 1.3 mm Micro Better than Mini<br>That QuickAnchor (Mitek) Products.<br>Norwood MA) | Micro Significant stronger vs. Mini Anchor Technique |

CSF=Cerebrospinal Fluid Leaks, SD=Spinal Drains, PDC=Primary Closure, LD=Lumbar Drain, Reop=Reoperation, DE=Delayed Exploration, pts=Patients, LAM=Laminectomies, NIF=Non-instrumented Fusions, ESI=Epidural Spinal Injections, SC=Synovial Cysts, OYL=Ossification Yellow Ligament, FS=Fibrin Sealant, SW=Sandwich, Con=Conventional, BSA= Bone Suture Anchors, PB=Pullout Button, FDP= Flexor Digitorum Profundis MG=Medical Glue, GS=Gelatin Sponge, Come=Comorbidity

2001, Brustein *et al.* compared pullout button (PB) strengths in reattaching FDP to the distal phalanx utilizing micro vs. mini BSA in 9 human cadaveric hands; the 1.3 micro technique was stronger than the mini technique utilizing the QuickAnchor (Depuy, J & J, Mitek Products, Norwood, MA, USA).<sup>[1]</sup>



**Figure 2:** Depuy Mitek Mini Gill II Titanium Anchor Suture Anchor (QuickAnchor: DepuySynthes, Part of Johnson&Johnson Family Companies). The nitinol arcs are used to reattach soft-tissues to bone. The GII Anchor is small with a high pull-out strength. The drill hole is 2.4 x 8.8mm. It utilizes multiple suture types including ORTHOCORD®, PANACRYL® & ETHIBOND®. Its indications for use include Ulnar or lateral collateral ligament reconstruction in the hand.

### Suture Anchor Repairs in Maxillofacial Surgery

In 1997, in the Journal of Maxillofacial Surgery, Fields *et al.* evaluated the pullout force of mini vs. micro bone suture anchors re: pullout strength from 22 cadaveric posterior mandibular condyles [Table 1].<sup>[3]</sup> The mini BSA showed greater pullout force vs. the micro BSA (Mitek (QuickAnchor Products, Norwood MA, USA)); in pullout testing, the micro broke in 25% of cases vs. just 10% for the mini system.

### Incidence of Dural Tears (DT) and Treatment Modalities in Lumbar Surgery

Different lumbar studies report varying frequencies of intraoperative dural fistulas and repair techniques [Table 2].<sup>[2,5,6]</sup> In 54 patients, Wang *et al.* (2012) described the superiority of utilizing the sandwich technique vs. conventional measures to cover the dura following thoracolumbar surgery; this series included 23 subdural tumors [Table 2].<sup>[5]</sup> The sandwich technique was comprised of a first layer of medical/glue (fibrin sealant), followed by a gelatin sponge, succeeded by the final layer of medical/glue (fibrin sealant). The conventional closure technique employed routine suture closure followed by the application of a gelatin sponge. Note, according to the product insert,

**Table 2:** Incidence of Spinal Cerebrospinal Fluid Fistulas/Dural Tears and Repair Techniques.

| Author Ref Year                                       | Type of Surgery   | Study Design  | Method   | Findings   | Conclusions  |
|---|---|---|--|--|--|
| Wang <sup>[5]</sup> Orthop Surg 2012                  | 54 patients<br>2007-2011<br>SW vs. Con<br>Repair DT<br>23 Subdural Spinal Tumors          | A:Con = Suture and GS<br>B:SW<br>MG-SF-MG<br>A Tumors:<br>4 Cervical<br>8 Thoracic<br>11 Lumbar | Tumors<br>31 Cervical<br>10 Thoracic<br>16 Lumbar  | Group B: SW<br>Technique:Less<br>Postop Drainage Days<br>1-3   | Group B<br>Reduced<br>Postoperative<br>Recurrent CSF<br>Leakage  |
| Epstein <sup>[2]</sup> Surg Neurol International 2015 | CSF Fistulas<br>24 (7.,14%) 336<br>LAM NIF<br>17/336 or 5.05%<br>CSF Leaks<br>Without ESI | Leaks:<br>7 Preop ESI<br>6 SC<br>5 OYL<br>3 Postop Scar<br>3 Intradural Tumors                  | Dural Repairs:<br>7.-0 Gore -Tex<br>Sutures Microdural<br>Staples, Muscle<br>Patch Graft Bovine<br>Pericardium | FS (Tisseel Baxter International Inc. Westlake Village, CA, USA)<br>USA)   | Duragen (Integra LifeSciences Hawthorne NY USA) Sutureable   |
| Woodroffe <sup>[6]</sup> Clin Neurol Neurosurg 2018   | Manage CSF<br>Leaks 124 (3.1%)<br>pts 3965 Spinal Procedures                              | Primary vs. Delayed Repair<br>+/- SD<br>PDC 64<br>Successful PDC 47 (73.4%)                     | LD 49<br>Success 43 (87.8%)<br>Exploration of Wound 34 pts   | PDC Not Achieved<br>and no LD 39.5 %<br>Reop<br>CSF Leaks requiring<br>Re-Exploration for<br>Repair 27.4% Cases. | DE<br>>> Increased LOS<br>19.6 vs. 7.8 days<br>More<br>Readmissions 2.1<br>vs. 1.0 days<br>Infections<br>15 vs. 0*** |

CSF=Cerebrospinal Fluid Leaks, SD=Spinal Drains, PDC=Primary Closure, LD=Lumbar Drain, Reop=Reoperation, DE=Delayed Exploration, pts=Patients, LAM=Laminectomies, NIF=Non-instrumented Fusions, ESI=Epidural Spinal Injections, SC=Synovial Cysts, OYL=Ossification Yellow Ligament, FS=Fibrin Sealant, SW=Sandwich, Con=Conventional, BSA=Bone Suture Anchor, PB=Pullout Button, FDP= Flexor Digitorum Profundus, MG=Medical Glue, GS=Gelatin Sponge

GELFOAM should not be left in the epidural compartment following laminectomy as it may contribute to "...multiple neurologic events ...including but not limited to cauda equina syndromes". The sandwich technique decreased postoperative drainage (days 1-3), and reduced postoperative recurrent CSF leaks observed in 18 patients with subdural tumors; 13/31 received the sandwich repair vs. 15/23 treated with conventional repairs. In Epstein's series in 2015, 24 (7.14%) of 336 patients undergoing multilevel lumbar laminectomies and non-instrumented posterolateral fusions developed CSF fistulas; if you remove the 7 associated with preoperative epidural steroid injections (i.e. responsible for perforating the dura), the number of postoperative CSF leaks decreased to 17/336 or 5.05%.<sup>[2]</sup> Dural repairs included the primary utilization of 7-0 Gore-Tex sutures (suture is larger than the needle and occludes needle holes) to directly repair the defect and/or to sew to any requisite dural patch grafts (fascia, bovine pericardium, muscle). It also included the application of microdural staples (1.4 mm) where appropriate. This was then succeeded by the sandwich technique (i.e. a thin initial layer of fibrin sealant (Tisseel; Baxter International Inc. Westlake Village, CA, USA) followed by Duragen (sutureable; Integra Life Sciences, Hawthorne, NY, USA)), followed by a final layer of fibrin sealant (Tisseel). In Woodroffe *et al* series, 124 (3.1%) patients undergoing 3965 spinal procedures developed CSF leaks.<sup>[6]</sup> Of these, 64 patients underwent primary dural repair; it was effective in 47 patients (73.4%). Lumbar drains successfully controlled fistulas in 43 of 49 (87.8%) cases. Further, 27.4% of CSF leaks required re-exploration for repair, and those undergoing delayed vs. immediate dural repair had; longer lengths of stay (19.6 days delayed repair vs. 7.8 days immediate repair), higher rates of readmission (2.1 vs. 1.0 days), and higher infection rates (15 vs. 0).

### Proposed Micro Bone Suture Anchor Repair of Complex Lumbar Dural Defects

Patients undergoing primary, secondary, or multiple reoperations to repair major lumbar dural defects may require mini/micro bone suture anchors to achieve adequate dural repair [Figures 1 and 2]. These patients typically have no lateral dura to sew to, or very tenuous and/or frayed dura that is unable to hold sutures (e.g. suture recommended 7-0 Gore-Tex). Once it has been determined that a primary dura-dura or graft-dura repair is not feasible, application of the mini/micro suture anchor technique is an excellent alternative closure option. The mini/micro bone suture anchors can be directly placed/screwed/tapped into the bone surrounding the spinal decompression. These may be applied every few mm depending on the size and/or complexity of the dural defect; the more difficult/complex the repair, the closer these bone suture anchors should be placed so that when the sutures are applied to the grafts, the closure is as "water-tight" as possible. Overlying this closure,

the use of the sandwich technique may be utilized; first layer Tisseel (or other dural sealant but no complications have been reported with Tisseel), followed by Duragen, and a final layer of Tisseel; the latter increases the durability and strength of the closure.

### CONCLUSION

It may be difficult to treat complex primary and/or recurrent cerebrospinal fluid fistulas/dural tears (CSF/DT) that have occurred during lumbar surgery [Table 2].<sup>[2,5,6]</sup> If there is insufficient or no lateral dura present "to sew to", the application of mini/micro bone suture anchors into the bony margins surrounding the decompression/dural defects may facilitate "water tight" dural closure [Table 1] [Figures 1 and 2].<sup>[1,3,4]</sup>

### Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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### Conflicts of interest

There are no conflicts of interest.

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