Clinical Case Report

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A novel arthroscopic all-inside suture technique using the Fast-Fix 360 system for repairing horizontal meniscal tears in young athletes

3 case reports

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Abstract

Rationale: Considering the risk of osteoarthritis following resection of a horizontally torn meniscus of the knee, repairing and preserving the meniscus as much as possible is preferred. We report 3 cases of restoration of horizontally torn menisci using a novel arthroscopic method we have called "all-inside interleaf vertical suture" that afforded preservation.

Patient concerns: The 3 patients (aged 14, 17, and 21 years) had knee pain through sports activity.

Diagnoses: All patients had horizontal tears in the posteromedial part of the meniscus.

Interventions: The method uses Fast-Fix, whereby a first anchor is inserted from the tibial surface of the tear's superior leaflet and a second anchor is inserted from the femoral surface of the tear's inferior leaflet, and the 2 leaflets are closed using vertical suture. In all cases, the suture knots were embedded between the superior leaflet and inferior leaflet, avoiding contact with the articular cartilage, and superior leaflet and inferior leaflet crimping was good.

Outcomes: All 3 were able to resume competing in sport and ≥ 1 year after surgery they had no pain and their postoperative mean Lysholm scores were 99.7. There were no complications or recurrence. On magnetic resonance imaging, the signal intensity of all the horizontal tears was high before surgery but low after surgery, suggesting that the repaired tear was healing.

Lessons: The all-inside interleaf vertical suture procedure is a new surgical technique that can repair posteromedial horizontal meniscal tears of the knee of young people by easy crimping of the superior and inferior leaflets without the suture knots causing complications.

Abbreviations: ACL = anterior cruciate ligament, ALP = anterior lateral portal, AMP = anterior medial portal, FF = Fast-Fix, IL = inferior leaflet, MRI = magnetic resonance imaging, SL = superior leaflet.

Keywords: all-inside suture, arthroscopy, horizontal tear, knee, meniscus repair

1. Introduction

The meniscus serves to buffer loading on the tibiofemoral joint. It is also involved in stabilization, proprioception, lubrication, and articular cartilage nutrition within the knee. Healthy menisci may be damaged by large external trauma, whereas degenerated menisci may be damaged by small external trauma, which may cause pain and reduce performance. Therefore, damaged menisci should be repaired as much as possible. Meniscal tears can be classified into longitudinal, radial, and horizontal tears. Much fundamental and clinical research has been done on longitudinal tears. In contrast, despite horizontal tears being the most common type in middle-aged people due to degeneration and in young people who play sports,[1] they have attracted little research. Surgical intervention of meniscal horizontal tears is usually single-leaflet resection[2] or resection of both leaflets because of lack of vascularization and relative ease of the procedure.[3] However, research on sheep models and cadavers has shown that meniscectomy increases contact pressure on the tibiofemoral articular surface, which causes cartilage damage and degeneration over time leading to osteoarthritis.[4,5] Consequently, restoration procedures are now recommended for horizontal tears.[6] In recent years, with developments in arthroscopic procedures, new devices, and augmentation techniques, a variety of restoration methods for horizontal tears and their treatment outcomes have been reported.[7]

We have developed an arthroscopic "all-inside interleaf vertical suture method" using the Fast-Fix (FF) instrument to repair horizontal tears in the posteromedial horn of the meniscus. We report trial procedures performed on 3 young sports players and their follow-ups.

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2. Methods

2.1. Surgical indications

Surgery was indicated for young people injured through sports in whom magnetic resonance imaging (MRI) showed posteromedial horizontal tears of grade 3 signal intensity[8] and whose symptoms had not resolved within 3 months even with conservative treatment, or when early surgical intervention was appropriate due to injury complications such as anterior cruciate ligament (ACL) injury. Informed consent was obtained from the patients and their parents.

2.2. Surgical technique

An arthroscope is inserted through the anterior lateral portal (ALP) and a probe is inserted through the anterior medial portal (AMP). The joint cavity is inspected and horizontal tears in the meniscus evaluated. Degenerated parts near the free edge of the horizontal tear are debrided by basket punching and shaving as sparingly as possible to clearly define the superior and inferior leaflet (IL) borders of the tear. Repair is carried out using the Fast-Fix 360 system (Smith & Nephew Endoscopy, Andover, MA) with reversed curved needles. If there is degeneration in the posterior region of the medial meniscus, the arthroscope is inserted through the ALP and the FF through the AMP. If there is degeneration in the posteromedial region of the medial meniscus, the arthroscope is inserted through the AMP and the FF through the ALP. If there is degeneration in the posteromedial region of the lateral meniscus, to reduce risk of damage to nerves and blood vessels, the arthroscope is inserted through the ALP and the FF through the AMP. First, the delivery needle of the FF is inserted though the tibial surface of the superior leaflet (SL) near the free edge with the tip curving toward the femoral side, and the first anchor is seated outside the joint capsule of the SL (Fig. 1A). Next, the delivery needle of FF is inserted though the femoral surface of the IL near the free edge with the tip curving toward the tibial side, and the second anchor is seated outside the joint capsule of the IL (Fig. 1B). By ligating this with a sliding knot, the horizontal tear can be repaired with vertical sutures through the leaflets (Fig. 1C and D). The procedure makes it possible to crimp and fix the meniscus from the cleaved side of the leaflets. If the tear is large, several FF should be inserted spaced 5 to 10 mm apart and ligated. In that case, if the first FF suture is tied completely, the tear will close and there will be no suitable site for the next FF insertion. Therefore, rather than completely tying the FF after anchoring, several FF and anchors should be inserted before tying them sequentially. This facilitates anchoring at suitable sites and robust fixation of the leaflets by crimping, even when tears are large. We have called this procedure "all-inside interleaf vertical suture."

2.3. Postoperative rehabilitation

Postoperatively, partial load bearing was allowed after 2 weeks and full load bearing after 5 weeks. With a hinged rigid orthosis, extension was restricted to –30° and flexion to 90° up to 2 weeks, and to 0° and 120° respectively until 4 weeks postoperatively. Load bearing in deep flexion positions such as crouching was forbidden for 2 months. Postoperative MRI was performed, and provided there were no meniscus symptoms and recovery of muscular strength and performance was smooth, we allowed return to competition.

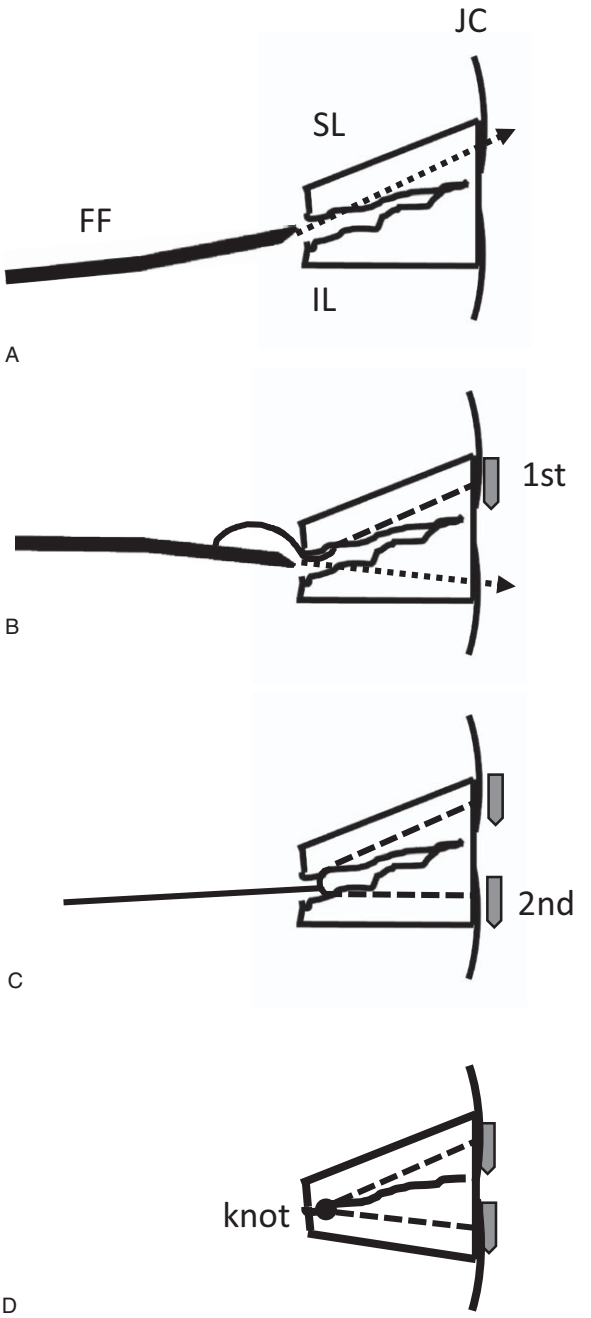

Figure 1. Schematic diagrams of the technique. (A) FF used with the tip curved towards the femur. The FF needle is inserted from the tibial surface of the SL near its free edge. First anchor is placed outside the joint capsule (lined arrow indicates insertion direction of the first anchor needle). (B) FF used with the tip curved towards the tibia. Insertion is from the femoral surface of the IL near its free edge. Second anchor is placed outside the joint capsule (lined arrow indicates the insertion direction of the second anchor needle). (C) When a sliding knot is closed, vertical sutures are placed in the horizontal tear. (D) Sutures are tied and cut with the knots embedded between leaflets when closing the horizontal tear (• indicates knots). FF = Fast-Fix, IL = inferior leaflet of horizontal torn meniscus, JC = joint capsule, SL = superior leaflet of horizontal torn meniscus, 1st = first anchor of FF, 2nd = second anchor of FF).

3. Case reports

3.1. Case 1

A 17-year-old male who had pain in his right knee for 1 year received conservative treatment at a local clinic, but had to quit

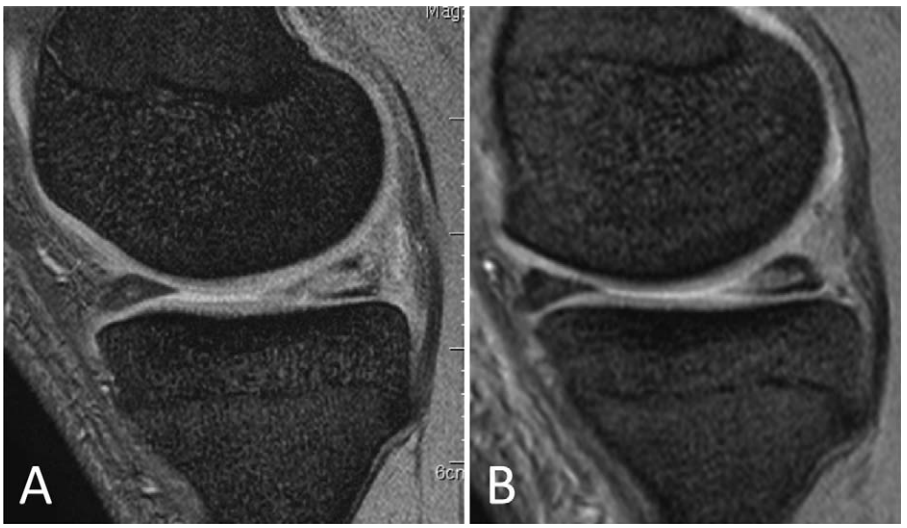

Figure 2. MRI findings of case 1. (A) Preoperatively, horizontal tear in the medial meniscus in the sagittal plane. (B) Six months postoperatively, in the vicinity of the meniscocapsular attachment of the posteromedial part of the meniscus, the signal intensity was low compared to high before surgery. MRI = magnetic resonance imaging.

judo because of difficulty squatting. At our hospital, patellar ballottement and the McMurray test were both positive. MRI of the medial meniscus showed a horizontal tear of grade 3 signal intensity in the posteromedial segment (Fig. 2A). Degenerated parts near the free edge were partially resected and the horizontal tear was repaired by all-inside interleaf vertical suture (Fig. 3). Postoperative rehabilitation was as described above, and the patient resumed judo 4.5 months after surgery. Postoperative

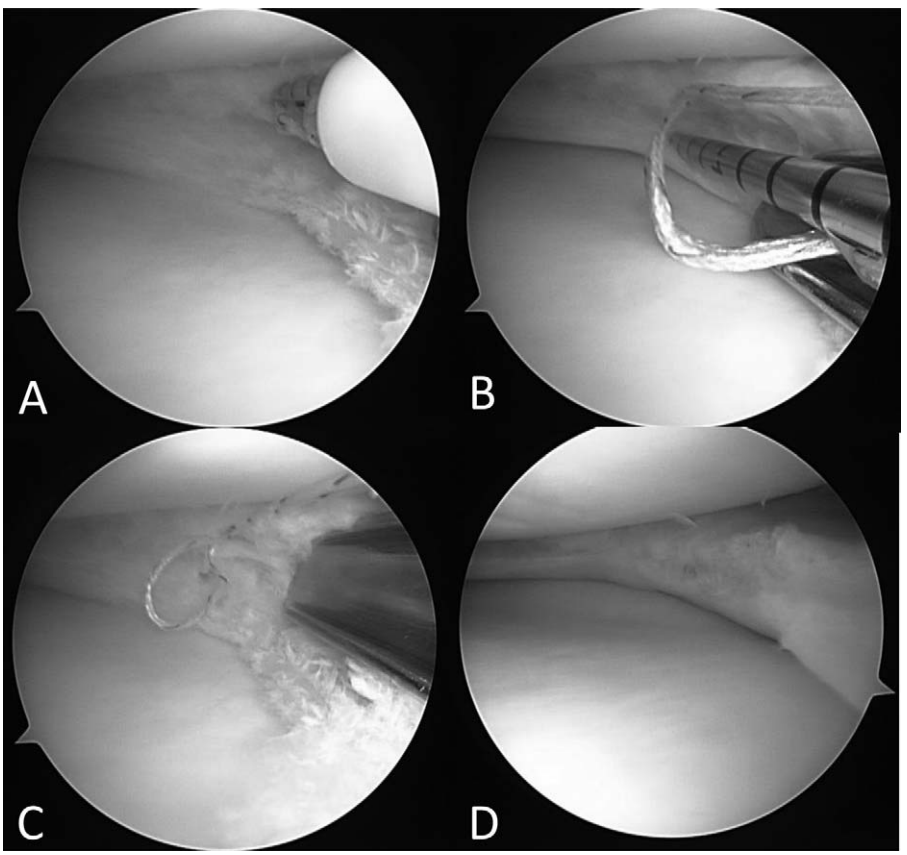

Figure 3. Arthroscopic findings of case 1. (A) After minimal partial resection of the degenerative tear about the free edge of the medial meniscus, first anchor is inserted from the tibial surface of the superior leaflet, (B) second anchor is inserted from the femoral surface of the inferior leaflet, (C) the sliding knot is tied and (D) the horizontal tear is closed and the knot is embedded between the leaflets.

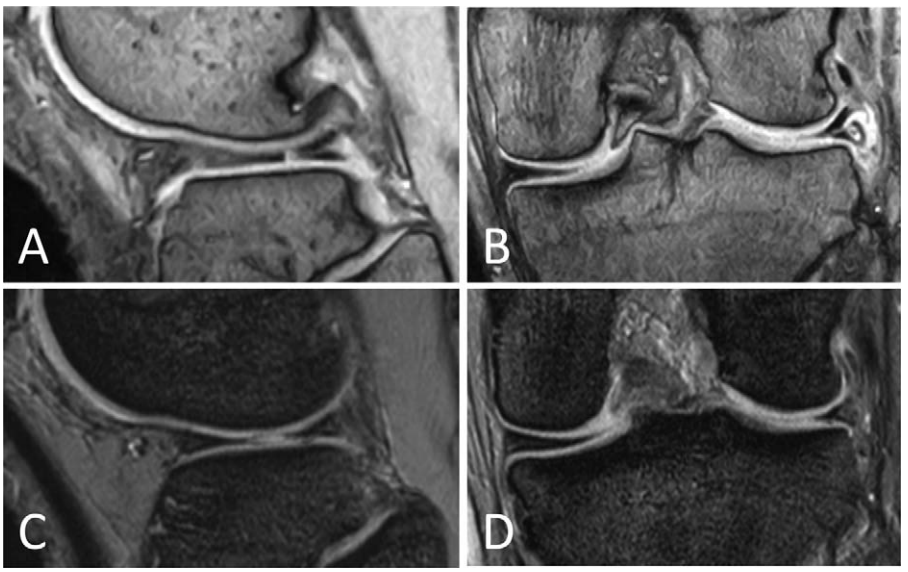

Figure 4. MRI findings of case 3. Preoperatively (A) in the sagittal plane and (B) coronal plane, a medial radial tear and a posteromedial horizontal tear in the lateral meniscus. At 4 months postoperatively, (C) in the sagittal plane, and (D) coronal plane, the signal intensity is low in the vicinity of the horizontal tear. MRI = magnetic resonance imaging.

MRI at 6 months showed low signal intensity in the vicinity of the meniscocapsular attachment of the repaired part of the meniscus, and the signal intensity of the actual repaired region had become grade 2 (Fig. 2B). One year postoperatively, his Lysholm score was 100, and the patient was still engaged in judo.

3.2. Case 2

A 14-year-old boy presented at our hospital having twisted his left knee playing soccer. On MR imaging, the ACL injury and a horizontal tear of grade 3 signal intensity in the posterior horn of the medial meniscus were observed. One month later, degenerated parts of the medial meniscus were partially resected and the tear was repaired by all-inside interleaf vertical suture; the ACL was also reconstructed. Postoperatively, we performed rehabilitation according to the above protocol for 2 months. Postoperative MRI at 9 months showed a signal intensity of grade 1 in the repaired region of the meniscus. The judgment of returning to competition was based on recovery of muscular strength, agility, and endurance according to our criteria for ACL reconstruction, and the patient resumed playing soccer at 11 months. At 20 months after the operation his Lysholm score was 99.

3.3. Case 3

A 21-year-old man presented after conservative treatment at his local clinic failed to alleviate left knee pain that he first noticed while short-distance running 3 months earlier. MRI showed a radial tear of the medial segment in the lateral meniscus and a posteromedial horizontal tear of grade 3 signal intensity (Fig. 4A and B). As the lateral meniscus had incomplete discoid injury, saucerization of the degenerated parts and radial tear was performed. After saucerization, the horizontal tear still had to be treated. Therefore, all-inside interleaf vertical suture was performed (Fig. 5). Postoperative rehabilitation was as described above. Postoperative MRI at 4 months showed grade 1 signal intensity for the repaired horizontal tear (Fig. 4C and D). At 5 months, the patient resumed sprint racing. One year postoperatively, his Lysholm score was 100.

4. Discussion

Horizontal meniscal tears have often been surgically treated by resection of a single leaflet[2] or both leaflets. However, both interventions result in increased contact pressure on the articular cartridge, which can cause the onset and progression of osteoarthritis.[9,10] Therefore, nowadays, reparation of horizontal meniscal tears is recommended.[6,7] Arthroscopic suturing can be performed using 'all inside' methods using bioabsobable implants such as Biofix arrows (ConMed Linvatec, Largo, FL)[11] or all-inside suture instruments such as FF.[12,13] With the latter, an anchor is introduced from the femoral surface of the SL, then a second anchor is introduced from the tibial surface of the IL, and a suture straddles the surface of the free edge of the tear. Thus, an overlock stitch closes the tear.[12,13] A divergent double vertical suture[14] inside-out technique has also been reported. The treatment results of these all-inside and inside-out methods have been reported as good, based on clinical symptoms, findings, and frequency of reoperation.[7,11,12,15,16] However, with those all-inside methods, bioabsorbable implants and hard suture knots are placed on the surface of the meniscus where they are in contact with the articular cartilage, thereby posing a long-term risk of cartilage damage.[17,18] Moreover, there is insufficient crimping in vascularized areas where optimal healing can be expected. Furthermore, when overlock stitching is used along the free edge, each leaflet shrinks in that vicinity when they are ligated, raising concerns of gaps forming between SL and IL where there is lack of vascularization. On the other hand, compared to the all-inside method, the risk of neurovascular injury is increased in the inside-out method, additional skin incision is necessary, and the probability of a longer operation time is high. Therefore, from the viewpoint of minimal invasion and for convenience, the all-inside method is preferable if the same objective can be achieved.

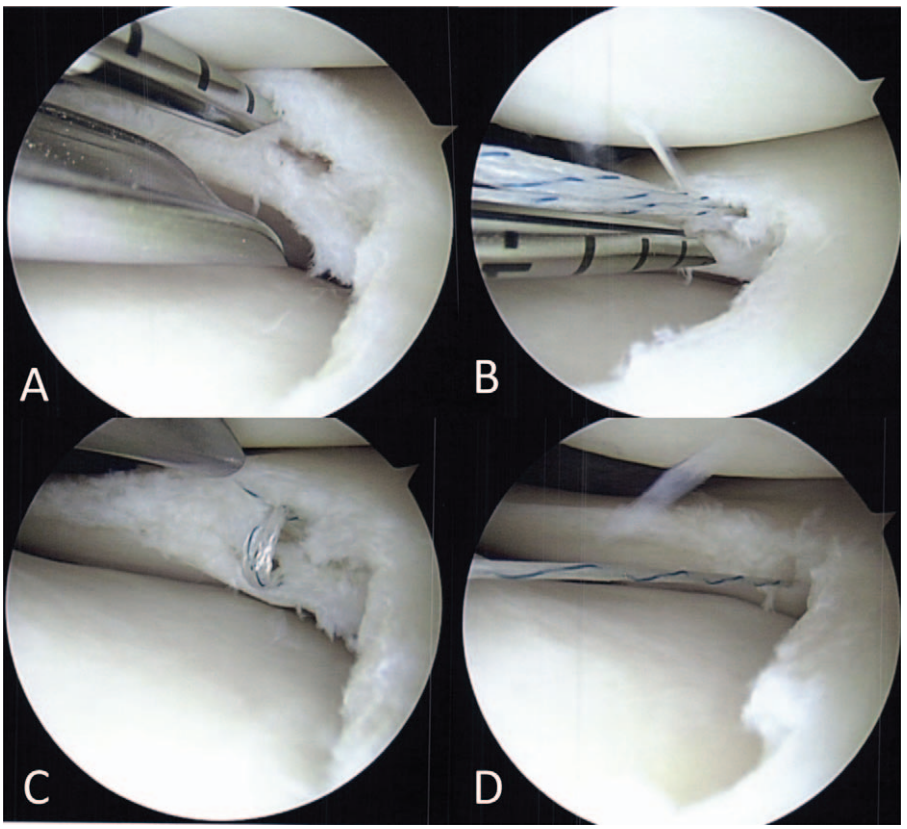

Figure 5. Arthroscopic findings of case 3. (A) Presence of incomplete discoid injury of the lateral meniscus. After saucerization of the degenerated parts and radial tear, first anchor was inserted from the tibial surface of the superior leaflet and (B) second anchor was inserted through the femoral surface of the inferior leaflet, (C) the sliding knot was closed, and (D) the horizontal tear was closed and the knot embedded between the leaflets.

We have devised a new all-inside method. Using FF, the vicinity of the SL and IL free edges of the tear are crimped using all-inside interleaf vertical suture threaded from the SL tibial surface through first anchor seated outside the SL joint capsule and threaded from the IL femoral side through second anchor which is seated outside the IL joint capsule. This method has the following advantages: vertical suture is placed between SL and IL of the horizontal torn meniscus so that the knot does not come into contact with the articular cartilage and damage it; anchors are seated outside the capsule, the leaflets are closed together and ligated, and the vicinity around the meniscocapsular attachment where there is vascularization can also be crimped; and since it is vertically sutured from the vicinity of the free edge and crimped, good crimp fixation can be achieved without shrinking SL or IL where there is no vascularization.

In all 3 of our trial cases, the suture knots were embedded between the SL and IL such that they did not contact the cartilage and the leaflets were crimped robustly. Clinical results were good: all 3 patients were able to resume competitive sport; there was no pain even ≥1year after surgery; and their Lysholm scores were good. Furthermore, there were no postoperative complications. On MRI, the signal intensity in the vicinity of the horizontal tears was high preoperatively but low postoperatively, indicating healing of the tear. The all-inside interleaf vertical suture procedure can be used to repair posteromedial horizontal tears in menisci of young people by crimping the SL and IL leaflets easily while avoiding complications by embedding the knots between the leaflets.

5. Conclusion

The all-inside interleaf vertical suture procedure is a new surgical technique that can repair posteromedial horizontal meniscal tears of the knee of young people by easy crimping of the SL and IL without the suture knots causing complications.

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