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Case Report

Double Decker anterior cruciate ligament avulsion

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ABSTRACT

Distal anterior cruciate ligament avulsion from tibial side is an unusual injury. It can be either bony avulsion, which is more common, or rarely a soft tissue peeling of tibial spine with no bone injury. This case report represents a very infrequent injury of combined soft tissue peeling of distal anterior cruciate ligament along with bony avulsion of tibial spine in a 12-years-old boy after falling from his bike.

Introduction

The tibial avulsion of the anterior cruciate ligament (ACL) is primarily observed in the pediatric and adolescent age population. ACL avulsion is commonly resulted from hyperextension knee injury, typically occurring during riding a bicycle. The ligament is usually avulsed from tibial attachment with a piece of bone [1–3].

Tibial spine bony avulsions are historically classified on plain radiographs according to the Meyers and Mckeever classification system [4], which was introduced in 1959. In type I, fractures are nondisplaced; type II fractures produce displacement of the anterior margin while the posterior part is still seated onto the tibia; and type III fractures are completely displaced. This classification system was improved by Zaricznyj [5] who added type IV with complete fragment comminution. The most common complications associated with tibial spine fractures are arthrofibrosis, residual laxity, fracture nonunion or malunion, and tibial physis growth arrest [6].

Tibial spine avulsions graded as Type I or Type II fractures that are reducible can be treated conservatively with immobilization of the knee in full extension. Type II fractures that are unable to be reduced adequately in full extension or completely displaced Type III and Type IV fractures are recommended for surgical intervention [7].

A tibial-sided soft-tissue avulsion of the ACL is a rare and challenging condition. Unlike femoral-sided ACL repair, which is fairly reported in the literature, acute tibial-sided ACL peeling off has been scarcely reported. In this case report we present a very rare segmental injury of combined tibial spine fracture with peeling off of the native ACL from the avulsed fragment.

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Fig. 1. anteroposterior view of the patient's right knee showing a displaced tibial spine fracture.

Case presentation

A 12-year-old boy was admitted to the emergency department of our department on a wheel-chair in full flexed right knee without swelling. After extending the knee for radiological study, the knee swelling started immediately. He sustained hyperextension knee injury after a sudden fall from his bike. He felt sudden pain and giving-way during pivoting on his right knee to avoid a car coming. Right after emergency care of this injury, X-rays and CT scan were done to evaluate his knee injury. (Figs. 1–6).

Patient was admitted to the theater within 10 h. The knee injury was secured in above knee plaster slab till time of surgery. He was planned for open reduction and pullout fixation of the tibial spine fracture using Fiberwire sutures. The surgery was performed under general anesthesia. The patient was positioned supine on the operative table with a lateral post. Examination under anesthesia was performed confirming anterior knee laxity. No other collateral injury was noticed. A medial parapatellar approach was used for open reduction of the fragment. After evacuating the hematoma, fat pad excision and washing out the joint, the ACL distal soft tissue stump was strikingly found to be peeled off the avulsed fragment. (Figs. 7,8).

A tibial C guide (Arthrex, Naples, FL) was used to drill tibial tunnels, 1.5 cm apart using ACL guide pin. Two separate independent holes were made within the detached fragment from inferior to superior. A Scorpion Suture Passer (Arthrex, Naples, FL) was used to pass two FiberTape sutures (Arthrex, Naples, FL) within the ACL soft tissue stump. The 2 ends of sutured were crossed to cinch the ACL stump. The two crossed ends were then retrieved through the tibial spine and tibial tunnels. Traction on the sutures retrieved from tibial was applied to reduce the ACL and the bony fragment in its native footprint.

Sutured were knotted on anteromedial cortex of the tibia with a bone bridge of about 1.5 cm in 30 degrees of knee flexion. Stability was checked out clinically. Intraoperative fluoroscopy was used to check the fragment reduction to its native footprint with restoration of normal tibial spine morphology. (Figs. 9–12).

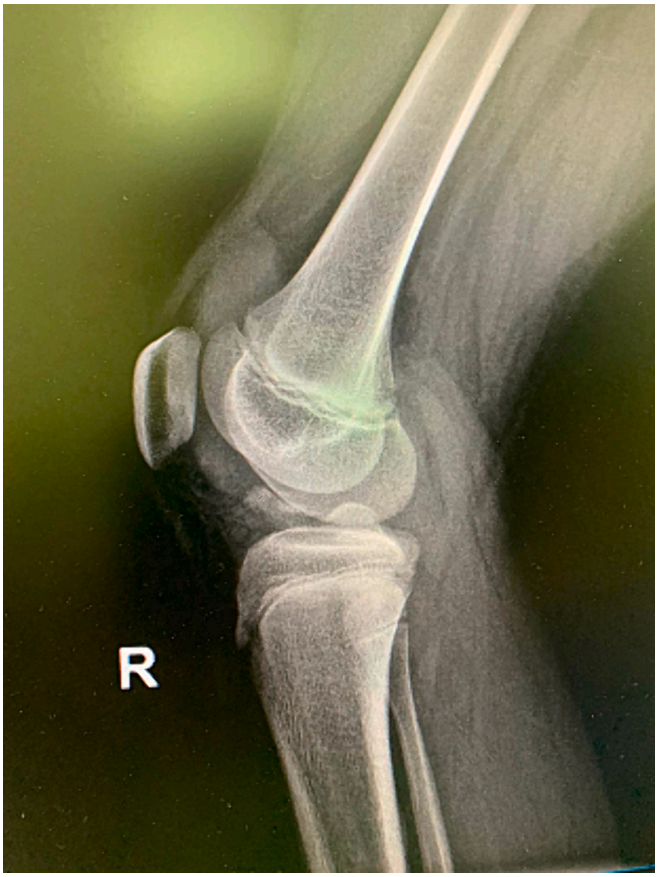

Fig. 2. lateral view of the patient's right knee showing a displaced tibial spine fracture.

After the surgery, the rehabilitation protocol was focused on the protection of healing of the ligament and the bone. Therefore, rehabilitation was tailored in a way to delay range of motion exercise. A long leg cast was applied for 2 weeks, and then a hinged knee brace locked in extension for another 2 weeks. Patellar mobilization exercises and quadriceps strengthening isometric exercise were initiated immediate after surgery. The brace was then adjusted to allow increased range of motion of the knee. At 6 and 8 weeks after surgery, 90° and 120° of motion, respectively, were allowed. A pair of crutches was used to allow partial weight bearing from 3 days to 3 months after surgery.

During follow up, the knee was stable and the fragment healed completely with no signs of malreduction or residual laxity. (Fig. 13).

The patient had regular follow up visits at 1st week, second seek, first month and then every 6 weeks. At each visit the patient was assessed clinically and radiologically. The final follow up was at one year (12 months since the surgery). His range of motion was almost normal. His final Lysholm score was 92 points.

Discussion

Tibial spine avulsions are uncommon injuries that are frequently presented in children and adolescents aged 8–15 years old. They represent a real pediatric knee challenge. The exact mechanism of injury can be due to a non-contact twisting knee motion or a traumatic hyperextension of the knee. In skeletally immature patients, the tibial eminence may fail at lower tensile forces than the ACL due to incomplete ossification and will lead to the equivalent of an adult ACL injury [8].

This case presents a very rare injury that, according to our knowledge, not described before in the English literature. The combined soft tissue distal stump peeling along with fracture of the tibial spine was not reported before and it's hard to explain the exact mechanism. However, recent reported had shown rotator cuff tears along with greater tuberosity avulsion from proximal humerus [9–11].

Fig. 3. 3D CT scan of the patient's right knee showing a displaced tibial spine fracture.

Fig. 4. a Sagittal CT views of the patient's right knee showing a displaced tibial spine fracture.

This type of double injuries may be explained by a considerable stretching of the ligament fibers was first occurred and started to peel from anterior part of the tibial spine. However, the posterior fibers were still intact and caused avulsion of the bony part. It is impossible that both occurred at the same time of injury. One of them must have been partially occurred before the other.

In this case, combined ACL soft tissue suturing along with bony fixation was mandatory in comparison with other reported techniques which fix either soft tissue ACL fibers using pullout sutures on tibial cortex or fixing bony avulsed fragment alone using antegrade or retrograde screws. In this case, a suture passer was used to pass two crossed high strength sutures within the ACL soft tissue stump. Two small tibial bone tunnels that were incorporated through the fracture fragment itself allowed the fixation over a tibial cortex bone bridge. Drilling and passing the sutures through the avulsed fragment itself offer exceptional fixation strength and an anatomic fracture reduction. This technique allowed easy tensioning of the ACL fibers along with reduction of the bony fragment without the need for complex suture passage underneath or around the avulsed fragment. It also allowed for proper tensioning over the tibial bone bridge prior to final fixation.

Many other techniques were reported in the literature to repair tibial avulsion injuries like; tibial cortical button, cortical screws, knotless anchors and others [6,8,12–14]. However, in those skeletal immature population, the suture fixation may represent a better construct choice for fixation of tibial eminence avulsion fractures [15,16].

The commonest mechanism of tibial spine fracture is falling form a bicycle rather than a road traffic accident. Tibial eminence usually avulsed under forced valgus and hyper-extension or tibial internal rotation. Because of peculiar nature of chondro-epiphyseal maturity, same forces lead to more incidence of tibial eminence avulsion injuries in children and ACL substance tear in adult. Hence, before ossification of ACL insertion site (14–16 years), which is mainly cartilaginous and considered as a weak link, there are clustering of avulsion injuries rather than ACL tear before this age group [16].

To the best of our knowledge, no data were available about combined ACL peel off with tibial eminence fractures. However, there is indirect literature insights about this issue hidden within the residual laxity after fixation of tibial eminence fractures. Kieser et al. [17] reported residual positive Lachman test in more than 30 % of their cases. Pan et al. [18] reported residual pivot shift and instability in

Fig. 5. a coronal CT views of the patient's right knee showing a displaced tibial spine fracture.

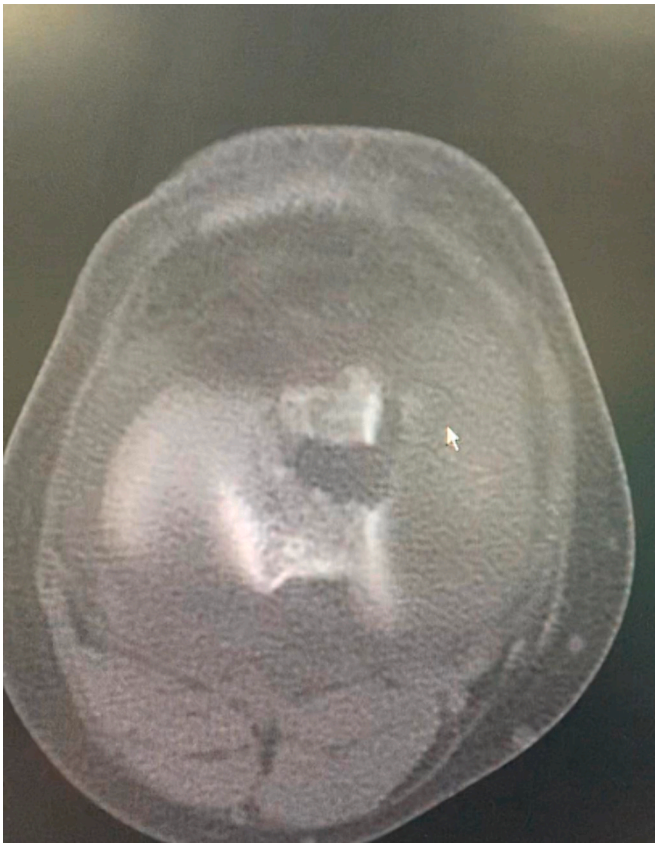

Fig. 6. an axial CT views of the patient's right knee showing a displaced tibial spine fracture.

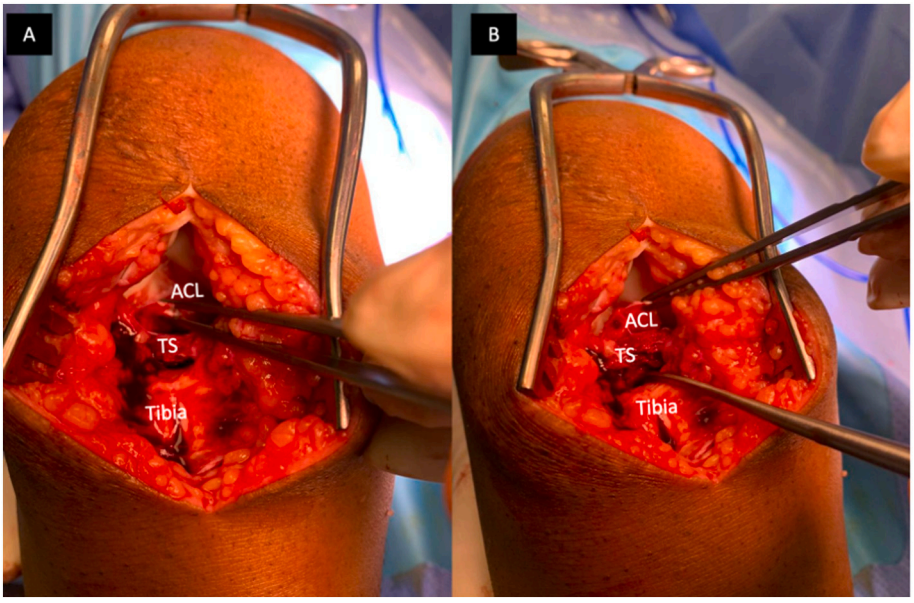

Fig. 7. (a and b): Intraoperative photos of patient's right knee showing double level injury of combined tibial spine avulsion from tibia and ACL distal stump peeling from avulsed fragment.

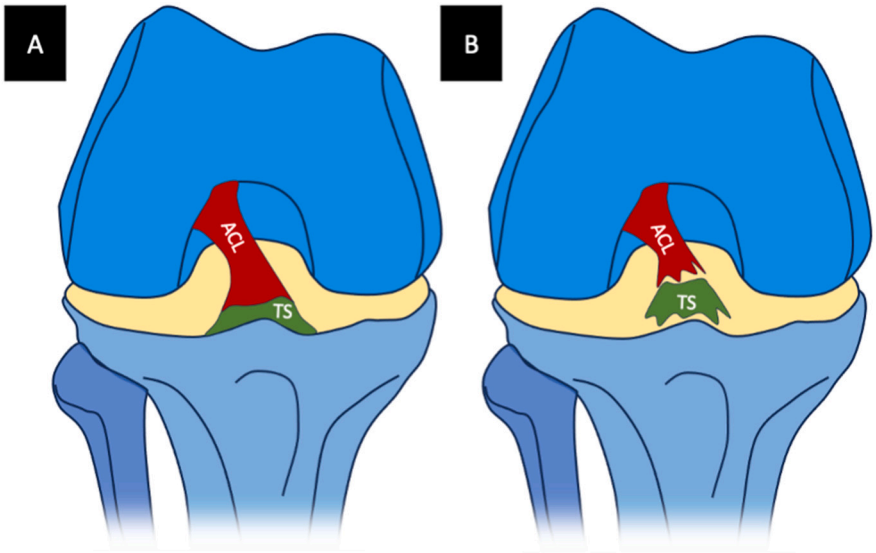

Fig. 8. (a and b): drawing of the right knee showing the double decker injury of distal ACL stump.

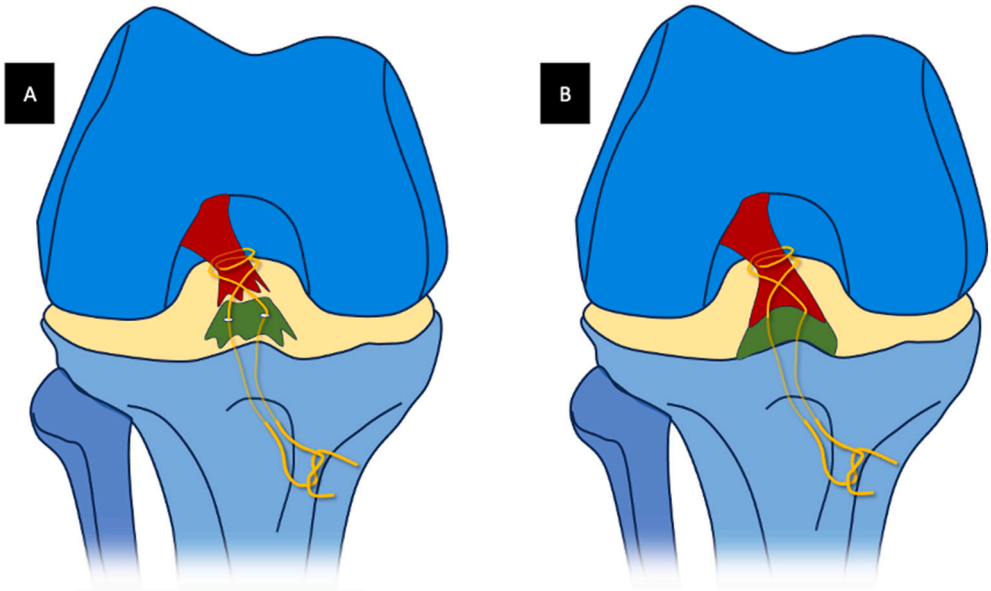

Fig. 9. (a and b): drawing of the right knee showing crossed FiberTape suture fixation of the double decker injury over a tibial bone bridge.

many of their cases whatever the fixation method. This residual laxity indirectly proves that there is an element of soft tissue stretching of the ACL before the tibial eminence avulsion. Therefore, the primary goal in those case is not just mere bony avulsion fixation, however, ACL tension must be restored adequately intraoperatively using sutures passing through the ACL fibers and re-tensioning the ACL over the tibial cortical surface. In our case, the ACL was not just stretched out, it was peeled off the tibial eminence anteriorly, then at a certain point, the cartilaginous link between tibial eminence and the tibial footprint failed revealing this rare double level injury which was adequately reduced and fixed using double soft tissue and bony fixations.

Conclusions

The presence of tibial eminence avulsions does not necessarily mean intact ACL fibers. A prober ACL stump evaluation must be advocated in all cases with tibial spine fractures. The ACL may be stretched out or partially peeled off the tibial spine before the avulsion happened. The primary goal then is to restore the tension of the ACL stump, not just refixing the avulsed fragment.

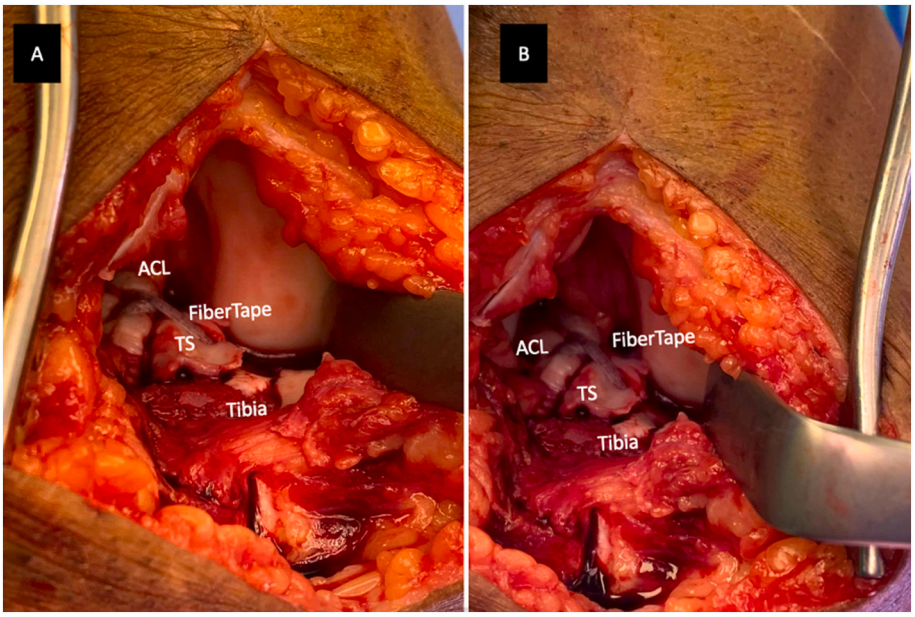

Fig. 10. (a and b): Intraoperative photos showing reduced ACL stump over the avulsed fragment which was reduced with the same suture to its footprint.

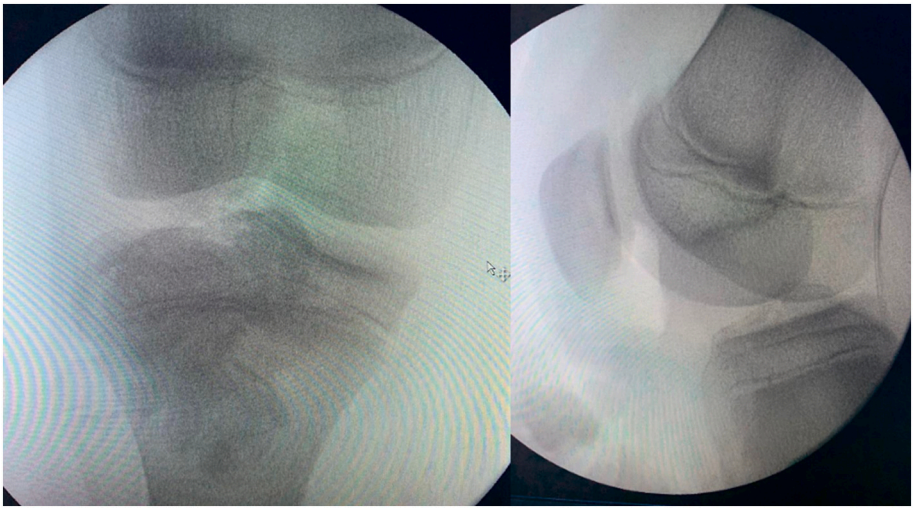

Fig. 11. intraoperative fluroscopic view showing restoration of the normal morphology of the tibial spine with adequate reduction of the fragment.

CRediT authorship contribution statement

Mohamed Abdelmonsef Ibrahim Elghaish: Validation, Methodology. **Sharif Mustafa Ahmad Ismail El-Lahham:** Formal analysis, Data curation, Conceptualization. **Ahmed Hassan Saad Abou Helwo:** Writing – original draft, Visualization. **Mohamed Mahmoud Abouelfettouh Abdelgelil Elfekky:** Writing – original draft, Visualization, Supervision, Conceptualization. **Hesham Mohamed Gawish:** Writing – original draft, Methodology, Conceptualization.

Declaration of competing interest

None.

Fig. 12. Immediate postoperative X-ray showing well reduced tibial spine avulsion.

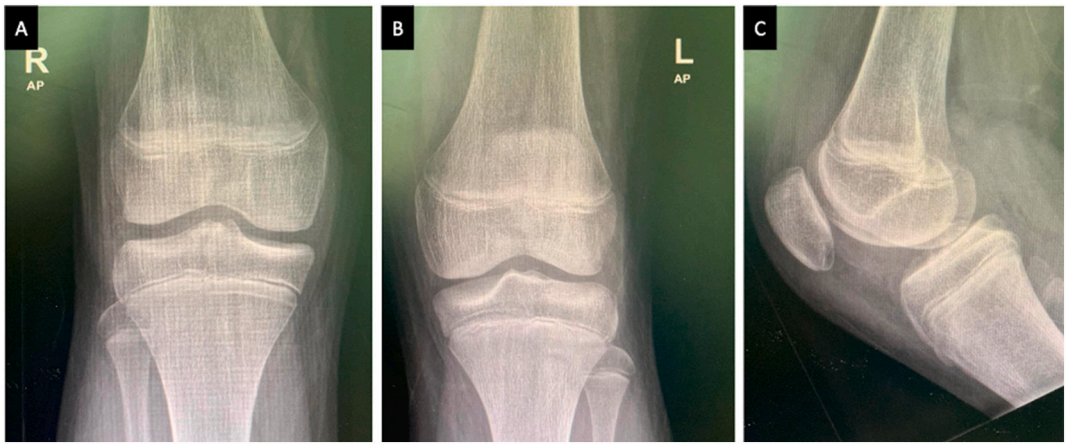

Fig. 13. the final one year follow up x-rays showing complete healing of the right ACL tibial spine mimicking the left side (double mountain sign) in the AP and lateral views.

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Declaration of Generative AI and AI-assisted technologies in the writing process

No AI tools were used while generating this article. The authors take full responsibility for the content of the publication.

Meeting presented

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