Patellofemoral Instability Secondary to Trochlear Dysplasia - A Case Report

Timothy Kagoda Byakika and *Philip Gituri Mwawingwa*

The Nairobi Hospital, Nairobi, Kenya

Correspondence to: Prof. Timothy Kagoda Byakika; email: timothy.kagoda@gmail.com

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Summary

Patellofemoral joint instability is a debilitating condition that affects the biomechanical relationships between the soft tissues and the bony architecture of the knee joint. Trochlear dysplasia is an identifiable etiology in 85-96% of patients with patellar instability. Trochleoplasty is a surgical procedure that aims at restoring a sulcus or creating a near-normal trochlear deep enough to accommodate the patellar in the trochlear groove, restoring patellofemoral congruence, patella tracking, and biomechanics during flexion and extension. This case report describes a sulcus-deepening trochleoplasty through a superolateral parapatellar arthrotomy in a 15-year-old adolescent who presented with a severe form of patellar instability due to trochlear dysplasia.

Keywords: Trochlear dysplasia, Trochleoplasty, MPFL- medial patellofemoral ligament, Sulcus-deepening trochleoplasty

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Introduction

Patellofemoral instability (PI) is a disabling condition that is mainly encountered in children, adolescents, and young adults. 75% of index patellar dislocations occur at 25 years or younger (1). In North America, the incidence of primary patellar dislocation is about 6 per 100,000, and peaks at the age of 10-17 year-olds at 21 per 100,000(2).

PI is associated with multiple risk factors including age, level of activity, patella alta, patella tilt, trochlear dysplasia, incompetent medial soft tissue structures especially medial patellofemoral ligament (MPFL) complex, and coronal and rotational plane malalignment (3)(4). However, trochlear dysplasia is the risk factor with the greatest association with recurrent PI (3,5,6).

For normal patellofemoral tracking and maintenance of patellar stability, a normal trochlear morphology is vital. Amiss et al demonstrated patellofemoral kinematics in normal knees. From the extension, the patella will engage the femoral trochlear groove at 20 degrees of flexion. For the remaining portion of knee flexion, the patella remains situated in the groove. The MPFL acts as the major restraint to lateral patellar translation from full extension through the initial 20-70^0 of knee flexion (7,8). With an inefficient MPFL, the forces necessary for subluxation of the patellar are low during the first 20° of flexion. A shallower trochlear groove reduced the force required for patellar displacement throughout the total range of motion of the knee to a similar extent as an incompetent MPFL (9).

The incidence of trochlear dysplasia among patients with patellar instability is between 85-96%(5). Trochleoplasty is indicated in a patient with high-grade trochlear dysplasia with patellar instability with absent patellofemoral arthritic changes and either previously corrected or absent coronal as well as rotational malalignment. The main objective of sulcus-deepening trochleoplasty is to restore the anatomy of the trochlear to avoid patellar instability, recurrent knee pain, and long-term patellofemoral osteoarthritis. Recurrence of patellofemoral instability after sulcus deepening trochleoplasty is rare, and most likely results from missed associated abnormalities (10).

We present a case report on an adolescent with chronic patellar instability due to high-grade trochlea dysplasia who underwent sulcus-deepening trochleoplasty through an arthrotomy.

Case presentation

Clinical presentation

A 15-year-old boy presented with chronic left patella instability with a recurrent subluxation in 2021. He had noted a few years back that the patella kept moving out of place. On presentation, the anterior knee was painful and interfered with activities of daily living, and prevented him from engaging in sports. Clinically, he was in good general condition. The left knee demonstrated abnormal patellar tracking (Figure 1) evidenced by a positive jumping J-sign and a positive apprehension test.

Diagnosis assessment

Lateral left knee radiographs (Figure 2) demonstrated patella alta (Insall-Salvati ratio of 2.0), a crossing sign, and type 3 trochlear dysplasia. An MRI (Figure 3) demonstrated a TT-TG distance of 12.2mm with a flat and incongruent trochlea with International Cartilage Repair Society [ICRS] grade 1. A Ct scan of the knee (Figure 4) demonstrated a cliff pattern of the distal femur on the axial cuts.

Figure 1. An image demonstrating Patella subluxation at 50^0 of knee flexion (blue bent-up arrow)

Figure 2. A lateral knee radiograph demonstrating a supratrochlear spur at the anterior aspect of the distal femoral physis (white arrow), and crossing sign (orange arrow) i.e., the deepest point of the trochlear sulcus.

Ethical consideration

Being a minor, informed consent was obtained from the mother as written authorization for the use and disclosure of his protected health information.

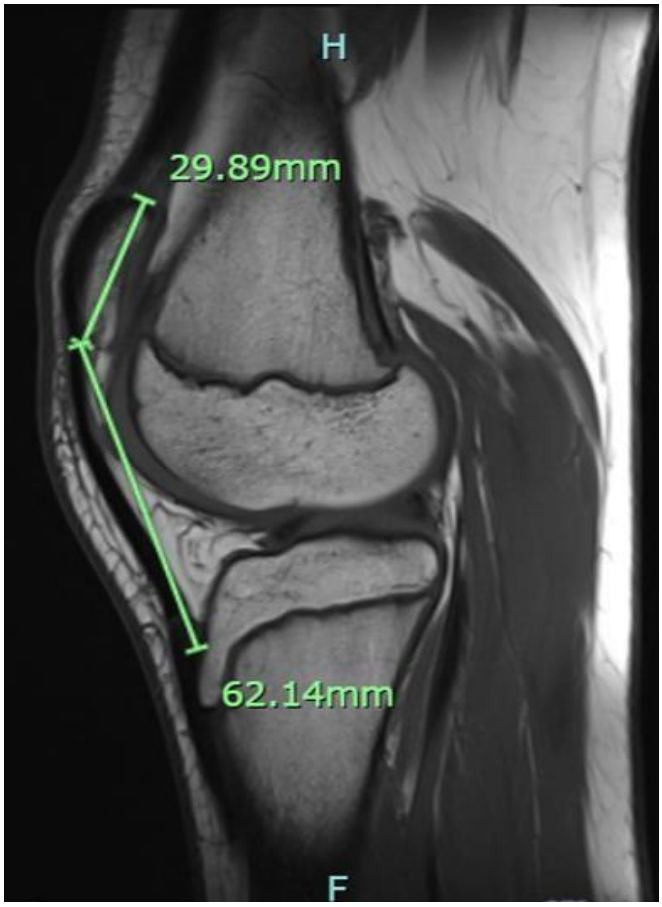

Figure 3. An MRI sagittal image showing patella alta with an insall-salvati ratio of 2.07 (62.14/29.98)

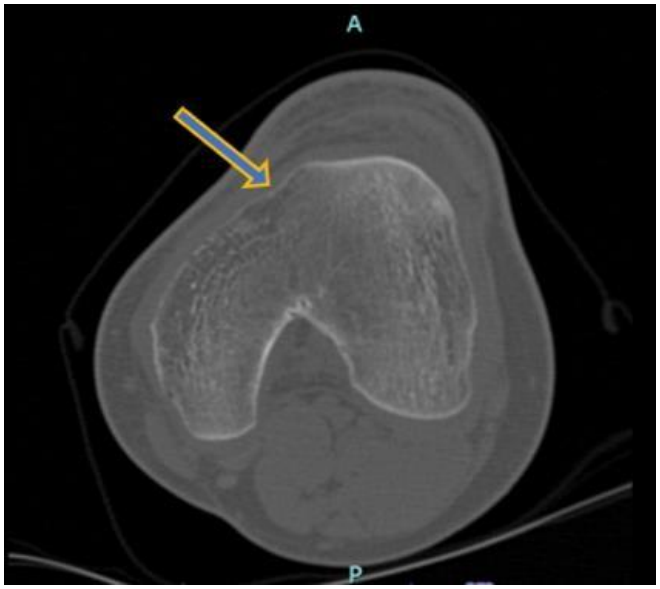

Figure 4. An axial Ct scan image showing a 'cliff pattern' i.e., a sharp convex separation between the medial and lateral facets due to medial femoral condyle hypoplasia (blue arrow with a golden accent)

Methodology

Management

The surgical procedure was a sulcus deepening trochleoplasty through a superolateral parapatellar arthrotomy (Figure 5) with associated Z-lengthening of the double layers of the lateral retinaculum. Once the anterior surface of the distal femur is exposed, an osteochondral flap (Figure 6) is elevated first with a number 23 blade and deepened with an osteotome, and subchondral bone is removed with the aid of curved curette to shape and reconstruct the trochlear groove.


Figure 5. A postsurgical image illustrating the superolateral parapatellar incision that was used. Flexion of the knee to 110^0 was achieved with patella tracking maintained within the trochlear

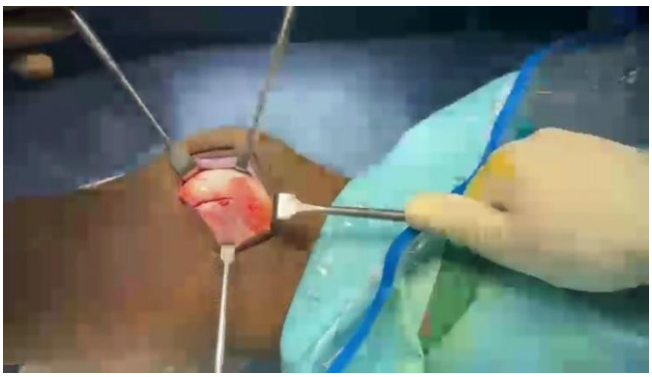
Figure 6. Demonstrates the peripheral osteotomy designed to raise the osteochondral flap

The sulcus aims to get a lateral inclination of about 20 degrees. The osteochondral flap is repositioned onto the distal femur with a deep trochlear groove reconstructed and held in place with vicryl sutures and suture anchors, first on the trochlear and then, laterally and medially to

secure the flap over the subchondral bone (Figure 7a). Once the fixation was done, patellar tracking was confirmed with a full range of knee motion after the medial patellofemoral ligament (MPFL) was reconstructed using a hamstring graft to add stability in extension.

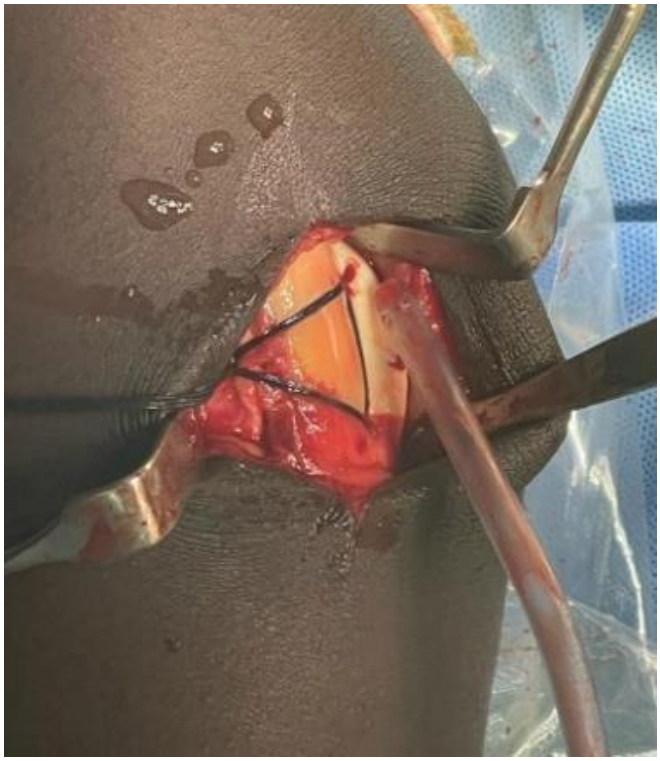

Figure 7 (a). Demonstrates the final reconstruction of the trochlear groove with 2 vicryl suture anchors distally and proximally to stabilize the osteochondral flap

Outcome and follow-up

Postoperatively, the knee was splinted in a range-of-motion knee brace for 6 weeks to protect the reconstruction. The rehabilitation entailed full weight bearing with crutches and tolerated range of motion exercises of the knee to 45 degrees in the first 2 weeks and increasing to 90 degrees thereafter to 6 weeks. Quadriceps strengthening exercises were started within the first week. By 4 weeks, he was weaned off crutches. At 6 weeks, his patellar tracking was great and without apprehension of dislocation. At 10 weeks postoperatively (Figures 7b and 7c), he had good knee function and no pain. He was followed up for 18 weeks and then 6 monthly for up to 1 year. The patient has been appreciative of the care given this far, due to patellofemoral stability and considers having the same surgery on the right side if it became as symptomatic as the left knee was.

Figure 7 (b)

Figure 7 (c)

Figures 7 (b) and (c) demonstrate good knee range of motion 10 months after the operation with no patella subluxation compared with figure 1 above.

Discussion

We present a case of an adolescent with long-standing left knee pain, increased episodes of recurrent patella subluxation as he grew up, and reduced range of motion,

coupled with an inability to engage in sports due to the increased frequency of painful subluxations. We categorized his pathology as Dejour Type D based on the presence of a flat trochlear, cliff pattern, supratrochlear spur, and double-contour sign. He had not responded to conservative management namely physiotherapy (quadriceps strengthening exercises) administered for several years. At the time of the presentation, his engagement in activities of daily living and sports was grossly restricted leading to a degree of emotional upset. The anatomical defects of the knee contribute to abnormal biomechanics with the left being more severe than the right. This is possibly a genetic variant as well described in the literature (11).

Patellofemoral instability is a condition that affects active young children, adolescents, and young adults (12). When unaddressed, recurrent PI can lead to patellofemoral chondral injuries, arthritis, and reduced knee function. As is the case in this patient, this translates to a negative impact on their quality of life and their ability to participate in recreative activities and sports (13) with adverse psychosocial consequences.

This is a good case to study as it demonstrates very clearly the importance of the morphologic bony architecture of the anterior compartment of the knee and their individual effects on joint biomechanics.

Trochleoplasty is a surgical procedure that aims at restoring a sulcus or creating a near-normal trochlear deep enough to accommodate the patellar in the trochlear groove, restoring patellofemoral congruence, patella tracking, and biomechanics during flexion and extension (14,15). This was demonstrated in theatre by the absence of the 'J'-sign. In addition to the sulcus trochleoplasty, MPFL reconstruction with gracilis autograft was performed. There are 3 main trochleoplasty techniques: lateral facet elevation; trochlear deepening; and recession wedge (16).

To perform trochleoplasty successfully, it is imperative to ensure certain requirements (15):

1. Ensure trochlear articular cartilage is normal or near normal (International Cartilage Repair Society grade 1 or 2). Overt patellofemoral arthritis and higher-grade cartilage degeneration are contraindications of Trochleoplasty in the setting of trochlear dysplasia.
2. Trochleoplasty requires additional corrective surgical procedures e.g., bony (tibial tubercle transfer or Fulkerson osteotomy) and soft tissue (vastus medialis obliquus [VMO] plasty, lateral release/lengthening, MPFL reconstruction)
3. There should be an absence of coronal and rotational limb malalignment

We confirmed that the articular cartilage was normal and that there was no coronal and rotational malalignment on the limb. An MPFL reconstruction was performed as the soft tissue surgery to act as a check rein.

The sulcus deepening trochleoplasty was favored in this case. It was first described by Bilton Polar in 1890, and later in 1978 Masse (17) described it. H. Dejour modified and popularized it (18). The procedure obliterates the prominent trochlear sulcus and creates a groove of sufficient depth. This is done by the removal of cancellous bone sufficient enough to have osteochondral flaps to create the trochlear groove. The osteochondral flaps are fixed at 2 points to re-create the trochlear sulcus with diverging facets from this central area.

Trochleoplasty is a complex procedure, which needs careful and thorough planning to avoid complications such as chondral damage, overcorrection, and recurrent patellofemoral instability (19). Good patient counseling and understanding of the intended outcome are vital before consenting to surgery. The surgeon has also to factor in the demanding surgery in terms of equipment and instruments needed which may not all be available and may need to be improvised. There should also be awareness of the risks of the surgery.

Trochlear dysplasia is not a common knee pathology but should be suspected in younger patients with recurrent patella subluxation. A systematic clinical assessment, and examination, coupled with X-rays and CT scan investigations, are vital in getting to a clear diagnosis. The condition can be very debilitating but to the deserving patient, the relief after surgery is a productive lifestyle with improved quality of life as was the case here.

Conclusion

Trochlear dysplasia is a debilitating cause of patellofemoral instability that affects the biomechanical relationship between the bony architecture and soft tissues. This case report is ably demonstrating how sulcus deepening trochleoplasty through the superolateral arthrotomy restores trochlear sulcus, and patellar tracking, and improves anterior knee pain associated with trochlear dysplasia It is a demanding procedure, but necessary with the aim to restore anterior knee biomechanics and prevents DJDs. There is a need for the surgeon to be careful and thorough to avoid complications such as chondral damage, overcorrection, and recurrent patellofemoral instability. It is both successful in the short- and long-term when done together with MPFL reconstruction, as in this case, the knee biomechanics is restored.

Ethical consideration

Informed consent was acquired from the patient for publication of the case report.

Author contributions

TKB led in conceptualization, funding acquisition, investigation, methodology, resources, supervision, validation and in the writing of the first draft while PGM contributed to data curation, visualization and reviewing and editing the original draft.

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