Radiology Case Reports 14 (2019) 526–529

Available online at www.sciencedirect.com

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Case Report

Bipartite patella separation and partial quadriceps tendon rupture in the setting of trauma

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ARTICLE INFO

Article history:
Received 17 July 2018
Revised 24 September 2018
Accepted 1 October 2018
Available online 22 October 2018

Keywords:
Bipartite patella
Quadriceps rupture
Trauma

ABSTRACT

Normal development of the patella typically involves fusion of secondary ossification centers into a single bone during adolescence, with failure of fusion resulting in bipartite and tripartite patellae. In such variants, injury to incomplete ossification center fusion, though uncommon, has been reported to occur in the setting of traumatic quadriceps tendon rupture. The authors present a rare and complex case of traumatic bipartite fragment separation, patellar avulsion, and a complex partial quadriceps tendon tear confirmed surgically in a 36-year-old male. In this case, a tear in the lateral aspect of the quadriceps tendon attached to the nonfused patellar ossification center resulted in retraction of the band containing the bipartite fragment and separation of the patellar fragments, with superior displacement of the smaller bony avulsion likely due to complex attachments from the medial aspect of the quadriceps tendon. Knowledge of the classical locations of a bipartite and tripartite patella can aid in the differentiation of the anatomic variant versus patellar avulsion. Additionally, knowledge of the variable and complex nature of the quadriceps tendon aids in understanding the process of patellar avulsions and various tears, leading to the appropriate orthopedic management.

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; ORIF, open reduction and internal fixation.
Competing Interests: The authors have declared that no competing interests exist.

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https://doi.org/10.1016/j.radcr.2018.10.003

Background

The patella usually develops as a single bone within the quadriceps fascia. It is held in place superiorly by the quadriceps tendon and inferiorly by the patellar tendon. This apparatus is necessary for knee extension and protects the knee joint anteriorly. During adolescence, secondary ossification centers of the patellar bone usually fuse to form a single ossification center, therefore forming a single bone in most of the population [1].

However, in a small percentage of the people, normal variants found incidentally occur where the patellar bone is seemingly divided into 2 or 3 separate parts called bipartite and tripartite patellae, respectively [2]. These variants are the result of the failure of secondary ossification centers to fuse into a single patellar ossification center. Injury to the incomplete ossification center fusion seen in bipartite and tripartite patella is rare, and has been reported to be associated with traumatic quadriceps tendon rupture, with only 7 previously reported cases [3–8].

Case report

A 36-year-old healthy man presented to the emergency department with acute right lower extremity pain. The patient described feeling a popping sensation in his right knee after landing from a jump while playing basketball. He reported an inability to extend his knee, but otherwise denied sensory or motor deficits. The patient's past medical history was significant for a "heart murmur" and glaucoma, while surgical and family histories were unremarkable. On presentation, the patient's vitals were unremarkable. Physical examination was remarkable for tenderness and swelling just superior to the right knee. A mass-like lesion was palpated in the distal aspect of the anterior right thigh. The knee was without valgus or varus deformities and demonstrated negative drawer tests. The patient was able to normally flex his knee, but unable to extend at the knee. Bilateral dorsalis pedis pulses were intact and no distal sensory deficits were elicited.

Based on the patient's presentation, radiographs of the knee were ordered which demonstrated a bony fragment superior to the right knee with a superolateral patellar defect, raising suspicion of a quadriceps tendon avulsion rupture and right knee effusion. Subsequent noncontrast-enhanced computed tomography of the right knee demonstrated a well-corticated ossific density and patellar defect, consistent with a bipartite patella separation. An additional smaller bony fragment was seen medial to the dominant fragment and there was localized anterolateral thigh hematoma concerning for a partial quadriceps tendon tear.

The patient was placed in a knee immobilizer, advised to avoid weight bearing on his right lower extremity, and discharged from the emergency department. The patient returned 1 week later for a scheduled primary repair of the right quadriceps tendon and open treatment of a right bipartite patella fracture. Intraoperative examination demonstrated a near complete rupture of the quadriceps tendon which was inclusive of the 2.5 × 1.5 cm bipartite portion of the patella with a minimal amount of articular surface involved. In order to best promote reliable healing through a tendon-to-bone repair, the decision was made to excise the bipartite fragment. The knee was surgically reduced and the quadriceps rupture repaired with multiple #2 FiberWire sutures, with fixations performed at both the inferior and superior poles of the patella.

The patient was discharged from the PACU in a knee immobilizer after successful right quadriceps tendon repair and excision of right bipartite patella fragment.

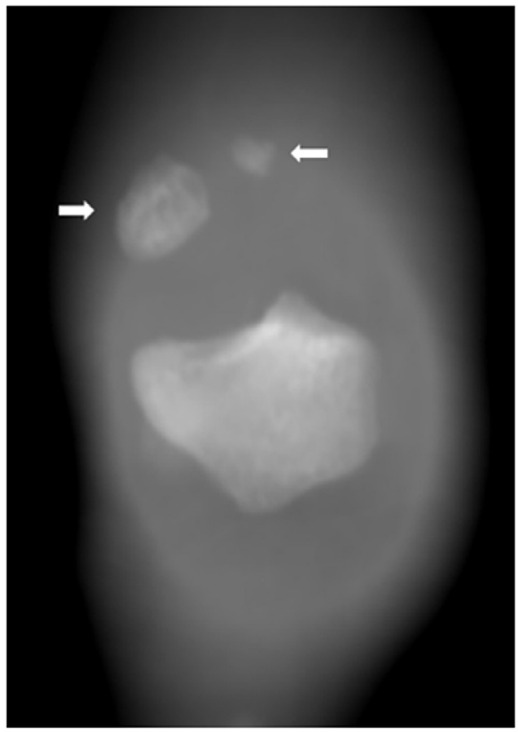

Fig. 1 – Coronal maximum intensity projection CT image demonstrates a superolateral defect within the patella with two well-corticated fragments (arrowheads) which are displaced superiorly due to avulsion/separation.

Discussion

Bipartite and tripartite patellae are normal anatomic variants caused by failure of fusion of primary and secondary ossification centers and they remain separate. Bipartite patella is usually incidental and asymptomatic, but recent literature suggests rare pain syndromes due to this variant. First described in 1883 by Gruber, this anatomic variant was classified by Saupe in 1921 and later reclassified in 2010 by Oohashi et al. [9]. The superolateral type is the most common of the variants making up 75% [10].

There is a scarcity of case reports documenting separation of bipartite patella as a complication of the variant. Furthermore, bipartite patella separation with concurrent quadriceps tendon rupture in a healthy, athletic young adult are reported only twice in our literature search [Fig. 1].

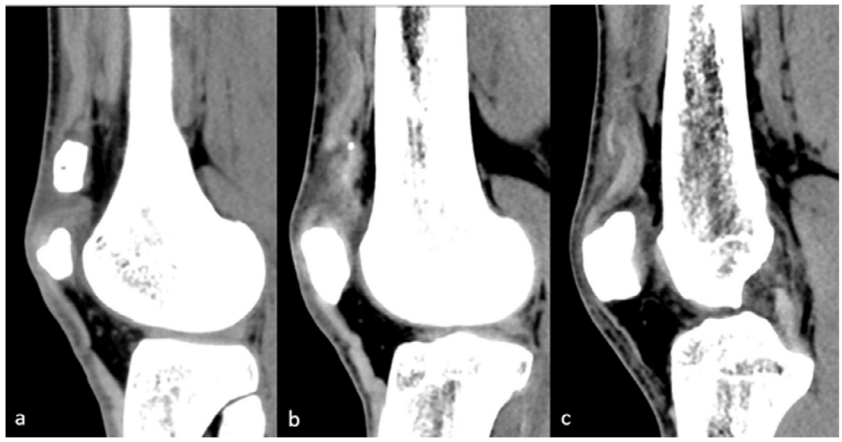

Fig. 2 – Three sagittal CT slices of the knee demonstrating separated bipartite fragment with retraction of the ligamentous attachment (Fig 2A), smaller avulsed patellar fragment with retracted ligamentous attachment and adjacent fluid (Fig 2B), and subtle retraction and heterogeneity of the quadriceps tendon attached to the patella suggesting laxity and partial tear (Fig 2C).

The quadriceps tendon is a complex multilayered structure arising from vastus intermedius, vastus medalis and vastus lateralis, and the rectus femoris [11,12]. Most tendons are made up of 2 (30%) and 3 (56%) layers with the lateral aspect having a single thick layer, and the medial aspect comprising 2 or 3 layers [11]. As the largest muscle in the quadriceps muscle complex, the vastus lateralis pulls the patella laterally [13] and is likely the main contributor to the lateral aspect of the quadriceps tendon. Although highly variable and complex, in this case it is thought that a tear in the lateral aspect of the quadriceps tendon attached to the nonfused patellar ossification center resulted in retraction of the band containing the bipartite fragment and separation of the patellar fragments [Fig. 2]. The smaller bony avulsion demonstrates probable complex attachments from the medial aspect of the quadriceps tendon, explaining the superior displacement of the avulsed fragment [Fig. 3]. The tendinous insertion onto the patella also appears to be retracted [Fig. 2C]. Without evidence of patella baja, this suggests a partial tear of the quadriceps tendon with maintenance of at least the minimum tendon integrity required to support the patella in place. These radiological findings are consistent with the surgical findings of a near complete rupture of the quadriceps tendon.

For management of an extra-articular fracture of a bipartite patella, as in our case, surgical excision of the fracture fragment may be performed; however, if a significant portion of the articular surface is involved, open reduction and internal fixation is the management option of choice [14–15]. Presurgical radiologic evaluation should include an magnetic resonance imaging to aid the surgeon in the involved structures, such as evaluation of the cartilaginous articular surface between the bipartite fragment and patella, as well as the extent of the quadriceps injury.

Knowledge of the complexity of the quadriceps tendon can explain the unusual findings seen in our patient. Further knowledge of the classical locations of ossification centers in bipartite and tripartite patella help discriminate true patellar avulsions from normal variants. This novel case exemplifies the combination of normal variant leading to an unusual complication of bipartite separation with small bony avulsion and partial quadriceps tendon rupture giving us insight to the complexity of the structures at hand.

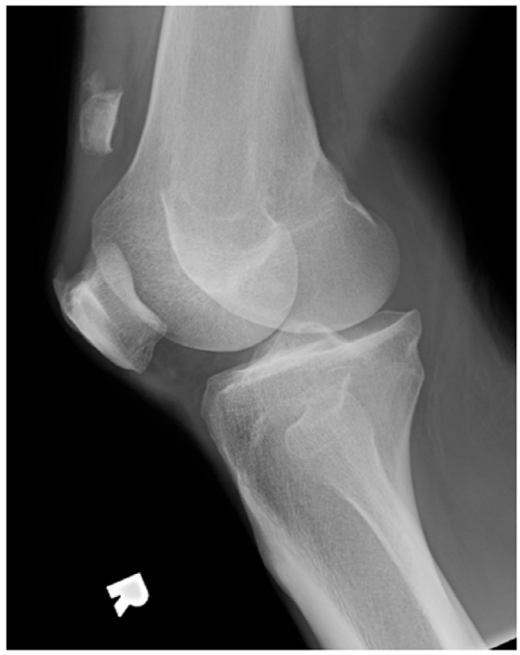

Fig. 3 – Lateral radiograph demonstrating superiorly displaced bony fragment suggestive of avulsion versus separation.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Author's contributions

RS conceived the case report, gathered patient data, and drafted the manuscript. AW, PM and CB interpreted the data and critically revised the manuscript. JB and NS gather patient data. VK interpreted the data, including the imaging. All authors approved the final version to be published and agree to be accountable for all aspects of the work.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2018.10.003.

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