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Review

Surgical Treatment of Symptomatic Bipartite Patella: A Case Report and Review of the Current Literature

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ABSTRACT

Although bipartite patella is accepted as a normal anatomic variant, it might occasionally cause anterior knee pain. The symptomatic bipartite patella can primarily benefit from conservative methods. However, all conservative treatment methods may fail in some cases, and surgical treatment may be necessary in these refractory cases. Herein, a 26-year-old male patient with symptomatic bipartite patella is presented. Despite using anti-inflammatory medications, rest, ice application, and activity modification, the patient's complaints did not regress at the 6-month follow-up. Open surgical excision of the fragment was performed, and the patient returned to his routine daily activities without restriction. Since refractory symptomatic bipartite patella is rare, there has yet to be a consensus on the optimal surgical treatment method. This article aims to present an extensive literature search to discuss all aspects of surgical treatment of symptomatic bipartite patella.

Keywords: Anterior knee pain, bipartite patella, open excision, surgical treatment, symptomatic bipartite patella

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INTRODUCTION

Ossification of the patella begins between the ages of 3 to 5, often with a single central ossification nucleus [1,2]. Around the age of 12, secondary ossification centers may arise during the ossification of the patella [3–5]. A distinctive patella is formed when the primary and secondary ossification centers fuse [6]. However, the bipartite or tripartite patella occurs when these ossification centers fail to unite and remain separate [2,3,7,8]. Bipartite patella is recognized as a common anatomic variation or developmental variant of the patella and is typically detected incidentally on knee radiographs collected for various purposes while remaining asymptomatic. The incidence of the bipartite patella in the general population is around 1-2% [1,9,10].

Bipartite patella is usually asymptomatic and remains silent in most patients [11–13]. Although the exact pathophysiology of why an asymptomatic bipartite patella becomes symptomatic is not clarified, chronic repetitive microtrauma on the synchondrosis and the resulting inflammation is responsible for the symptoms [4,14]. In other words, the symptomatic bipartite patella can be considered an overuse syndrome [15,16]. Since bipartite patella is a relatively rare anatomic variant, the symptomatic bipartite patella is an even less common clinical condition.

As with all overuse syndromes, the symptomatic bipartite patella can primarily benefit from conservative methods, such as rest and activity modification, cryotherapy, physical therapy,

and nonsteroidal anti-inflammatory medications [17–21]. These methods aim to unload the extensor mechanism of the knee joint, reduce inflammation, and control pain. However, all conservative treatment methods may fail in some cases, and surgical treatment may be necessary in these refractory cases.

To date, various surgical treatment options have been utilized, such as open or arthroscopic excision [7,11,12,22–24], lateral retinacular release [25–29], and internal fixation of the fragment [6,14,30–33]. However, due to the rarity of symptomatic cases, high-level evidence supporting one technique over another is limited, and current recommendations are based primarily on small case series and expert opinions [8,34]. This lack of consensus highlights a critical gap in the literature that this case report and accompanying review aim to address.

The present study seeks to add clarity by presenting a case of successful treatment with open fragment excision in a patient with symptomatic bipartite patella. Additionally, this review of the literature aims to provide a comprehensive synthesis of the available surgical options, focusing on the outcomes, indications, and complications of each approach. By highlighting both the strengths and limitations of existing techniques, this report contributes to the ongoing discussion regarding the optimal management of refractory symptomatic bipartite patella.

CASE PRESENTATION

A 26-year-old construction worker presented to the outpatient clinic complaining of anterior knee pain. His pain had started four months ago and was particularly aggravated following heavy activities that required kneeling and squatting. Apart from the pain, there was also occasional crepitation over the patella. He was otherwise healthy, and his past medical history revealed nothing abnormal. On physical examination, mild swelling or protrusion was observed over the superolateral corner of the patella. The active and passive ranges of motion were within normal limits, and the knee was stable. There was tenderness over the swelling on palpation, and the patellar grinding test was positive.

Direct radiographic knee imaging showed no significant pathology except for a bipartite patella (Fig. 1). Based on the physical examination and direct radiographic findings, the diagnosis of the symptomatic bipartite patella was suspected. Magnetic resonance imaging (MRI) of the knee joint was requested to confirm the provisional diagnosis and to detect other possible pathologies explaining the patient's complaints. MRI examination demonstrated marked intraosseous edema within the bipartite patella fragment and the synchondrotic articulation. The rest of the knee joint was reported as normal (Fig. 2).

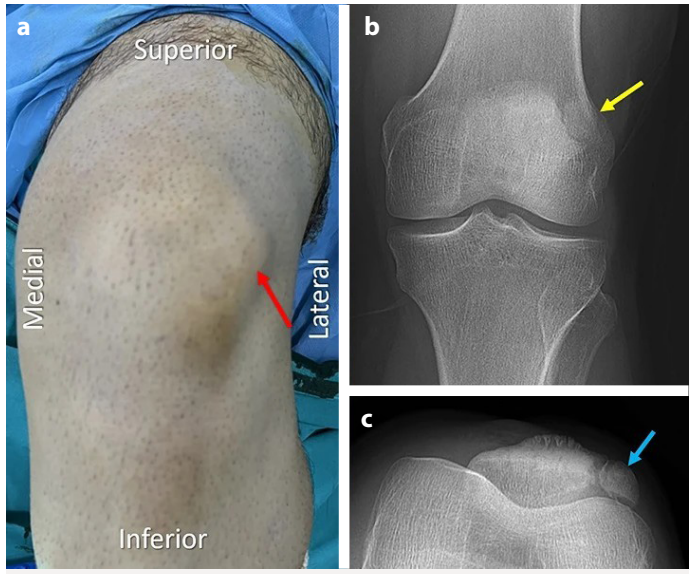

Figure 1. (a) Clinical appearance of the knee from the anterior aspect (red arrow shows the bony prominence caused by the bipartite patella fragment). **(b)** anteroposterior, and **(c)** tangential knee radiographs showing the bipartite patella (yellow and blue arrows).

As MRI findings supported our clinical diagnosis, the patient was diagnosed with symptomatic bipartite patella. Conservative treatment consisting of activity restriction, knee brace during kneeling, and non-steroid anti-inflammatory drug therapy was initiated. Despite three months of conservative treatment, there was no significant improvement in the patient's complaints. A local anesthetic injection was made around the bipartite fragment and synchronistic joint to understand whether the patient would benefit from surgical excision. Immediately after the simulation test, the patient's complaints disappeared. Thereupon, surgical excision was planned for the patient. Although the standard duration of conservative treatment can vary, in this case, three months was deemed sufficient due to the patient's persistent symptoms and the clear benefit observed from the local anesthetic injection, indicating that surgery was appropriate.

First, diagnostic knee arthroscopy was performed by applying a tourniquet to the thigh under spinal anesthesia. The articular cartilage of the patella was intact, and the patellofemoral joint movements were normal on dynamic examination (Fig. 3). After the arthroscopic examination, a longitudinal incision was made over the superolateral corner of the patella. During deep dissection, it was observed that a significant part of the vastus lateralis tendon was inserted into the bipartite patella fragment. The fragment was separated from the synchondrosis and surrounding soft tissues by sharp dissection. The fragment

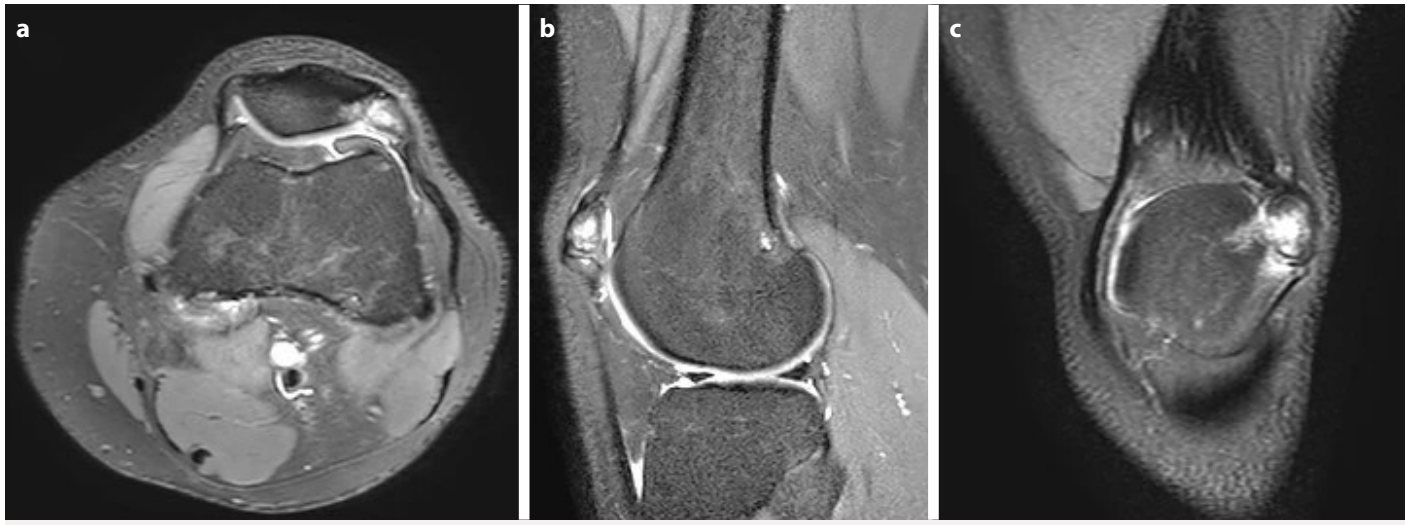

Figure 2. (a) Axial and **(b)** sagittal Proton density weighted (PDW), **(c)** coronal T2 weighted MR images show bone marrow edema within the bipartite patella and adjacent area to synchondrosis.

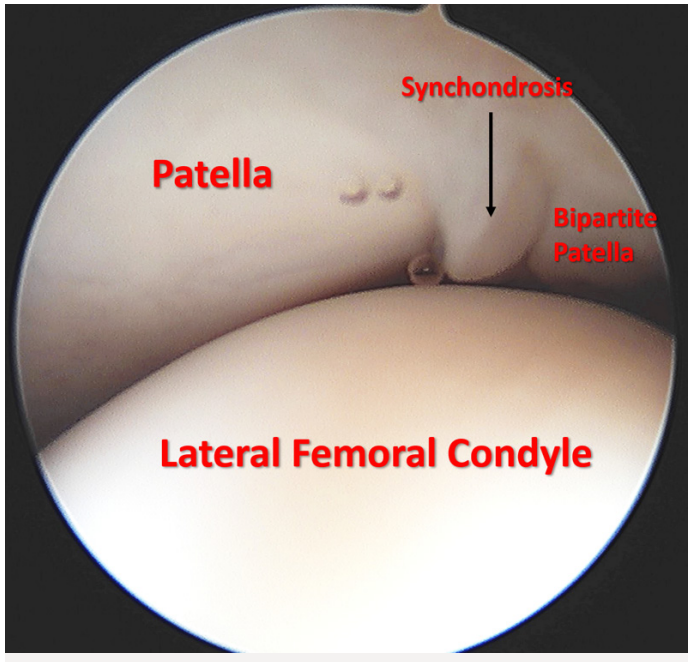

Figure 3. Arthroscopic image showing the patella, synchondrosis, bipartite fragment and lateral femoral condyle from the anteromedial portal.

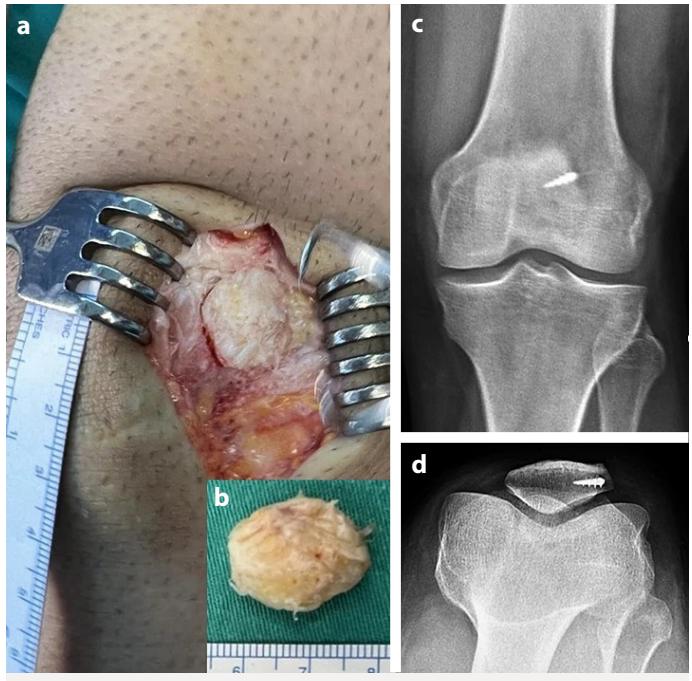

Figure 4. (a) Intraoperative appearance of the fragment before removal. **(b)** Bipartite patella fragment after excision. **(c)** Anteroposterior **(d)** tangential knee radiographs showing metallic anchors and total removal of the fragment without residue.

was about 2 x 2 cm in size. The synchondrotic joint was curetted down to the spongious bone, and the vastus lateralis tendon was sutured to the patella using a metal anchor (Fig. 4).

The postoperative period was uneventful. Full weight-bearing, active and passive knee range of motion exercises were started immediately on the second postoperative day. Sutures were removed at the end of the second week. At the sixth-week follow-up, knee ROM was painless and similar to the contralateral side. At the final follow-up six months after the surgery, the patient had no pain and returned to his previous

level of activity and work. Lysholm knee score was excellent (100 points).

Literature Search

A comprehensive review of the literature was conducted to find all studies that assessed surgical treatment for symptomatic bipartite patella from 1950 to the present. The following electronic databases were searched: CINAHL, MEDLINE, PubMed, Scopus, Google Scholar, and SPORTDiscus. 'Bipartite patella' was used as the search term, and only articles written in English were reviewed. Duplications, studies reporting conservative treatment, review articles, systematic reviews, and surgical technique papers that do not report details of patients were excluded. A total of 44 papers were eligible for the analysis [3–7,11–17,21–33,35–52].

Literature Search Results

Table 1 summarizes the previously published studies that report surgical treatment of bipartite patella. There were 205 patients in 44 publications [3–7,10–17,21–33,35–46,48,49,51,52]. Since some studies did not report detailed demographic data, descriptive statistics were calculated based on the available data. The mean age was 20.46 years (range, 10-69 years). There were 149 (75%) male and 50 (25%) female patients. The right side was involved in 83 (49%), the left side in 81 (48%), and bilateral involvement in 5 (3%) patients. Various surgical techniques were used for the treatment (Table 1). The treatment outcomes were reported for 205 patients. 192 (93.5%) patients had complete relief of symptoms, and 8 (4%) had occasional pain.

Only in one (0.5%) patient, the symptoms did not resolve following open excision of the fragment. However, this patient had additional patellofemoral osteoarthritis and diffuse cartilage lesion; thus, a partial patellectomy [13] had to be performed. Four patients required secondary revision surgery [6], including lateral release (0.5%), excision of the residual fragment (0.5%), and removal of fixation screws in two cases (1%).

DISCUSSION

The most important finding of this study is that open fragment excision provided complete relief of symptoms in a patient with refractory symptomatic bipartite patella, allowing a return to full activity without any restrictions. This outcome is consistent with the findings of most previous studies, which report excellent results following surgical excision in cases where conservative treatment fails. Our literature review further supports excision as an effective treatment option, particularly in cases where the fragment is small and located outside the patellofemoral joint. Additionally, while various surgical techniques—such as lateral retinacular release and fragment fixation—are available, no single method has demonstrated clear superiority, emphasizing the importance of individualized treatment based on the fragment's characteristics and the surgeon's expertise. In the following paragraphs, we will discuss the findings of this case in light of the existing literature on bipartite patella and its treatment options.

Diagnosis and Surgical Indication

The first radiological examination is usually direct radiographic imaging for a patient presenting with anterior knee pain since it is inexpensive and quickly accessible. The detection of the bipartite patella is generally made on radiographs, especially tangential views. However, radiological detection does not establish the relationship between anterior knee pain and the bipartite patella. Since it is an asymptomatic normal variant, it must be objectively determined that the complaints originate from the bipartite patella. In other words, other causes of anterior knee pain should be carefully excluded before a diagnosis of the symptomatic bipartite patella. MRI is the most valuable imaging modality in confirming the diagnosis of the symptomatic bipartite patella. Kavanagh et al. [53] reviewed MRI findings of 53 patients with a bipartite patella. They reported that identifying bone marrow edema at or adjacent to the bipartite fragment by MRI was the sole imaging finding that reflects a scenario where the bipartite patella is the primary cause of symptomatology. Secondly, an MRI allows for a thorough screening of the knee joint and excludes other possible causes explaining the anterior knee pain. Kavanagh et al. [53] found other reasons explaining anterior knee pain in a significant proportion of bipartite patella cases (72%) without accompanying edema. Apart from MRI, scintigraphy might be an alternative method for confirming the diagnosis, but due to its low specificity, this method is a limited technique.

The initial treatment of symptomatic bipartite patella is conservative. Surgical treatment should be considered in patients for whom conservative treatment is insufficient to relieve symptoms. Before deciding on surgical intervention, local anesthetic injections provide valuable insight into whether the patient will benefit from surgical treatment. The regression of symptoms with a local anesthetic injection around the bipartite fragment strengthens the indication for surgery.

In case of a positive history of trauma, a vertical patella fracture should be kept in mind and excluded [21,30,42]. Although the clinical findings are different, the radiographic appearance of these two entities resembles each other (Fig. 5). In bipartite patella, the synchondrosis is rounded and irregular, but the fracture usually extends distally and is sharp-edged.

Table 1. Previous cases and case series that reported surgical treatment of bipartite patella in current literature

Author	Year	# Cases	Sex	Age (years) Mean/range	Side	Treatment
Green [16]	1975	3	3 M	14.3 (13-15)	3 R	Open excision
Halpern and Hewitt [5]	1978	1	F	20	Bilateral	Open excision
Weaver [13]	1977	16	12 M, 4 F	19 (12-42)	NR	Open excision
Ogden et al. [4]	1983	1	M	15	L	Open excision
Yamaguchi et al. [35]	1990	6		17.8 (14-25)	5 R,1 L	Open excision
Bourne and Bianco [36]	1990	16	12 M, 4 F	14.5 (11,5-19)	8 R,8 L	Open excision
Ogata [37]	1994	13	10 M, 3 F	21	6L,5R,2B	Open excision
Eberhard et al. [38]	1995	1	M	44	NR	Open excision
Ireland and Chang [39]	1995	1	M	47	Left	Diagnostic arthroscopy followed by open excision
Iossifidis and Brueton [12]	1995	7	3 F, 4 M	30 (21-46)	Unilateral	Arthroscopic excision
Mori et al. [27]	1995	15	9 M, 6 F	16.6 (13-24)	8L,6R,1B	Modified lateral release with extension to proximal attachment of separated fragment
Kumar et al. [29]	1999	1	M	36	L	Lateral release & Medial plication
Tashiro et al. [40]	2002	1	M	41	L	Open excision
Adachi et al. [41]	2002	12	10 M, 2 F	15.6 (12-28)	7R,5L	Arthroscopic VL release
Canizares and Selesnick [3]	2003	1	M	32	R	Diagnostic arthroscopy followed by open excision
Okuno et al. [21]	2004	1	M	16	R	ORIF (Tension band wiring)
Azarbod et al. [11]	2005	1	M	26	R	Arthroscopic excision
Morrison et al. [7]	2006	1	M	20	L	Open excision
Enomoto et al. [24]	2006	1	M	32	R	Open excision
Tauber et al. [42]	2006	1	F	18	L	ORIF (Tension band wiring)
Gorva et al. [33]	2006	1	M	69	R	ORIF (with anchors)
Thomas et al. [43]	2007	1	F	40	R	Open excision of fragment; repair of quadriceps tendon
Woods et al. [44]	2007	1	M	44	L	Open excision of fragment; repair of quadriceps tendon
Tonotsuka and Yamamoto [32]	2008	1	M	66	L	ORIF (fragment with compression screws; repair of quadriceps tendon)
Yoo et al. [45]	2008	1	M	37	R	Arthroscopic excision
Weckström et al. [17]	2008	25	25 M	15 (10-22)	13R,12L	Open excision (n:24), Arthroscopic excision(n:1)
Carney et al. [22]	2010	1	M	26	R	Arthroscopic excision
Felli et al. [23]	2011	1	F	22	NR	Arthroscopic excision
Peek and Bary [46]	2012	1	M	12	R	Arthroscopic excision
Werner et al. [47]	2013	3	1 F, 2 M	16, 21, 36	2 R, 1 L	Arthroscopic excision (n=2) ORIF (screws fixation) (n=1)
Mohammad et al. [31]	2014	1	M	45	L	ORIF (screws fixation)

Table 1. Previous cases and case series that reported surgical treatment of bipartite patella in current literature (Cont.)

Author	Year	# Cases	Sex	Age (years) Mean/range	Side	Treatment
Vaishya et al. [48]	2015	5	5 M	21 (16-31)	2 R, 3 L	Arthroscopic excision (n=3) ORIF (screws fixation) (n=2)
Kaas and van der Werf [49]	2015	1	F	23	R	Open excision
Radha et al. [30]	2017	6	6 M	19, 26	NR	ORIF (screws fixation)
James et al. [50]	2017	1	M	16	L	Arthroscopic excision
Felli et al. [25]	2018	10	10 M	20.5 (19-27)	5 R, 5 L	Arthroscopic VL release
Seguritan et al. [51]	2018	1	M	36	R	Open excision of fragment; repair of quadriceps tendon
Saleh et al. [52]	2019	1	M	26	L	Open excision and LRR
Kallini et al. [6]	2021	27	16F,11M	15.4 (10-20)	9R,18L	Open excision (n=9), Open excision with a lateral release (n=8), Isolated lateral release (n=5), ORIF (n=4), Synchondrosis drilling (n=1)
Gupta et al. [28]	2021	1	M	16	L	Subperiosteal VL release
Naikoti and Thonse [14]	2021	1	M	32	L	ORIF (tension band wiring)
Pan and Hennrikus [15]	2022	8	2 F, 6 M	37.7 (21-63)	4 R, 4 L	Open excision (n=1) Diagnostic arthroscopy followed by open excision (n=6) Diagnostic arthroscopy followed by open excision with a lateral release (n=1)
Pan and Hennrikus [26]	2022	6	3 F, 3 M	15.8 (13-17)	3 R, 2 L, 1 Bilateral	Open excision (n=2) Complete lateral release, (n=1) Open excision with a complete lateral release (n=2) Open excision with a partial lateral release (n=2)

M: Male; F: Female; R: Right; L: Left; B: Bilateral; VL: Vastus Lateralis; ORIF: Open reduction internal fixation.

Surgical Treatment

Various surgical treatment modalities have been reported for the bipartite patella, including open and arthroscopic techniques [10,15,30]. However, these methods might be categorized into three main groups: (1) excision of the fragment, (2) lateral release, and (3) fixation of the fragment, respectively. There are no strict indications of the above-mentioned surgical techniques that favor one over the other. In the current extensive literature review, clinical results were satisfactory in almost all patients (96%), regardless of the surgical technique. Nevertheless, some authors proposed that removing the fragment that involves more than 40% of the patellar articular surface deteriorates the functions of the extensor mechanism. In such cases, it is recommended to choose techniques to preserve the fragment, such as lateral release or fragment fixation. In our case, the fragment covered a small part of the entire articular surface and was located outside the patellofemoral joint [6]. Therefore, there was no contraindication for its removal. In general, evaluating fragment size and location may be advisable before deciding on the optimal surgical technique.

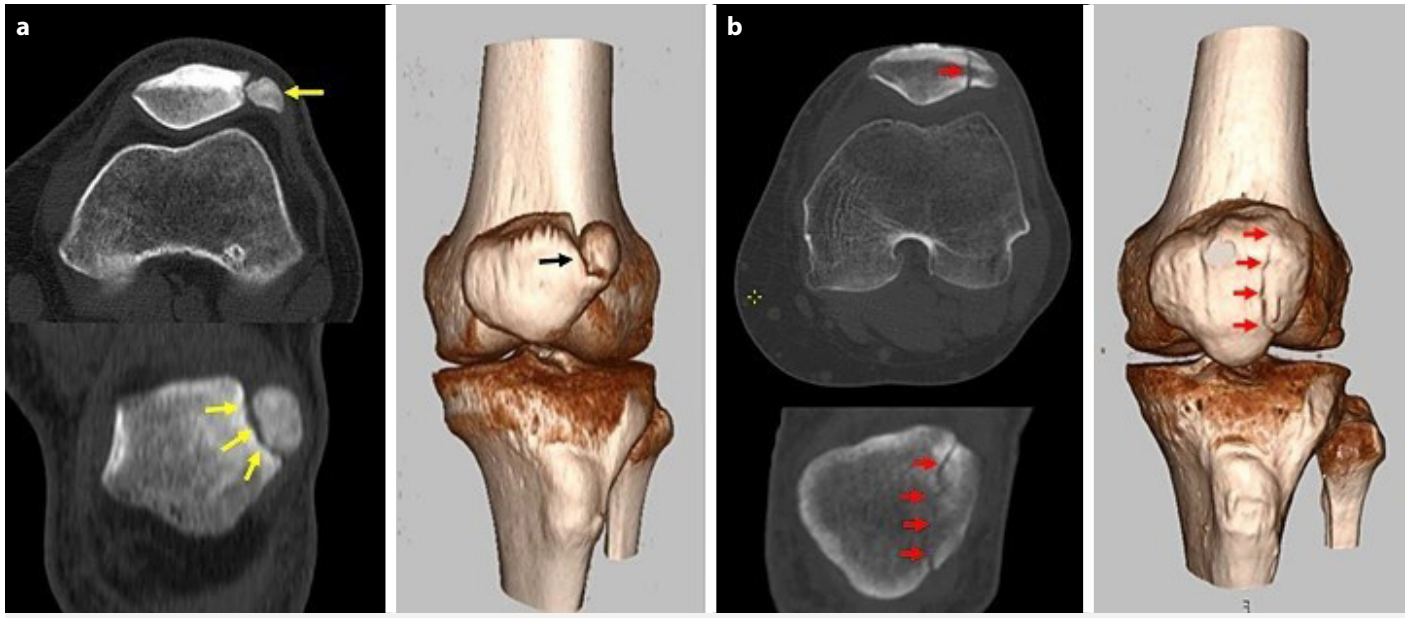

Figure 5. Axial, coronal, and 3D images of the **(a)** bipartite patella and **(b)** vertical patellar fracture. Please note the significant differences between the synchondrosis and fracture line (arrows).

Surgical Excision of the Fragment (Open and Arthroscopic)

Surgical excision was the most common treatment method among the reported cases. In the present review, open excision was performed in 112 knees (97 had isolated open excision, 4 had open excision followed by quadriceps tendon reattachment, and the remaining 11 had open excision simultaneous lateral release). Arthroscopic excision was chosen in 16 knees. Open excision is a relatively simple procedure that requires no special instrument, advanced surgical set-up, or advanced surgical skills [24,37,52,54]. Moreover, simultaneous repair of the quadriceps tendon is easy to perform. Since the surgical field is under direct vision, the risk of leaving residual tissue is low. However, compared to arthroscopic excision, it requires a longer period for recovery, patients have larger incision scars, and the risk of infection is greater [10,11,22,23,55,56]. On the other hand, arthroscopic visualization of the knee joint provides a second chance to examine and rule out the other pathologies that might cause anterior knee pain. Therefore, some authors have recommended initial diagnostic arthroscopy followed by open excision. This approach is highly recommended since it is safe and prevents undertreatment.

Lateral Release

The second most common technique was lateral retinacular release and its modifications. This treatment aims to eliminate the chronic repetitive traction applied to the bipartite patella synchondrosis by the extensor mechanism, which is thought to be the etiology of the complaints. In addition, if the fragment is relatively large and forms a significant part of the articular surface (>40%), this technique can be applied to preserve this fragment rather than remove it. Modified techniques such as complete lateral release, partial lateral release, vastus lateralis release, and subperiosteal vastus lateralis release have been used in the literature, either open or arthroscopically [25,27,28,41]. The lateral release has two major disadvantages. First, it might create iatrogenic medial instability, and second, possible muscle weakness due to discontinuity in the extensor mechanism [26,29]. To avoid this effect, the authors recommend only isolated vastus lateralis release. Thus, the amount of release should be properly adjusted. In the case series reported by Felli et al. and Adachi et al. [25,41], 22 patients underwent arthroscopy-assisted vastus lateralis release to avoid complications of complete lateral release. Many cases of spontaneous fusion have been observed because chronic repetitive traction is eliminated. To preserve the continuity of the tendon-periosteum complex with the patella, Ogata described a modified technique for subperiosteal release of the vastus lateralis from the accessory fragment [37]. The procedure's goal is to reduce mobility in the synchondrosis caused by traction of the vastus lateralis muscle, which is the same as the goal of a lateral retinacular release. However, this approach lessens the tension imbalance between the medial and lateral retinacula, iatrogenic medial instability, and vastus lateralis weakening [26,27,41].

Fixation of the fragment

The bipartite patella is not an accessory element; rather, it is the main component of the patella since it occurs due to a lack

of fusion in secondary ossification centers. Thus, removing a large bipartite patella fragment (>40%) weakens the extensor mechanism and distorts the patellar articular surface. Fixation of the fragment might be a better option when the fragment is large. Moreover, some authors favored this technique in the acute traumatic separation of the bipartite patella. In this review, open reduction and internal fixation (ORIF) were performed in 15 patients. Screws were used in 11 patients, tension band wiring was used in three patients, and a suture anchor was used in one patient as fixation material.

Fixation of the fragment targets the fusion of the fragment with the patella. Synchondrosis tissue should be carefully removed, and bleeding bony tissue should be exposed, similar to pseudoarthrosis surgery [30,31,42]. The advantage of ORIF is the preservation of the articular surface and structure of the patella. Besides, it has several disadvantages. Postoperative immobilization, longer recovery and regaining muscle strength, wound healing problems, and infection can be listed as significant disadvantages [32,33]. Theoretically, the failure of fusion is a risk. Finally, implant removal surgery late after union might be necessary.

Other Surgical Techniques

In addition to the above-mentioned primary surgical techniques, a few authors described other methods. Kallini et al. [6] performed arthroscopic synchondrosis drilling on one patient. The basic principle behind this technique is the induction of union by increasing vascular nourishment of the synchondrosis. Some cases were treated using a combination of the techniques mentioned above, such as surgical excision of the fragment combined with lateral retinacular release and lateral release combined with medial plication [3,27].

Limitations

This case report has several limitations. First, the follow-up period of six months may not be sufficient to assess the long-term outcomes of surgical excision in the symptomatic bipartite patella, and a longer follow-up is needed to confirm the durability of the results. Second, no pre-operative scoring was performed, which limits the ability to objectively compare the patient's condition before and after the surgery. Lastly, while this report highlights a successful case of open fragment excision, the study's findings are based on a single patient, and further research with larger patient cohorts is necessary to validate the results and provide more substantial evidence for surgical decision-making.

CONCLUSION

Bipartite patella is relatively easy to diagnose; however, diagnosing symptomatic bipartite patella requires additional examination and imaging, with MRI being the most valuable diagnostic tool. Bone marrow edema within the fragment and around the synchondrosis is a key indicator, especially after excluding other pathologies. Conservative treatment is the first-line approach, and patients should be followed for a sufficient period to allow for symptom relief. For cases that do not respond to conservative management, a local anesthetic injection can help determine the potential benefit of surgical intervention. In our case, surgical excision provided complete symptom relief and allowed the patient to return to full activity. The literature supports surgical excision as a valid option for refractory symptomatic bipartite patella, with low complication rates reported across different techniques. Although no single surgical method has demonstrated clear superiority, the choice of technique can be tailored to the surgeon's experience, available instrumentation, and the characteristics of the fragment. Finally, diagnostic arthroscopy should be performed at the start of the operation to assess intra-articular pathologies, which may complement MRI findings.

DECLARATIONS

Ethics Committee Approval: Not applicable.

Author Contributions: Idea/Concept – MY, OFE; Design – FD, OFE; Control/Supervision – MY, OFE; Data Collection and/or Processing – FD; Analysis and/or Interpretation – MY; Literature review – OFE, FD; Writing – MY; Critical Review – MY, FD; References and fundings – MY, FD; Materials – OFE

Data Avaliability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest: The authors declared that they have no competing interests.

Informed Consent: Written informed consent was obtained from the patient to the anonymous use of the imaging files.

Use of AI for Writing Assistance: The authors declared that they had not used any type of generative artificial intelligence for the writing of this manuscript, nor for the creation of images, graphics, tables, or their corresponding captions.

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ABBREVIATIONS

MRI - Magnetic resonance imaging

ORIF - Open reduction and internal fixation

VL - Vastus lateralis

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