Technical Note

Low-Profile, Suture Anchor Tension Band Construct for Olecranon Fractures and Osteotomies

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Abstract: Olecranon fractures are common and frequently require surgical intervention when they are displaced or unstable. Treatment is largely dictated by fracture type and surgeon preference. Traditional methods of fixation, including tension band wiring and locking plate fixation, have adequate union rates; however, both techniques are associated with increased reoperation rates due to symptomatic hardware. The aim of this article is to describe a technique using a low-profile, suture anchor tension band construct for simple transverse olecranon fractures, triceps avulsions, and olecranon osteotomies. The goal of this technique is to produce stable fixation and allow early range of motion while mitigating the reoperation rate caused by symptomatic or prominent hardware with olecranon plate fixation during fracture and olecranon osteotomies.

Olecranon fractures are a common upper-extremity injury accounting for 0.9% of all fractures and 10% of upper-extremity fractures. They are usually the result of a direct blow from a ground-level fall. The most common fracture pattern is a simple transverse, non-comminuted fracture of the olecranon with intra-articular displacement (Fig 1).[1] Due to the displaced intra-articular pattern, the majority of olecranon fractures require operative management. There are a variety of different treatment options that have classically included tension band wiring (TBW), locking plates, intramedullary screw fixation, and fragment excision with triceps advancement in select cases.[2-4] Regardless of the surgical technique, the goals of operative management are to provide stable fixation, restore the extensor mechanism, and achieve anatomic reduction to restore the articular congruity. Historically, TBW has been considered the gold standard for simple transverse olecranon fractures; however, it is associated with high rates of complications.[5]

One of the main complications associated with TBW is the development of symptomatic hardware and subsequent reoperation for hardware removal. Symptomatic hardware rates associated with TBW have been reported as high as 80%.[5,6] To address the issues of symptomatic hardware and the high rate of reoperation associated with TBW, we developed a technique that uses suture anchors. We hypothesized that an all-suture tension band construct could provide anatomic reduction and stable fixation while decreasing reoperation rates due to symptomatic or prominent hardware.

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Surgical Technique

This technique uses the following items: 2.5-mm drill bit, a system 7 power drill, pointed reduction clamps, four 4.75-mm SwiveLock suture anchors (Arthrex, Naples, FL), #2 FiberWire suture (Arthrex), #2 FiberTape suture (Arthrex), suture passer, straight needle, needle driver, and suture scissors.

Patient Position

The patient is placed in the prone position. A well-padded high arm tourniquet is placed on the operative side and inflated to 200 mm Hg. The operative arm is placed on an arm board attached to the end of the table and sterile towels or a bump under the arm. The

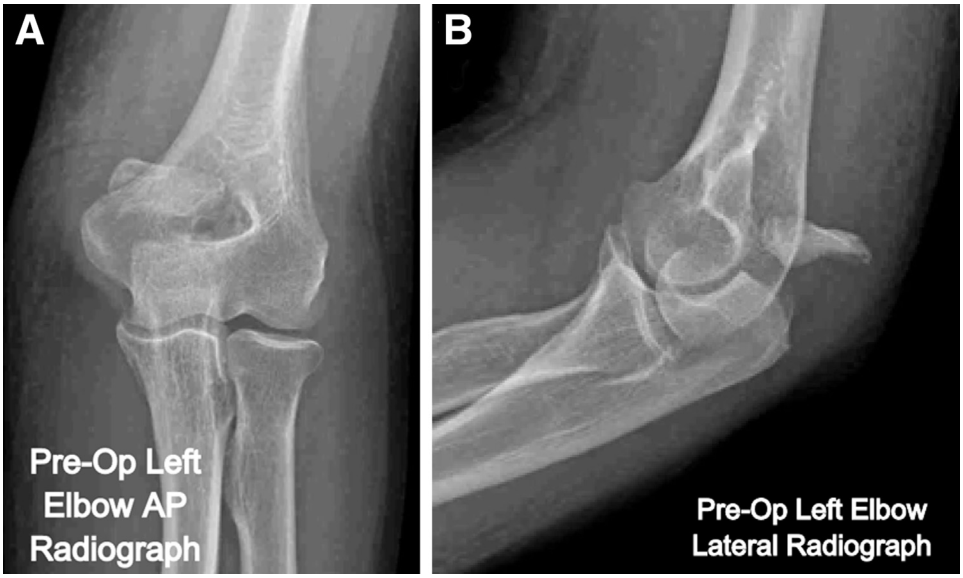

Fig 1. Preoperative left elbow radiographs. Initial injury anteroposterior radiographs (A) and lateral (B) of the left elbow demonstrating a displaced transverse olecranon fracture.

arm is prepped and draped in sterile fashion. Radiographs are taken to confirm fracture pattern (Fig 1).

Surgical Approach

A 5- to 6-cm posterior midline longitudinal incision is made while curving radially around the tip of the olecranon to avoid the ulnar nerve (Fig 2). Skin and subcutaneous tissue are then carefully dissected, elevating full-thickness flaps until the fracture site is identified. The fracture is exposed and meticulously cleared of any hematoma, debris, and interposed soft tissue that may prevent anatomic reduction.

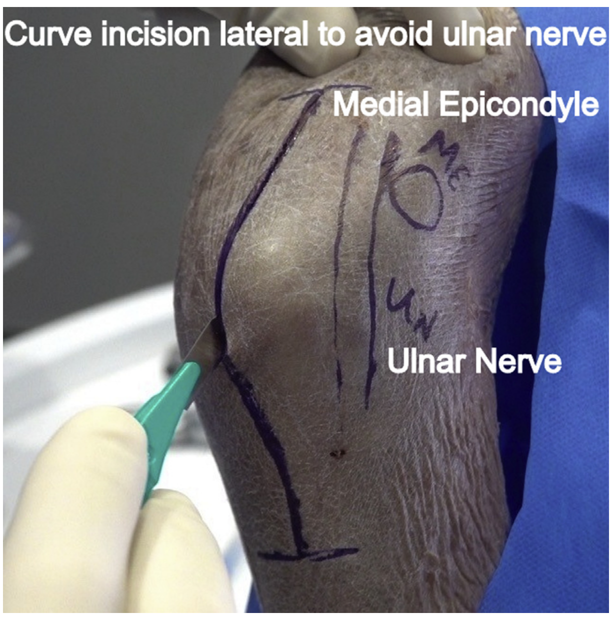

Fig 2. Surgical incision. A longitudinal incision is curved lateral to avoid the ulnar nerve and expose the olecranon. This is being performed on a left elbow cadaveric specimen in a prone position.

Fracture Reduction and Fixation

A unicortical 2.5-mm drill hole is made on the dorsal surface of the distal ulnar fracture fragment to help accommodate a pointed reduction clamp and aid in reduction (Table 1). The ability to achieve anatomic reduction is confirmed by direct visualization and orthogonal intraoperative fluoroscopy before proceeding with fracture fixation. The distal fracture fragment is prepared for placement of two 4.75-mm SwiveLock anchors (Arthrex) by predrilling 2 parallel holes into the healthy cancellous bone of the ulnar metaphysis (Fig 3). The holes are oriented longitudinally along the intramedullary canal and perpendicular to the fracture line. Radiographs are taken during the initial drill pass or punch for these suture anchors to note the location of the anchors and therefore avoid contact with the additional suture anchors that will be placed in the distal ulna fragment later in the procedure (Table 1). Two preloaded 4.75-mm SwiveLock suture anchors (Arthrex) are then placed into the distal fragment. The avulsed olecranon fragment is prepared by drilling two 2.5-mm bone tunnels, at least 10 mm apart (Table 1), perpendicular to the fracture site to obtain bicortical compression on far and near sides of the fracture (Fig 4). Anatomic reduction is obtained with the pointed reduction clamp and confirmed with orthogonal intraoperative fluoroscopy. The anchor sutures are then shuttled through their respective tunnels in the proximal olecranon fracture fragment (Fig 5). The #2 FiberTape suture (Arthrex) is then passed with a straight needle between the triceps and olecranon tip horizontally, alternatively this can be performed by

Table 1. Pearls and Pitfalls to Suture Tension Band Construct for Olecranon Fractures and Osteotomies

Step	Pearl	Pitfall
Drill 2.5-mm unicortical holes on the dorsal aspect of the distal fragment for reduction forceps	This will provide a stable foundation for pointed reduction clamp	Failure to drill holes and secure reduction may cause inadequate reduction of fracture during suture bridge tension band
Radiograph taken to note the location of the initial suture anchors in the distal ulna fragment	Careful planning of suture anchor placement will help avoid contact when placing the additional distal ulna anchors later in the procedure	Risk for suture anchor contact and disruption of fixation when placing the additional distal ulna anchors
Anchoring FiberTape suture through the fracture site	FiberTape should be anchored on the far side of fracture site close to the cortical region of the sigmoid notch in order to achieve compression on both near and far side of fracture	If FiberTape suture is anchored away from sigmoid notch, gapping may occur on the far side of the fracture
Drilling tunnels in the proximal fragment	Tunnels should be separated by at least 10 mm	A bone bridge of less than 10 mm will increase the risk of bone bridge failure or fracture
FiberTape passed horizontally through drill hole or between triceps and olecranon	This will provide stability and uniform compression of fracture while crossing suture bridge is created over the dorsal ulna	Inability to hold initial fixation may cause loss of compression and tension of fracture reduction
Place "distal row" suture anchors	Anchors should be placed with elbow extended	Without elbow extension, anchors will lose tension and fracture compression of near side reduction will be suboptimal

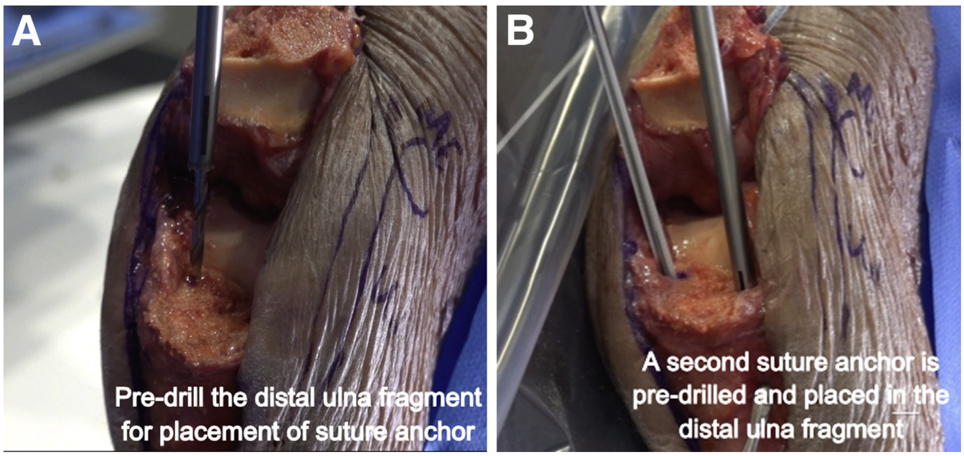

Fig 3. Preparing the distal ulnar fragment. (A) The radial aspect of the distal ulnar fragment is being predrilled close to the far cortex for placement of preloaded suture anchor. (B) Radial side anchor has been placed and the ulnar aspect of the distal ulnar fragment is being predrilled. This is being performed on a left elbow cadaveric specimen in a prone position.

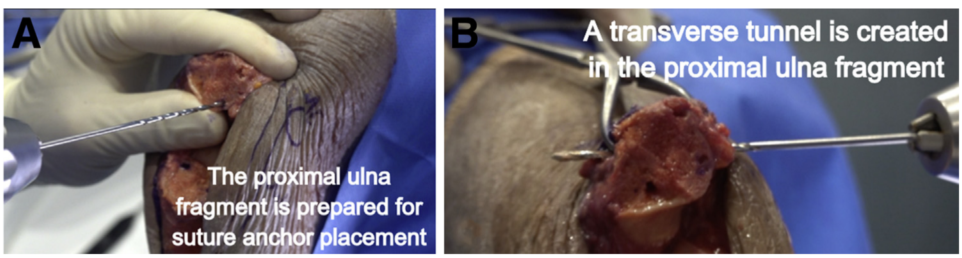

Fig 4. Preparing the proximal ulnar fragment. (A) The proximal fragment is prepared by drilling two 2.5-mm bone tunnels perpendicular to the fracture site. (B) A transverse tunnel parallel to the fracture site is created; this will allow passage of a FiberTape suture and provide medial and lateral compression across the fracture site. This is being performed on a left elbow cadaveric specimen in a prone position.

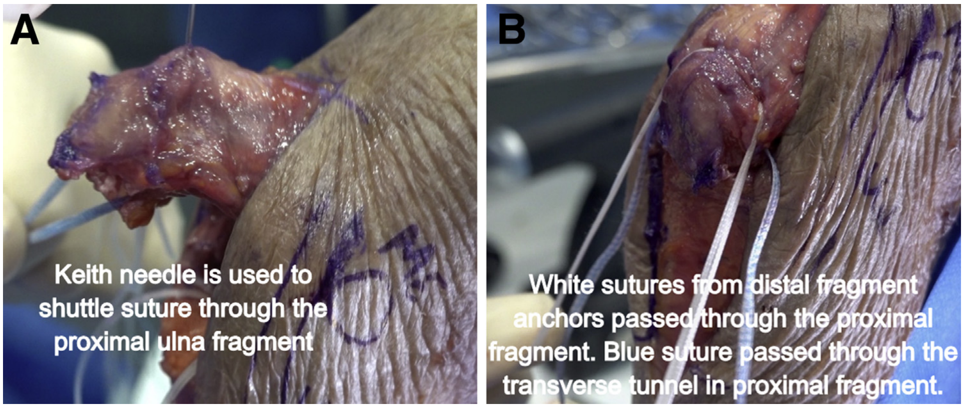

Fig 5. Suture management. (A) A Keith needle is used to shuttle the sutures through the proximal olecranon fragment. (B) The white sutures from the suture anchors in the distal fragment are passed through their respective tunnels in the proximal olecranon fragment, perpendicular to the fracture. The blue suture is passed through the transverse tunnel in the proximal olecranon fragment. This is being performed on a left elbow cadaveric specimen in a prone position.

making a drill pass horizontally in the proximal olecranon fragment then passing the FiberTape suture to achieve the same result (Table 1). The remaining #2 FiberTape sutures (Arthrex) are crossed in suture bridge fashion, crossing the dorsal aspect of the fracture and anchored into the distal ulnar fragment via two 4.5 mm SwiveLock anchors with the elbow in extension (Arthrex) (Fig 6 and 7, Table 1). The reduction is assessed with intraoperative fluoroscopy while taking the elbow through range of motion (Video 1). The wound is then irrigated and closed in standard layered fashion. Sterile dressings are applied, and the patient is placed in a posterior elbow splint in 60° to 70° of elbow flexion.

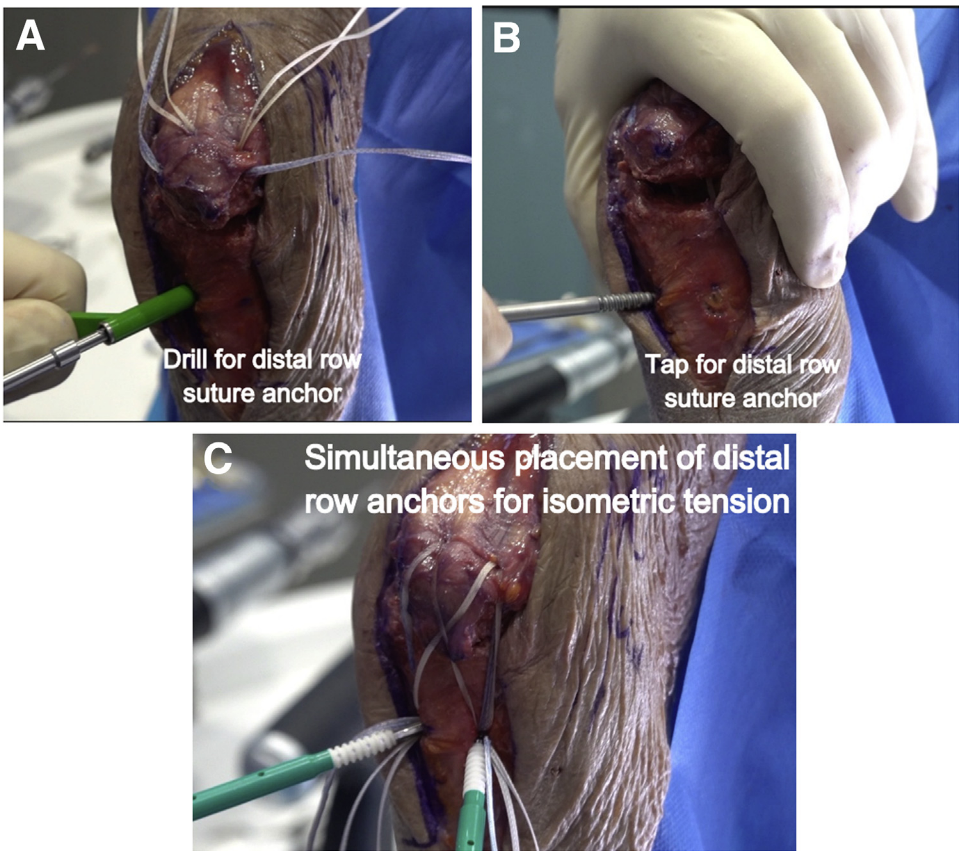

Fig 6. Distal row anchors. (A and B) The distal row is drilled and tapped in preparation for anchor placement. (C) The distal anchors are positioned simultaneously to achieve isometric tension across the fracture site. This is being performed on a left elbow cadaveric specimen in a prone position.

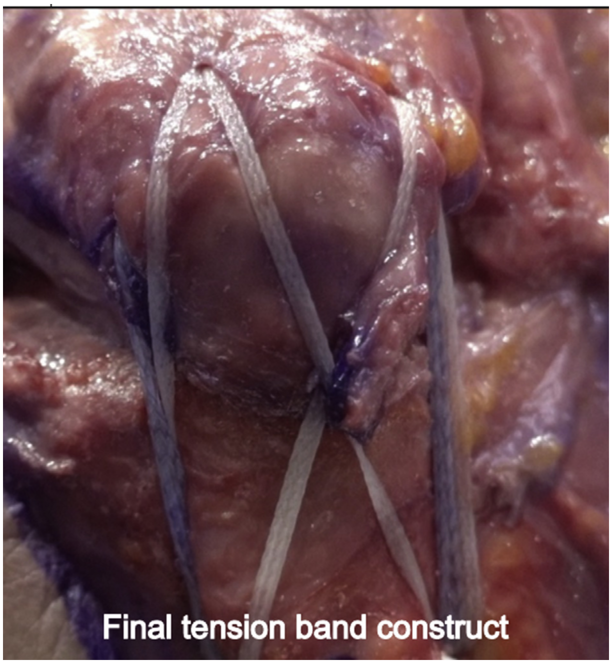

Fig 7. Final tension band construct. Final all-suture tension band construct. This is being performed on a left elbow cadaveric specimen in a prone position.

Postoperative Protocol

During the immediate postoperative period, the patient is instructed to perform hand and wrist range of motion exercises to prevent stiffness. At 1 week, the elbow splint is removed and physical therapy is initiated. The patient is encouraged to work on passive extension and active elbow flexion. Heavy lifting or axial loading of the operative extremity is avoided for at least 6 weeks after surgery. At 6 weeks postoperatively, the patient is allowed to progress to active extension if there is radiographic evidence of fracture healing. At 12 weeks postoperatively, the patient may return to unrestricted activity as tolerated. Radiographs are taken at 2 and 12 weeks postoperatively (Fig 8 and 9).

Discussion

Displaced, simple transverse olecranon fractures are a common upper-extremity injury that usually require operative management. TBW and locking plates are both well-accepted treatment options with excellent clinical results.[7,8] TBW converts the distractive force generated by the triceps into a compressive force at the articular surface.[9] While long-term patient-reported outcomes of olecranon fractures treated with TBW are excellent,[10] symptomatic hardware is a common complication with rates reported as high as 80%.[5,6]

Chalidis et al.[5] reviewed 62 patients who underwent TBW for isolated olecranon fractures. Hardware removal was performed in 51 of the 62 patients due to prominent hardware, localized pain, or the patient being “bothered” by the hardware. Similar findings were seen when Snoddy et al. reviewed 177 patients who underwent TBW or open reduction internal fixation with locking plates. They found that patients undergoing TBW had reported hardware prominence in 65.2% and subsequent hardware removal in 46.5%. The rate of hardware prominence and subsequent removal was significantly less in patients treated with locking plates, 18.7% and 39.5%, respectively.[11]

We hypothesized that an all-suture tension band construct using suture anchors can provide anatomic reduction and stable fixation of simple transverse olecranon fractures as effective as TBW with less of the aforementioned complications. The main advantage of our technique is avoiding placement of subcutaneous hardware, decreasing the need for reoperation and hardware removal. Biomechanical studies have demonstrated that high-performance suture such as FiberWire (Arthrex) is a suitable alternative to

Fig 8. Initial postoperative left elbow radiographs. Left elbow anteroposterior (A) and lateral (B) radiographs 2 weeks postoperatively after open reduction internal fixation with all suture tension band construct.

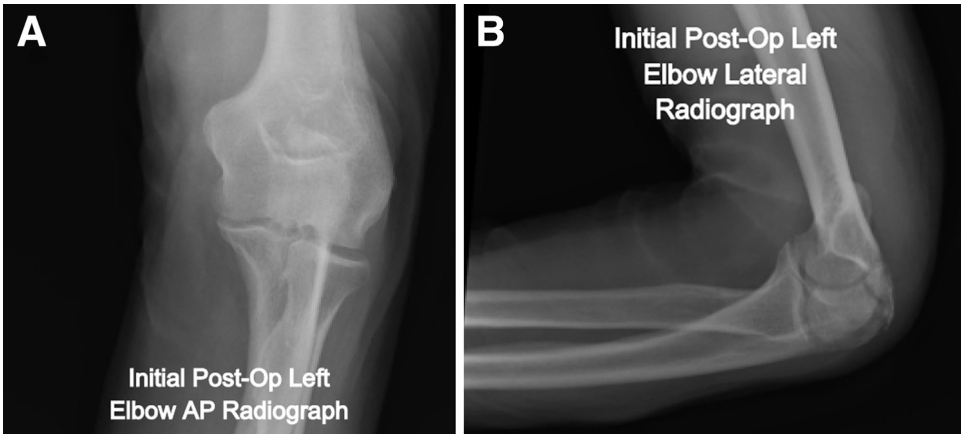

Fig 9. Final left elbow radiographs. Left elbow AP (A), oblique (B), and lateral (C) radiographs after complete healing of the olecranon fracture.

18-gauge stainless-steel wire in tension banding for olecranon and patellar fracture fixation.[12-14]

Wright et al.[14] evaluated the failure strength of tension band constructs consisting of 18-gauge stainless-steel wire, single-strand FiberWire with sliding knot, double-strand FiberWire with sliding knot, and double-strand FiberWire tied with a modified Wagoner's Hitch. The failure strength of constructs was stainless-steel wire 636N, single-strand FiberWire 343N, double-strand FiberWire 580N, and double-strand FiberWire with Wagoner's Hitch 1337N. Shoaib et al.[12] used sawbones to measure the fracture gap seen in simple olecranon fractures with tension band constructs using stainless-steel wire, ETHIBOND, and FiberWire. A force of 100 N was cyclically loaded to each tension band construct. The fracture gap with suture material was significantly greater than with stainless steel wire, but still less than 0.5 mm with loading of 100 N.

As with many operative challenges faced by orthopaedic surgeons, a myriad of surgical options exists, each with their own complications. The all-suture tension band construct provides another option for surgical treatment for transverse olecranon fractures. Table 2 outlines the advantages and disadvantages of this suture tension band construct technique. The goal of our construct is to capitalize on the principles of tension band wiring while avoiding its most common complications, symptomatic hardware and ultimately reoperation.

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Table 2. Advantages and Disadvantages to Suture Tension Band Construct for Olecranon Fractures and Osteotomies

Advantages	• Potentially decreases the rate of symptomatic hardware, as there is no metallic hardware used with this technique. • Potentially decreases the rate of subsequent surgery for removal of hardware secondary to potentially decreased rates of symptomatic hardware. • Potentially decreases the rate of wound healing complications and deep infection, as there is no metallic hardware, which can develop biofilm. • High performance suture are sustainable alternatives to stainless-steel wire in tension band constructs for fracture fixation.
Disadvantages	• The surgeon will have to learn additional steps to the technique, which may add time to the procedure when first beginning. • Additional cost of the suture and anchors compared with stainless-steel wire. • Will not see failure of fixation on follow up radiographs, as the suture and anchors are radiolucent.

donation of the cadaveric specimen and the use of their lab facility.

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