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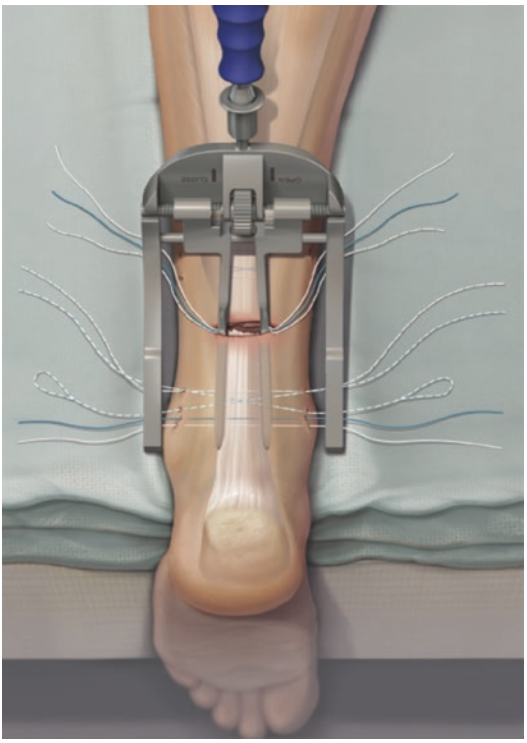

Minimally Invasive Repair of Acute Achilles Tendon Ruptures Using the Percutaneous Achilles Repair System (PARS) Arthrex Device

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34.1 Background

The Achilles tendon is formed from the merger of the gastrocnemius and soleus muscles to insert on the calcaneus. It is enclosed by a thin gliding membrane paratenon, which provides nutrition and vascular supply to the tendon [1].

The tendon is a viscoelastic structure, capable of undergoing elongation and deformation in response to stress. This is true only up to certain levels of strain; if strains are between 4% and 8% the Achilles tendon complex may be damaged, and ruptures can occur if strains exceed 8% [2].

Acute rupture of the Achilles tendon can be associated with a classic history of sudden onset of pain, with almost exclusively no direct trauma to the region. Patients give a typical history of hearing a ‘pop’ and believing they were hit by something or somebody.

Clinical examination reveals a loss of the physiologic position of the affected ankle, and can be evaluated with the patient prone with both knees flexed. Comparison will reveal a relatively more neutral to dorsiflexed position of the injured side.

Ecchymoses and swelling is common, and a palpable gap can sometimes be felt at the region of injury. A calf squeeze test may show no ankle plantar flexion.

Generally an X-ray is performed as baseline to exclude any bony pathology, but in general no imaging studies are required for the diagnosis of Achilles tendon rupture. Dynamic ultrasound can be useful to aid surgical planning, especially in the chronic setting, where tendon mobility and tissue integrity can be questionable and more complex reconstructions may be required.

34.2 Management

There is controversy regarding the optimal management of the acute Achilles rupture. Concern for higher rates of re-rupture in non-operatively managed patients has led to a rise in the popularity of surgical intervention. This is balanced by the risks of infection, wound issues, and other surgical and anaesthetic complications.

The rate of re-rupture has been consistently shown to be high with non-operative cohorts (as high as 10–12% in many recent meta-analyses [3], as opposed to 1–2% for patients treated operatively). These figures have been criticised for including patients not participating in functional rehabilitation in the non-operative cohort but recent studies continue to demonstrate higher rates of re-rupture in non-operative (6.7%) vs. operative (3.7%) Achilles injuries [4].

Another proposed advantage of surgical treatment over non-surgical is the reduced loss of plantar flexion push-off strength. Several studies have demonstrated relative push-off strength is higher following surgical repair compared to non-operative management [5].

Proponents of a surgical management also cite a return to functional activity and sports with surgical treatment. A recent systematic review demonstrated faster rehabilitation, reduced time back to work, and better functional outcome after surgery [6].

One of the major disadvantages of a surgical approach is the complication profile, notable wound healing and infection. Open repair has traditionally been performed with a large longitudinal incision and locking Krakow sutures to approximate the tendon ends. This has been shown to have a higher rate of complications over non-operative treatment, including wound problems [7].

The percutaneous or mini-incision techniques have shown reduced rates of these potentially disastrous complications. A recent study compared the PARS Arthrex system to open repair and found a significant reduction in total complications (5% vs. 10.6%), with improved rates of return to baseline activity [8].

This system also allows for a knotless approach at the repair site when combined with the Speedbridge system; this has been shown to produce excellent results in the elite athlete setting, where faster rehabilitation is made possible by fixation to bone in the distal os calcis, and there is a theoretical reduction in suture bulk and knot slippage [9].

To summarise, management decision-making should be patient focused, with a knowledge of occupation and sporting level, medical co-morbidities including smoking and vasculopathy, as well as patient wishes.

34.3 Operative Technique Using PARS®

A general anaesthetic is typically used. The patient is positioned in the semi-prone position with the legs positioned prone, the hips semi-prone and the upper body positioned lateral. Minimal bolster support is required. The uppermost arm is placed in an arm gutter and a sandbag may be placed under the iliac wing to prevent any forward tilt. A preoperative assessment of the patient to exclude significant limitation of hip external rotation or increased tibial torsion should be performed, as this may in rare cases make this positioning difficult. A fully prone position may be used in this case.

A tourniquet is applied around the thigh and inflated to 300 mmHg; this is easiest to apply before the patient is positioned semi-prone. Intravenous antibiotics are administered prior to inflation of the tourniquet. The feet are positioned over the end of the table with a pillow under both tibiae to allow the gastrocnemius to relax slightly.

It is desirable to prepare and drape both legs to allow for comparison of foot position following repair to ensure appropriate repair tension.

Skin sterilisation below the knee is sufficient in the acute repair setting using an alcoholic chlorhexidine preparation solution.

A 2–3 cm incision is placed 1 cm below the end of the proximal tendon stump. The incision can be made either vertically or horizontally depending on preference; the authors have experience with both with no significant complications. If made vertically, the incision is made just to the medial side of the mid-posterior line.

Meticulous skin and tissue handling is imperative throughout this procedure. After the skin is incised, the paratenon, if not already opened as a result of the injury, is incised. Often a gap is then seen with strands of ruptured tendon visible. The tendon ends need to be identified for the PARS device to be passed within the paratenon. Dissection can be performed to identify and free both the proximal and distal tendon ends using a blunt curve Mayo scissor.

The tendon may be stabilised using a tendon clamp, and the inner arms of the PARS jig are now placed within the paratenon on either side of the proximal tendon. Once inside, the inner arms can be opened or closed by rotating the wheel on the jig. The device is then inserted along either side of the tendon. The muscle belly will usually stop the device at an appropriate level (Fig. 34.1).

The jig has corresponding numbered holes on either side to allow for passing of sutures. We typically use suture tape, as it allows for stronger hold, with a flatter profile of suture. There are seven holes for suture options and holes 3 and 4 are obliquely orientated and designed for a looped suture to pass through. This is a locking suture. We typically use holes 1–5 for Achilles fixation. Pass sutures through holes 1–5, to have a configuration as shown. One looped suture is on either side of the jig (Fig. 34.2).

The jig is then slowly withdrawn out of the incision, and once the inner arms are seen, pull the suture loose from the outer arms and remove them from the wound to avoid getting stuck in the holes of the outer jig (Fig. 34.3).

The number 2 hole suture is then passed under suture 3 and 4 and through the loop on each side, and then pulled through to achieve a locking suture on each side (Figs. 34.4 and 34.5).

All steps are now repeated for the distal portion of the tendon, to achieve the following final configuration (Fig. 34.6). We recommend that it

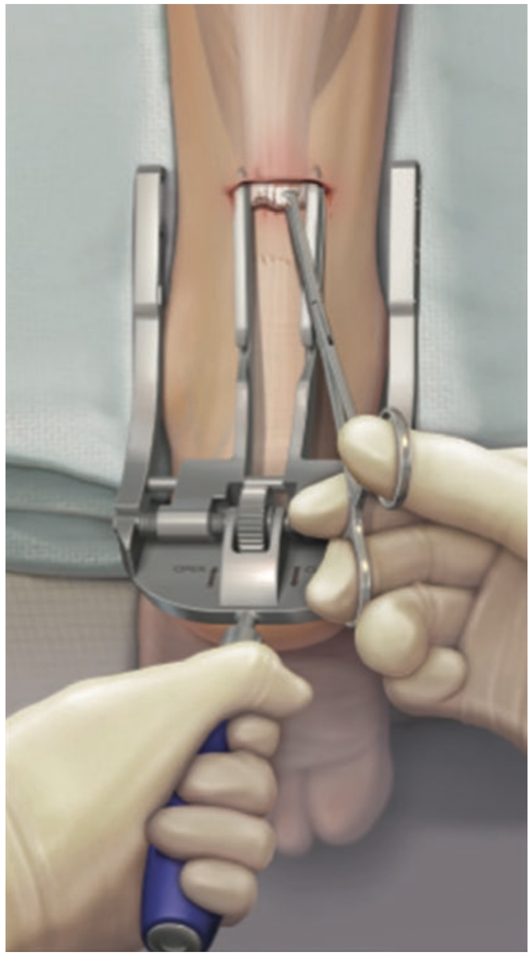


Fig. 34.1 Advancement of the PARS jig inside the paratenon, with careful traction on the proximal tendon

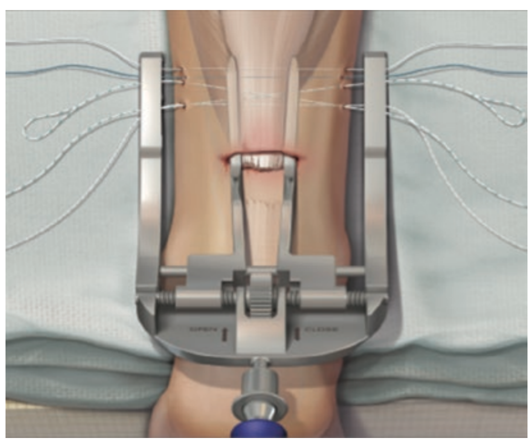


Fig. 34.2 Passage of sutures through the proximal tendon and PARS jig

is essential to check each suture both proximally and distally for pull out strength. If a suture pulls through the tendon on moderate tension, then it needs to be redone. When testing pull out strength, pull the sutures in a direction parallel with the Achilles tendon to avoid strafing the skin and wound edge.

The tendon is now ready to be repaired. With the foot in maximal plantar flexion, tie the suture from hole number 5 with 4 knots on each side. A low sterile table at the end of the bed is useful to lay the foot on in a plantarflexed position, both when exposing the tendon ends and when tying the repair. This is useful to free up the surgical assistant for other tasks. The height of the bed can then be adjusted to obtain the optimal foot position prior to tying the sutures.

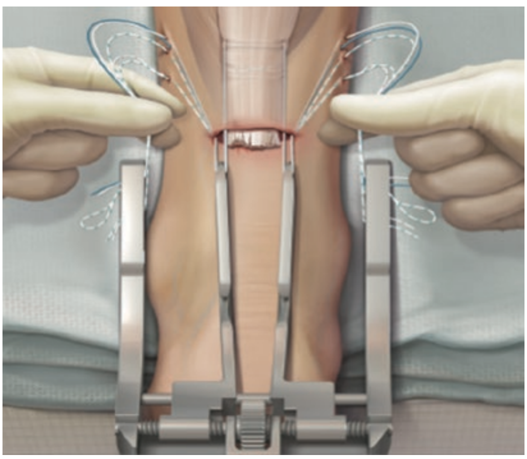


Fig. 34.3 De-tensioning the suture construct to facilitate removal of sutures and PARS jig

This will approximate the tendon and allow for tying of the locking sutures which will not slide. Tie the locking sutures on each side with 5 knots and then the final suture hole number 1 to complete the repair (Fig. 34.7).

A 2/0 vicryl epitendinous suture is then used to augment the repair, with care to place knots on the deep surgical side. The paratenon is then loosely closed with 2.0 vicryl rapide, and the small skin incision with interrupted 3.0 nylon. A front slab is then applied in 20° equinus.

34.4 Alternative Technique Using PARS/Speedbridge

This technique is a modified percutaneous technique that combines the benefits of percutaneous repair with direct bone fixation, bypassing suture

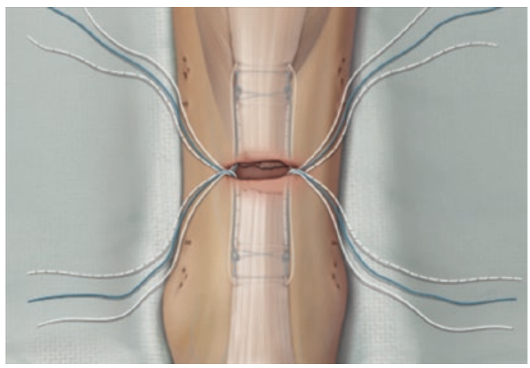
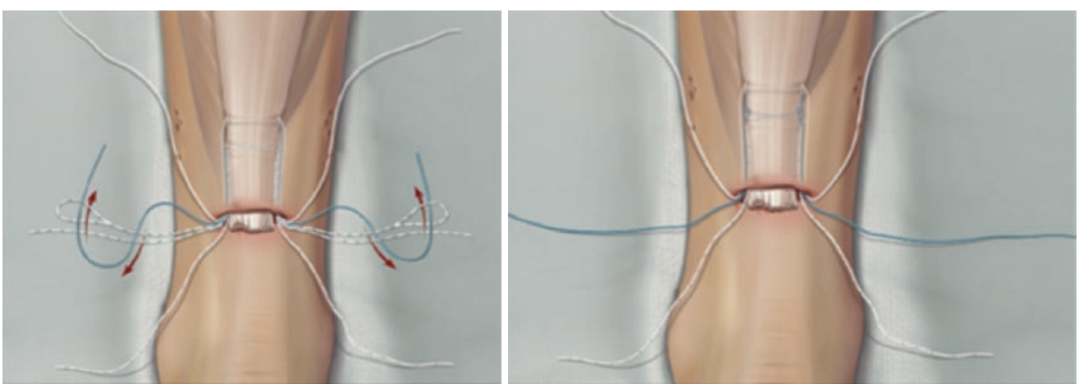


Fig. 34.6 Final suture construct prior to knot tying



Figs. 34.4 & 34.5 Creation of the locked suture know on each side of the proximal tendon

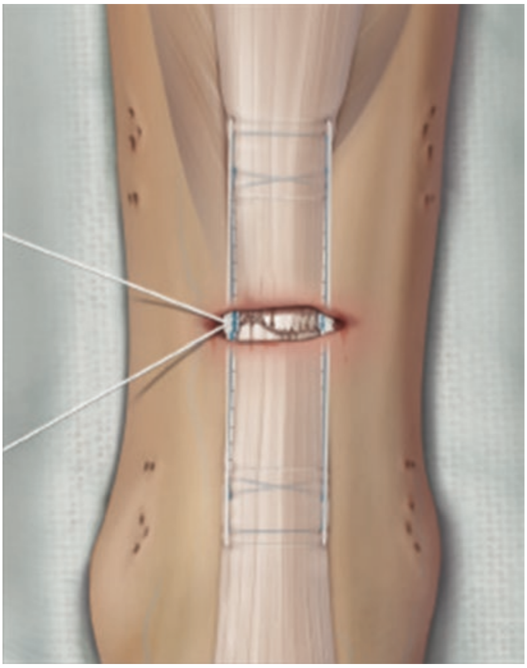


Fig. 34.7 Suture tying with the foot (not shown) in appropriate plantar flexion

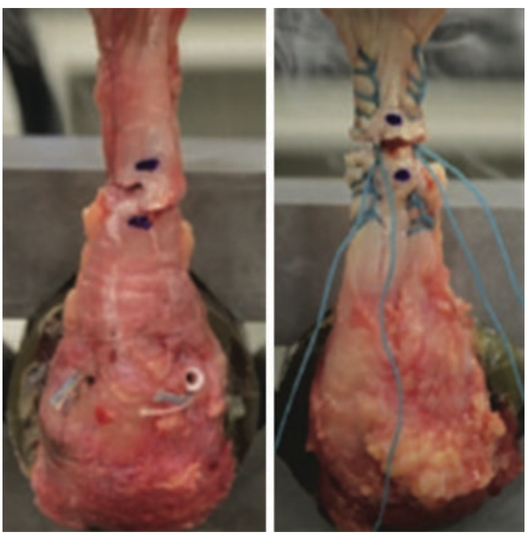


Fig. 34.8 Biomechanical comparison of PARS/Speedbridge combination construct compared to open Krakow repair

knots at the repair site as well as the potentially compromised tissue at the rupture site [9].

Biomechanical studies have demonstrated statistically significantly less cyclic displacement at 500–1000 cycles of this construct in comparison with a standard open Krakow suture repair [10] (Fig. 34.8).

The surgical technique is identical in positioning, incision and preparation of the proximal stump with the PARS device. Two stab incisions 2 cm apart are then made at the level of the Achilles insertion over the calcaneus and drilled using a 3.5 mm drill guide. These holes are then tapped in preparation for two 4.75 mm SwivelLock anchors (Figs. 34.9 and 34.10).

A Banana SutureLasso device is passed from each of the two distal incisions to capture the three sutures on each side of the tendon proximally, and these are pulled through into the distal incisions (Fig. 34.11).

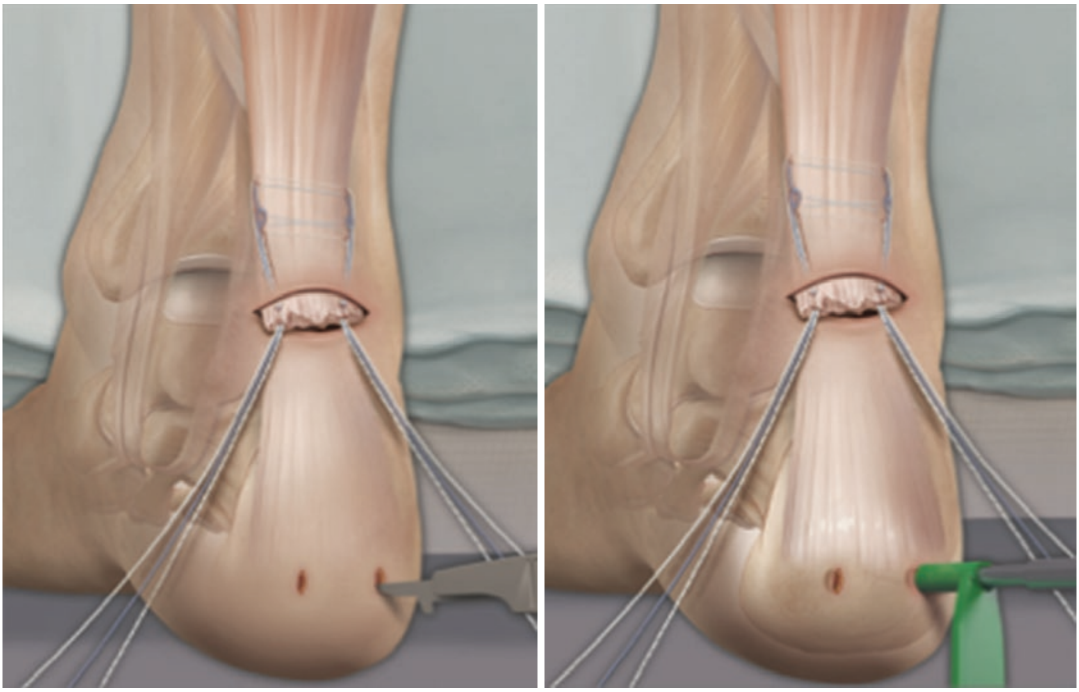
The anchors are then inserted at correct tension to achieve the final construct (Fig. 34.12). It is possible to place an epitendinous suture at the level of the proximal incision if desired.

34.5 Pearls and Pitfalls

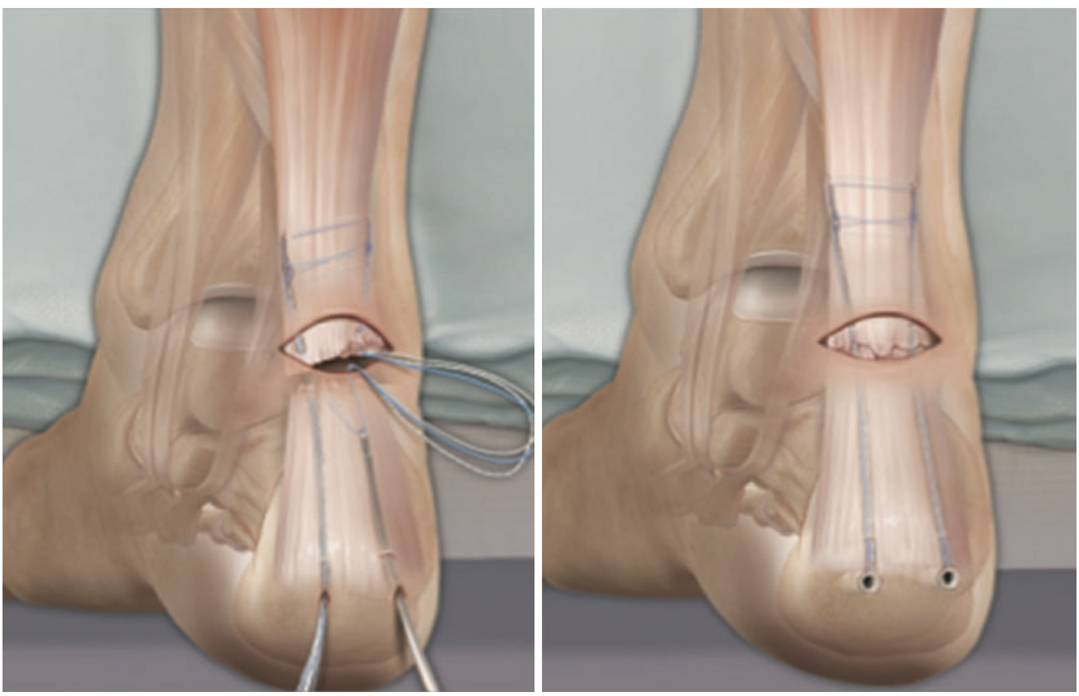
Use gentle pressure in a downwards direction on the tendon ends to hold the tendon in place when passing the sutures. We have found in very rare circumstances the proximal end of the tendon can be difficult to transfix with percutaneous sutures. In this case the PARS can be used for the distal stump, and a 'half-open' approach can be used, with a longer incision proximally. Given that it is the distal portion of the wounds that in our experience is most affected by wound issues in the open repair setting, this can be a useful adjunct in the difficult case.

We have found it useful to vary the angle of the jig slightly in the axial plane while passing the sutures; this can facilitate sutures at a slightly different angle in the substance of the tendon, and is a useful technique if sutures are pulling out on testing.

The authors use SutureTape® in distinction to a Fibrewire® or vicryl suture for repair. We have found this to be a lower profile suture reducing the size of knots and potential wound problems. SutureTape has also been shown to have a higher ultimate load to failure and greater tissue pull-through strength than a #2 FibreWire [11].



Figs. 34.9 & 34.10 Preparation of distal anchors after identical use of PARS jig in proximal tendon



Figs. 34.11 & 34.12 Sutures passage to distal anchor site and final construct after anchor insertion

In slight variation of the PARS only technique for suture knot tensioning, we have found that tying the locking sutures off first is best for approximation. Following this, we tie both sutures on one side of the Achilles tendon and slide the knot proximally by pulling on the suture on the opposite side. This leaves two knots proximally and away from the wound which we believe reduced the risk of wound problems due to suture bulk.

34.6 Post-operative Care

The wound(s) are dressed with an absorbent dressing and the patient is placed in a plaster dorsal slab with the foot in equinus of 20° to aid skin perfusion for 2 weeks.

We advocate DVT prophylaxis for 2 weeks whilst immobilised in a plaster slab; Achilles tendon injuries have the highest incidence of both radiologic and clinically relevant venothromboembolic events in foot and ankle surgery in a recent meta-analysis. The rate of DVT in general events was 1% and 13% for clinical and radiological VTEs, respectively, and 7% and 35%, respectively, for Achilles tendon ruptures [12].

Rest, non-weight bearing and elevation are advised to promote wound healing. From 2 weeks the patient may be placed into a removable boot with heel wedges and allowed to weight bear with crutches. Active, gentle ankle plantar flexion and dorsiflexion to neutral is commenced at 3 weeks to minimise paratenon adhesion. Wedges are removed weekly and the ankle should be plantigrade in the boot by 6 weeks and the boot removed by 7–8 weeks. Passive dorsiflexion should be avoided. A graduated therapy programme should aim for full recovery by approximately 6 months.

Acknowledgments All images courtesy of Arthrex Inc.

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