Knee cap recap - Congenital variations of the patella with distinguishing features.

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Purpose

Duplication of the patella is extremely rare, with less than 30 cases reported in the literature. It is important to differentiate a double patella from a bipartite patella, as this may influence the patient’s management. The aim of our study is to demonstrate MR imaging features of double patella and distinguishing features from bipartite patella.
Methods and Materials

We performed a review of the literature on MRI features of double patella and bipartite patella. Subsequently, the local radiology database was utilised to identify two cases of double patella and one case of bipartite patella, which all had MR imaging performed.
Results

Three types of double patella have been classified in the literature [1-4]: the "horizontal" type where the additional patellar bone lies higher than the main patella; the "frontal" type where the patellae are in a double layer configuration i.e. one on top of the other; and the "coronal" type where the two patellae are beside each other. In this study, we show two clinical cases which demonstrate the two most common types of double patella; the horizontal and frontal types.

The first case is a 24 year old man who presented to his general practitioner with pain in his right knee. There was no history of trauma. The external surface of the knee appears slightly abnormal on physical examination. The MRI reveals an additional bone lying at the superolateral aspect of the main patella, just anterior to the distal femur (Fig. 1 on page 7). This ellipsoid bone demonstrates a peripheral cortex and is invested in a layer of articular cartilage. There is articulation of this accessory patella with the posterior surface of the primary patella and with the anterior aspect of the femur, which shows local pressure erosion. This represents a "horizontal" double patella. The patient was due to be reviewed in the orthopaedic clinic for a possible patellectomy.

The second case is a female in her thirties, with known spondyloepiphyseal dysplasia (SED), who presented with clicking and locking of her knees. Xray shows a right double layered patella. There are also features of SED with flattening of the femoral condyles and sloping of the proximal tibial articular surface (Fig. 2 on page 7), flattening of both femoral heads, coxa vara and shallow acetabuli (Fig. 3 on page 8). MRI of the knee confirms two patellae, one on top of the other (Fig. 4 on page 9). The primary patella is fragmented which suggests the co-presence of multipartite patella. The secondary patella is invested in cartilage and has articulations with both the posterior aspect of the main patella and the anterior femoral condyle. This represents a 'frontal' double patella.

The frontal type of double patella has previously been described in association with the recessive form of multiple epiphyseal dysplasia (MED) [3]. It has been suggested that presence of a frontal type double layered patella is highly diagnostic, if not pathognomonic, for MED [5]. Interestingly in our second case, the patient has been diagnosed with a different form of skeletal dysplasia, spondyloepiphyseal dysplasia.

The cause of double patella is unclear. The most popular theory is that the duplicate patellae arise from a second, distinct ossification centre [6].
There are less than 30 cases of double patella that have been reported in the literature, most of which had only radiography performed to confirm the presence of two patellar bones and deformity of the knee. In the few cases where either CT or MRI were performed, the diagnostic criteria of a double patella extend to include the presence of articular cartilage over the surface of the accessory patella, the presence of an articulation between the two patella and an increase in total patella surface area [4,7], which have been demonstrated in our presentation. In both of the presented cases of patellar duplication, there is articular cartilage covering the second patella with articulation between the primary and secondary patella and between the secondary patella and the femur. Some of the literature case reports also describe the presence of additional ligaments of the second patella [2, 4].

Bipartite patella is a normal variant which occurs in approximately 1-2% of population [8]. There are three types of bipartite patella depending on the position of the separated fragment [8] - type I at the inferior pole (5%), type II at the lateral patellar margin (20%) and type III at the superolateral margin (75%), which is the commonest type of bipartite patella (Fig. 5 on page 10). Bipartite patella is often asymptomatic and an incidental finding.

Bipartite patella results from failure of the ossification nuclei to merge so that there is an additional secondary nucleus (accessory ossification centre) [9]. The cause of failure of fusion is most likely due to chronic trauma during ossification [9]. It has also been hypothesised that in the superolateral bipartite, there is association with stress at the insertion of the vastus lateralis [14]. The accessory bony fragment is usually united with the main patellar bone by fibrous union, with no extra ligament or joint with the femur. In contrast to the double patella, the bipartite or multipartite patellae total surface area is not increased [7].

While 98% of bipartite patella cases are asymptomatic and present as incidental findings, patients with double patella usually present in a symptomatic manner either due to chronic dislocation, clicking or locking, or pain in the affected knee. In the majority of double patella cases, operations are required including patellectomy, medialisation of the tibial tuberosity and fusion of the two patellae [2, 4, 10, 11, 12]. In comparison, a small percentage of bipartite cases undergo excision of the accessory bony segment [9, 13].

The main differences between double patella and bipartite patella are demonstrated in the table as shown below.

**Main differences between double patella and bipartite patella**
<table>
<thead>
<tr>
<th></th>
<th>Double patella</th>
<th>Bipartite patella</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prevalence</strong></td>
<td>Very rare, less than 30 cases reported.</td>
<td>1-2% population</td>
</tr>
<tr>
<td><strong>Ossification centre(s)</strong></td>
<td>2 separate ossification centres resulting in 2 individual patella bones</td>
<td>Failure of complete fusion of a multipartite ossification centre resulting in segmentation of the patella</td>
</tr>
<tr>
<td><strong>External appearance of knee</strong></td>
<td>Abnormal frontal knee contour</td>
<td>Normal frontal knee appearance</td>
</tr>
<tr>
<td><strong>MRI findings</strong></td>
<td>Articulation between two patellae +/- articulation between the additional patellar bone and femur +/- additional ligament and cartilage in additional patella. Increase of total patellar surface area.</td>
<td>Fragments are united by fibrous union. No additional joint or ligament formation. Total patellar surface area is not increased.</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td>Most cases: Patellectomy or fusion of the two patellar bones.</td>
<td>Most remain an incidental finding and are asymptomatic (98%) requiring no treatment; only excision of accessory bony segment if very symptomatic</td>
</tr>
</tbody>
</table>
Fig. 1: (a-c) Axial fat suppressed proton density weighted, (d-f) Sagital T1 weighted and (g-i) Sagital fat-suppressed T2 weighted MR images show horizontal type of the double patella, where the accessory patellar bone is superolateral to the main patella.

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**Fig. 2:** Lateral right knee radiograph shows a flexed knee with a double layered patella and flattening of the femoral condyles.

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Fig. 3: Frontal pelvic radiograph shows bilateral symmetrical congenital flattening of both femoral heads, coxa vara and deformed shallow acetabuli. Secondary degenerative changes are demonstrated at both hip joints.

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Fig. 4: (a-c) Sagital T1 weighted and (d-f) Sagital fat suppressed proton density images of a double layered patellae with one on top of the other. In addition, the main patella appears fragmented and there is flattening of the femoral condyles.

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Fig. 5: (a) coronal (b) axial (c-d) sagital MR images of bipartite patella at the superior lateral pole.

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Conclusion

Double patella is a distinct entity from bipartite patella with different presentation, imaging features and management.
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