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Chronic Midsubstance Patellar Tendon and Retinacular Rupture: Primary Repair Enhancement Using Bioinductive Implant Augmentation

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Technical Note

Chronic Midsubstance Patellar Tendon and Retinacular Rupture: Primary Repair Enhancement Using Bioinductive Implant Augmentation

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Abstract: Midsubstance tears of the patellar tendon are uncommon and present a difficult injury to treat. If left untreated, these can be debilitating injuries for patients and leave them with an overall lack of function in the injured extremity. Compared to a proximal or distal patellar tendon rupture, midsubstance tears rely on tendon-to-tendon healing instead of bone to tendon healing. Given this situation, specific preoperative planning and the use of a bioinductive scaffolding allows surgeons to enhance the overall construct, while promoting a beneficial healing environment. Although the addition of bioinductive implants has grown in popularity for upper extremity injuries, few cases describe its use in the lower extremity setting. Here, we present a case of midsubstance patellar tendon repair, as well as a medial and lateral retinacular repair using a structural biological implant with Type I collagen for augmentation to enhance our overall final construct.

Introduction

Patellar tendon injuries can be debilitating for patients and require surgical intervention to restore function. These injuries can occur in 3 different locations: The most common is an avulsion injury with or without bone from the inferior pole of the patella. The second location being an avulsion injury from the tibial tubercle, and the final location being a midsubstance tear. Upon presentation, patients may still be able to obtain extension due to an uninjured retinaculum; however, an extensor lag will be present. This phenomenon is secondary to the medial and lateral patellar retinaculum being on their respective sides of the patella remaining continuous with the vastus fascia to the tibia and the patella. They are minor patellar stabilizers and, if intact, can provide knee extension and straight leg raising despite a patellar or quadriceps tendon rupture.[1,2] When the retinaculum is disrupted, a complete lack of extension will be present. Each of these injuries requires specific preoperative planning to ensure an adequate repair to improve overall patient outcomes and restore function.

Multiple different types of repairs have been described in the literature, but each location presents its own unique challenges. For avulsion injuries with or without bone, suture anchor repairs with or without augmentation have been described. These include repairs, as described by Rose et al.,[3] using an anchor and suture construct for a distal patellar tendon avulsion injury. For proximal patellar tendon ruptures, Krackow stitches through the patellar tendon with sutures being passed distal to proximal through bone tunnels in the patella have good results, as described by Sanchez et al.[4] Some techniques also involve using an allograft by weaving it through the patellar tendon remnant and docking it into the proximal tibia via bone tunnels.[5] However, difficulty arises with midsubstance repairs due to tendon-to-tendon healing instead of bone-to-tendon healing. Difficulty is increased with more chronic tears, in addition to poor host tissue quality and multiple comorbidities.

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With the advancements in bioinductive augmentation, its popularity has grown and allows surgeons more options when faced with poor tendon healing environments, as well as different tear patterns. BioBrace (ConMed, Largo, FL) is a highly porous Type 1 collagen matrix reinforced with bioresorbable PLLA microfilaments to facilitate tendon and ligament healing. It provides load-sharing and load-bearing capabilities to enhance ligament and tendon healing by acting as a scaffolding for tissue regeneration, while simultaneously giving strength to the repair. The advantage of BioBrace is its ability to provide supplemental strength until ultimately being reabsorbed ∼2 years after implantation. Although bioinductive augmentation has been described in the literature for upper extremity procedures, very limited reports have been described for lower extremity techniques.[6-8]

We present a surgical technique for a midsubstance patellar tendon tear, and a complete inferior medial and lateral retinacular tear using a bioinductive augmentation with BioBrace implants.

Patient Evaluation, Imaging, and Indications

Early evaluation and recognition of patellar tendon injuries and/or tears are vital for improving long-term outcomes. Delay in initial presentation may lead to disability from a deficient knee extensor mechanism and can contribute to diminished tissue viability if surgical intervention is indicated. Initial complaint may include feeling an audible "pop" and weak or lack of

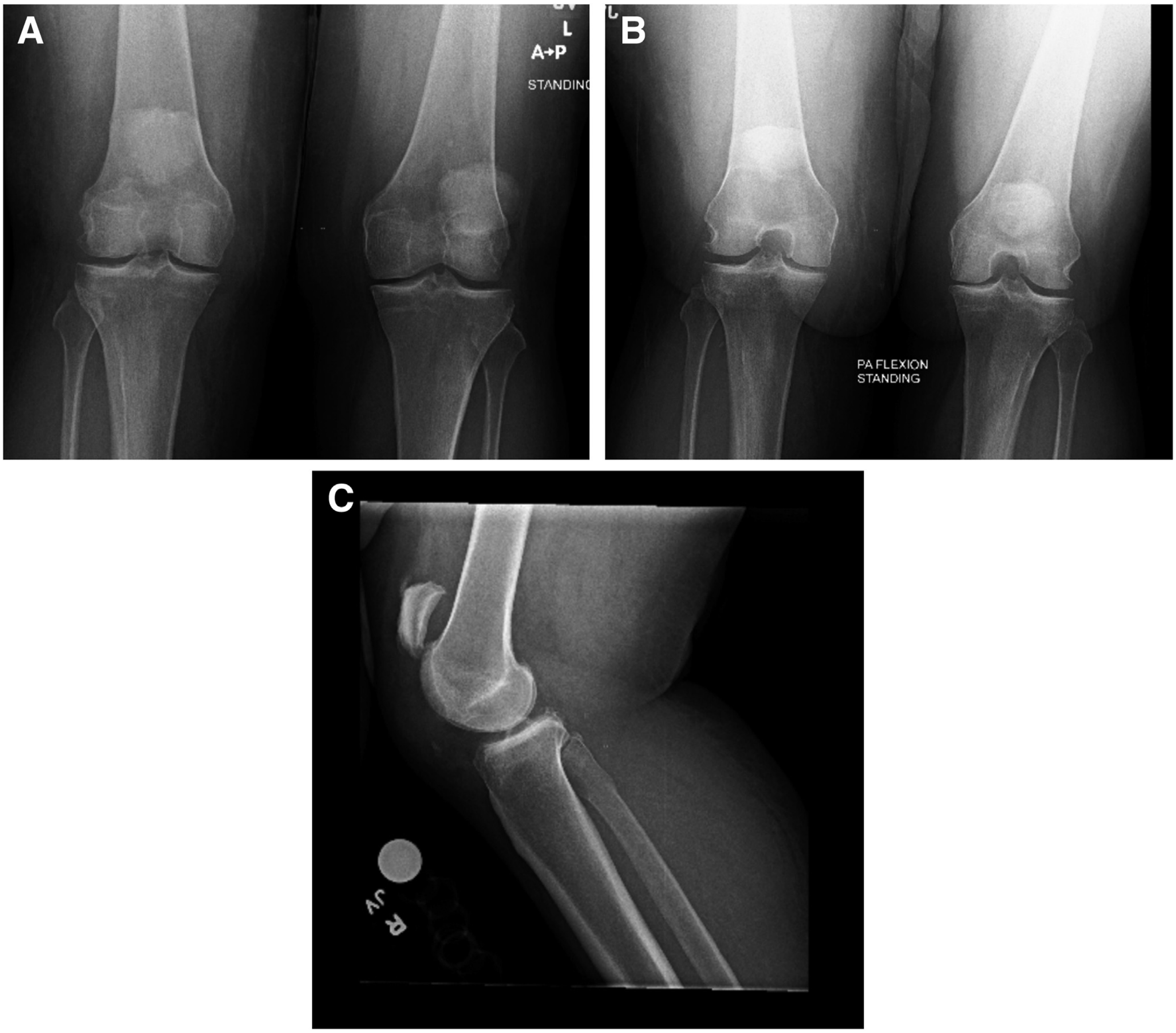

Fig 1. Preoperative radiographs (images A-C from left to right) demonstrating an AP knee, AP flexed knee, and lateral right knee. Note that the patella alta presents on the right lower extremity in all images.

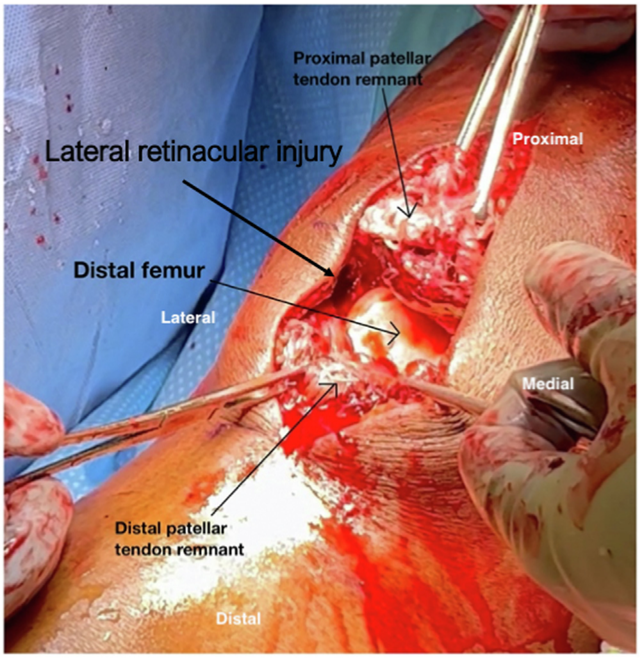

Fig 2. Intraoperative picture demonstrating the proximal and distal patellar tendon remnants due to a midsubstance patellar tendon rupture. Note the poor tissue quality presents within the remnants.

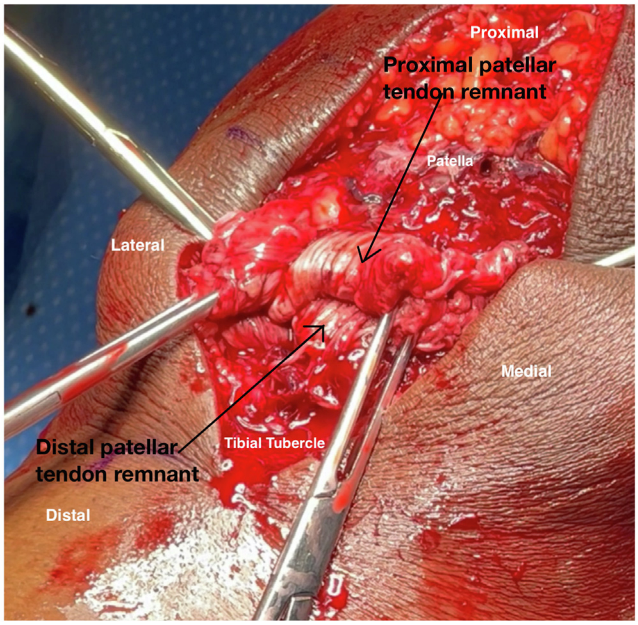

Fig 3. Intraoperative picture with the proximal and distal patellar tendon remnant pieces overlapping each other. Note the poor tissue quality and redundancy.

quadriceps strength. Physical examination should begin with evaluation of the skin, bony landmarks, signs of trauma, and comparison to the contralateral knee. Patellar tendon height and location relative to the contralateral knee may help confirm the presence of a patellar tendon rupture. Take note to look for a palpable defect below the inferior pole of the patella, as this is also a sign of a patellar tendon injury.[1]

Recommended radiographs include an anteroposterior and lateral image of the affected knee, as well as the contralateral knee for comparison. Radiographs can reveal whether the patella is appropriately aligned or if it is in patella alta or baja via the Insall-Salvati ratio (see Fig 1, A-C). If more imaging is needed, an MRI will allow further evaluation and help determine the exact location of the tear.[1]

Determination of whether surgical intervention is needed can be obtained through physical exam and radiographic findings. For nonoperative management, this generally includes partial tears with an intact extensor mechanism. However, most patellar tendon tears need surgical intervention to regain function and mobility. If an acute tear is present and recognized early, a primary end-to-end repair with a suture-anchor augmented construct can provide a biomechanically strong repair when compared to primary repair only.[9,10] Chronic tears present their own unique challenges that may lead to poorer outcomes. These variables include muscle contractures, poor host tissue, and comorbidities, among others. In this setting, a bioinductive augmentation may allow for a stronger final construct and an enhanced healing environment.

Surgical Technique

Video 1 is a narrated demonstration of the overall management and surgical technique used. The patient is placed supine on the operation table with a bump placed under the ipsilateral hip away from the sciatic nerve. A bone foam is also placed under the injured knee. A nonsterile tourniquet is applied, and the operative extremity is prepped and draped appropriately. A surgical timeout is performed prior to incision with the indicated procedure and appropriate side confirmed by all present in the operating room. A midline incision is made, centered over the patella, extending distally to the tibial tubercle. The prepatellar bursa is encountered and partially removed, revealing a large hematoma that is evacuated. Upon evaluation, the tear did not avulse off the patella, as anticipated. Instead, a midsubstance injury is noted with a macerated tendon present (Figs 2 and 3 below). Most of the tendon is still on the patella, and there are 2 large retinacular injuries extending all the way down into both gutters, medially and laterally. At this point, we are able to look up and down both the remnant on the patella and the remnant on the tibial tubercle. When presented with this finding, it is important to identify the

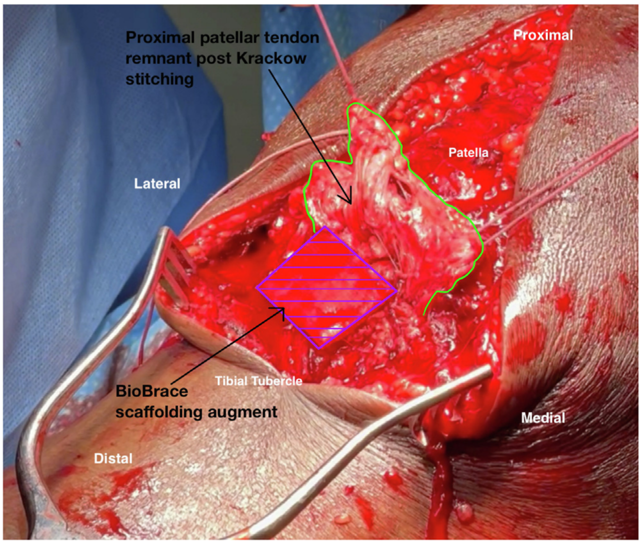

Fig 4. Intraoperative image demonstrating the BioBrace scaffolding placement prior to overlapping the tendon remnants. The purple outline represents the BioBrace augment, and the green outline represents the proximal patellar tendon remnant.

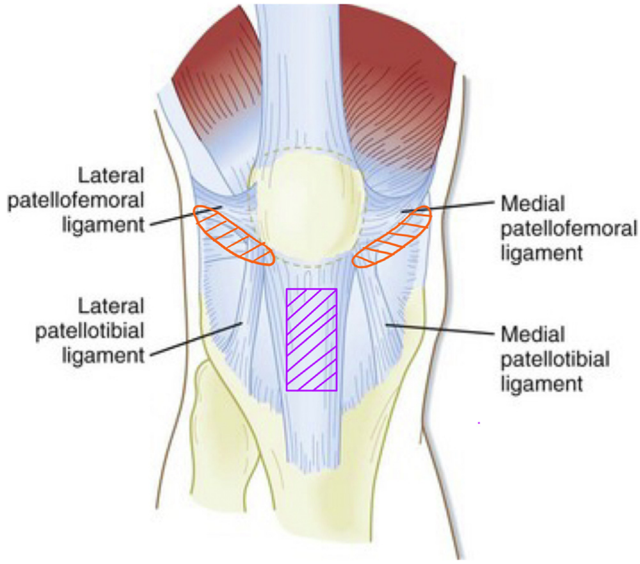

Fig 6. Schematic representations of the BioBrace augment location. The purple figure represents the BioBrace between the patellar tendon remnants. The orange figure represents the tubular BioBrace sewn in the retinacular repair.

appropriate anatomy and determine where the soft tissue injury has occurred. This will help realign the tissue appropriately and allow for proper soft tissue tensioning and patella realignment during the repair.

Because of the chronic nature of the tear and the present redundancy and thinning of the tissue, a Krackow stitch is placed on the superior and inferior remnants of the tendons from the patellar remnant and the tibial tubercle remnant, respectively. A 20 × 23 mm BioBrace patch is then placed between the 2 ends of the tendon remnants in a sandwich technique (see Figs 4, 5, and 6). A horizontal mattress suture is passed through the tendons remnants and subsequently tied down. This appropriately positions the BioBrace between the two remnant pieces. We then note that the extensor mechanism moves as a unit, and the patella is tracking appropriately within the patellofemoral compartment through the femoral trochlea. A second BioBrace 5 × 250 mm scaffold, which is tubular shaped, is placed in the retinacular injury both medially and laterally (see Fig 6[11]). The BioBrace is trimmed and able to extend from deep in the gutters to midline at the patellar tendon juncture. This allows a uniform construct throughout. It is then sewn in with a #2 Dynacord (DePuy Synthes, Raynham, MA). This helps improve the healing environment and augment the poor host tissue quality present. Completing this, we oversew with a #1 Stratafix (Ethicon Johnson & Johnson, New Brunswick, NJ).

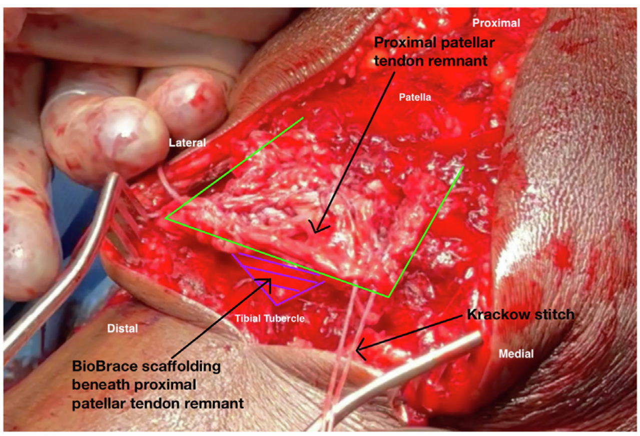

Fig 5. Intraoperative image showing the final placement of the BioBrace augment prior to being oversewn. The green outline represents the proximal patellar tendon remnant after medial and lateral Krackow stitches have been implemented.

When ranging the knee, it is found to be stable with some tension at 90° of flexion. The wound is then copiously irrigated one final time prior to closure. The closure consists of a 2-0 Vicryl followed by 3-0 Monocryl and then covered with Xeroform, 4 × 4's, ABDs, Webril, and an Ace bandage. The operative knee is placed in a hinged knee brace locked in extension, and the patient is taken off the operative table and transferred to a hospital bed.

Postoperative Management

Postoperative protocol consists of 6 weeks in a hinged knee brace with the knee locked in extension to help facilitate appropriate tendon healing. Weight-bearing status is then gradually increased, as long as compliance is maintained. Follow-up appointments are

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Obtain complete and adequate exposure by identifying all necessary anatomical landmarks.	Poor exposure may lead to procedure difficulties and inadequate repair.
Remove scar tissue and identify any concomitant injuries or instability.	Failure to remove scar tissue may impede/impair repair healing.
Evaluate retinacular involvement.	Missed retinacular tears may lead to continued instability and weakness with potential for repair failure.
Use locking sutures in a Krackow fashion to obtain adequate tensioning on the injured tendon.	Failure to do so may lead to suture failure and repair compromise.
Identify appropriate patellar positioning and tensioning within the patellofemoral joint.	Inadequate positioning may lead to persistent patella alta or overtensioning may lead to patella baja. This may cause decreased knee extension and/or increased risk of patellofemoral joint arthritis.
Incorporate running sutures through the retinaculum and BioBrace scaffolding to make a uniform construct. Krackow suture configuration may be helpful in this situation.	Suture loosening may lead to repair failure and scaffolding migration.
Once repair is complete, check knee range of motion and patellar positioning throughout the arc of motion. Note any subluxation or laxity.	Failure to do so may lead to a missed concomitant injury that could have been addressed at the time of procedure.
Keep knee locked in extension postoperatively to assist in tendon healing.	Early ROM may cause tendon lengthening and/or repair failure.

initially scheduled 3 weeks apart in the immediate postoperative period. At the 6-week postop appointment, 50% weight bearing is permitted, and the hinged knee brace is adjusted to allow 0-50° of knee flexion.

Subsequent follow-up appointments are scheduled at 3 and 6 months postoperatively to evaluate progression. At 3 months postop, as long as there is the ability to demonstrate 0-100° of knee ROM with 4/5 strength in knee extension, then progression to full weight bearing and unlimited knee flexion is permitted.

Discussion

Midsubstance patellar tendon tears remain a very rare and difficult injury to treat. Compared to proximal or distal patellar tendon ruptures where tendon-to-bone healing is present, midsubstance tears require tendon-to-tendon healing. Add in the potential of poor host tissue quality and patient comorbidities that diminish healing potential, a poor healing environment remains. With the advancements in bioinductive agents/patches and scaffolds, this allows surgeons to increase the healing potential and overall outcomes for patients.

The bioinductive patch helps stimulate native tissue healing, while providing a structural scaffolding during the healing process. Although limited research has been done regarding lower extremity tendon healing using a bioinductive patch, many reports have been done involving upper extremities. As described by Thon et al., arthroscopic application of a bioinductive collagen scaffold when combined with rotator cuff repair is shown to be a safe and effective treatment for healing of large and massive rotator cuff repairs with no complications related to the implant reported.[12] Taking these principles and applying them to the lower extremity, implanting a bioinductive patch has the potential to aid in the healing properties and enhance tendon-to-tendon healing.

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Improved tendon repair through BioBrace load sharing and enhanced healing environment	Increased cost to overall procedure

To our knowledge, limited reports have been described using bioinductive scaffolds in the lower extremity during tendon repairs. Only a few reports are found in the literature for hip abductor repair,[13,14] hip capsule repair,[15] patellar tendon repair,[7,8] quadriceps tendon repair,[16] and hamstring tendinopathy.[6] Although limited reports are present, the growing number of cases using bioinductive agents for lower extremity tendon and ligament repairs/reconstructions continues to grow and supports our use in this surgical technique.

Here, we emphasize the importance of retinacular repair when treating patellar tendon ruptures. With the ability to incorporate the 5 mm × 250 mm tubular shaped BioBrace implant into the retinacular repair, it allowed us to have a continuous scaffolding to repair the retinaculum to. This unique repair enhanced our final construct and helped provide a positive healing environment for improved outcomes.

Listed in Table 1 are some of the pearls and pitfalls. The advantages to this surgical technique include the ability to have a uniform construct to incorporate into the macerated tendon and retinaculum, as listed in

Table 2. The shape of the bioinductive agents helps restore a relative normal anatomy, while enhancing the healing environment. Another advantage to this technique was the fact that we were able to avoid drilling any bone tunnels through the patella or any drilling into the tibia. This helped eliminate any potential for an iatrogenic patellar fracture. Although uncommon, there is a case report of patellar fracture following tendon reconstruction via bone tunnels in the patella.[17]

Limitations to this technique include the fact that midsubstance patellar tendon ruptures are relatively rare, and the incorporation of a bioinductive scaffold is a relatively new adjunct with growing popularity. Limited reports exist for lower-extremity tendon augmentation, as opposed to upper extremity reports, although the same principles can be applied here. Further, long-term studies need to be evaluated and reported to determine the true value of the bioinductive augmentation and its relation to rerupture rates and overall patient outcomes.

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