Radial and Horizontal Meniscus Tear All-Inside Repair
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Radial and horizontal meniscus tear patterns have been shown in the literature to heal but can be difficult to sew. This difficulty is due in part to the suboptimal repair vectors achieved with standard repair techniques that rely on central-to-peripheral needle penetration through the meniscus with fixation into the perimeniscal capsular tissues. When repairing radial and horizontal tears with these techniques, it can be challenging to achieve anatomical reduction and uniform compression of the tear edges. They may also, to some extent, extrude or entrap the meniscus to the capsule and/or pericapsular tissues. Repairing the meniscus tissue to itself by directly encircling the tear with an all-inside arthroscopic approach may enhance our ability to easily and confidently repair these common tear patterns.

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Figure 1: Endoscopic photographs show a complete radial tear of the lateral meniscus (A) and probing of the tear revealed the adjacent popliteus tendon (B). After suture passer, all-inside, side-to-side suture repair (C) and a second look eight months postoperative using needle endoscopy (D).
Carbon Fiber Intramedullary Nail Fixation in Troublesome Long Bone Fractures and Nonunions

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Introduction
Metallic implants, frequently used for fracture stabilization, have limitations of rigidity, limited fatigue strength and imaging interference. Because of its superior properties, carbon fiber has emerged as an important material in the aerospace and high-tech industries. Recently, an innovative company has explored carbon fiber’s use in fracture surgery, noting substantial improvements in fatigue strength, modulus of elasticity and compatibility with conventional imaging modalities. I present four cases treated at Cedars-Sinai with this state-of-the-art technology.

Case 1: Distal femoral fracture with segmental bone loss
A 42-year-old male fell 50 feet, sustaining a comminuted, open right distal femoral fracture with segmental bone loss, which was initially treated with irrigation and debridement (I&D) followed by staged internal fixation. The patient developed aseptic, atrophic nonunion with associated hardware failure (Fig. 1A). The patient was transferred to Cedars-Sinai, where he underwent hardware removal and revision fixation using a retrograde, reamed intramedullary carbon fiber femoral nail (CarboFix Orthopedic, Herzeliya, Israel). The patient’s femur healed uneventfully (Fig. 1B,C).

Case 2: Tibia-fibula fracture
A 23-year-old male was involved in a motorcycle accident, sustaining an open tibia-fibula fracture (Fig. 2A) with associated soft tissue injury. The patient was treated with I&D, reamed carbon fiber intramedullary nailing and local wound care. The patient’s soft tissues healed uneventfully, and he was walking pain-free without assistive devices by seven weeks. X-rays showed complete bone healing by five months (Fig. 2B,C).

Case 3: Distal femoral nonunion
A 29-year-old obese male presented with distal femoral nonunion and associated hardware failure (Fig. 3A). The patient underwent closed revision fixation with a retrograde carbon fiber...
femoral nail. Within three weeks, the patient was ambulating without pain or assistive devices (Fig. 3B-D).

Case 4: Femoral pathological fracture
A 56-year-old male with multiple myeloma sustained a right proximal femoral pathologic fracture treated at an outside hospital with closed reduction and cephalomedullary nailing. The patient developed a malreduced nonunion with associated limb length discrepancy and hardware failure (Fig. 4A,B). The patient was transferred to Cedars-Sinai for further care and taken to surgery for revision open reduction and internal fixation with an antegrade carbon fiber femoral nail. At early follow-up, the patient was ambulating without pain or assistive devices, demonstrated equal limb lengths and showed healing on X-ray (Fig. 4C,D).

Discussion
Carbon fiber's superior material properties have made it the material of choice in industries requiring durable, flexible, lightweight materials. With no adverse reactions and a cost comparable to traditional metal implants, carbon fiber technology offers a viable option for the stabilization of difficult fractures in which fatigue strength, flexibility or imaging compatibility is required. These implants demonstrate unprecedented durability (an 8 mm nail does not break after 4 million cycles of 4-point bending at 1500 N), a modulus of elasticity closer to cortical bone than any metal and complete imaging compatibility. These features of fatigue strength, flexibility and radiolucency make carbon fiber an ideal material for fracture stabilization, especially in the setting of high-energy skeletal trauma, skeletal tumors and trauma complications.

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Case 1: Complete radial tear

This case involved a 25-year-old male who sustained a complete radial tear of his lateral meniscus at the level of the popliteal hiatus (Fig. 1A,B). After trimming away the central third with a biter, the middle and peripheral thirds were repaired with multiple side-to-side stitches placed via an all-inside technique using the Ceterix™ NovoStitch™ suture passer (Fig. 1C). Three 2-0 high-strength sutures were used to sew the tear side to side. The central most stitch was used to shuttle an absorbable suture. The patient remained non-weight bearing for six weeks, during which time active flexion up to (but not beyond) 90 degrees was allowed. At eight months postoperative, the patient was pain-free. A VisionScope® needle endoscopy was performed to confirm healing and guide his release to return to contact sport (Fig. 1D).

Case 2: Horizontal cleavage tear

In this case, a 28-year-old female had a chronic horizontal cleavage tear of the lateral meniscus (Fig. 2A). The central third was debrided with a biter and the tear surfaces were rasped. The superior and inferior lamina of the tear were then sewn directly to each other by passing sutures behind the meniscus from the tibial side of the meniscus to the femoral side (Fig. 2B) and tying around the trimmed apex with peripherally positioned Revo knots (Fig. 2C). Rehabilitation involved weight bearing, as tolerated in extension, with a hinged knee brace for four weeks. During this period, knee flexion was allowed to 90 degrees when not weight bearing. At three month’s follow-up, the patient’s pain and symptoms had resolved. At eight months postoperative, needle endoscopy was performed to confirm healing in anticipation of return to long-distance running (Fig. 2D). The tear was healed, the knots had incorporated into the meniscus and the sutures had synovialized.

References
2. Biedert, RM. Treatment of intrasubstance sutures had synovialized. The tear was healed, the knots had incorporated into the meniscus and the surfaces were rasped. The superior and inferior lamina of the tear were then sewn directly to each other by passing sutures behind the meniscus from the tibial side of the meniscus to the femoral side (Fig. 2B) and tying around the trimmed apex with peripherally positioned Revo knots (Fig. 2C). Rehabilitation involved weight bearing, as tolerated in extension, with a hinged knee brace for four weeks. During this period, knee flexion was allowed to 90 degrees when not weight bearing. At three month’s follow-up, the patient’s pain and symptoms had resolved. At eight months postoperative, needle endoscopy was performed to confirm healing and guide his release to return to contact sport (Fig. 1D).