Trochlear Dysplasia and the Role of Trochleoplasty

Robert F. LaPrade, MD, PhD[a,b,*], Tyler R. Cram, MA, ATC, OTC[a], Evan W. James, BS[b], Matthew T. Rasmussen, BS[c]

KEYWORDS

• Patellar instability • Trochleoplasty • Trochlear dysplasia • Patellofemoral joint

KEY POINTS

- Patients with trochlear dysplasia frequently have recurrent patellar instability.
- Imaging is the most useful diagnostic technique for classifying trochlear morphology, assessing the severity of dysplasia, and assisting in preoperative planning.
- In many patients, a trochleoplasty permanently restores bony patellofemoral joint stability.
- A trochleoplasty is often performed alongside other patellar reconstruction procedures, including a medial patellofemoral ligament reconstruction or a tibial tubercle osteotomy.
- Patients with open physes or with advanced patellofemoral arthritis should not be considered candidates for a trochleoplasty.

INTRODUCTION

The incidence of primary patellar dislocation is estimated at 5.8 cases per 100,000 individuals.[1] In the at-risk population, which includes patients from 10 to 17 years of age, the incidence of patellar dislocation increases to 29 cases per 100,000 individuals. Recurrent dislocations reportedly occur in 17% of all cases following a primary dislocation event. After a second dislocation, the chance of additional dislocations increases to approximately 50%. For this reason, treatment is imperative for patients

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[a] The Steadman Clinic, 181 West Meadow Drive, Suite 400, Vail, CO 81657, USA; [b] Center for Outcomes-based Orthopaedic Research, Steadman Philippon Research Institute, 181 West Meadow Drive, Suite 1000, Vail, CO 81657, USA; [c] Department of BioMedical Engineering, Steadman, Philippon Research Institute, 181 West Meadow Drive, Suite 1000, Vail, CO 81657, USA
* Corresponding author. The Steadman Clinic, 181 West Meadow Drive, Suite 400, Vail, CO 81657.
E-mail address: drlaprade@sprivail.org

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who experience recurrent patellofemoral dislocations because symptoms often do not spontaneously resolve.

Chronic patellar instability is thought to have a multifactorial cause. In a normal patellofemoral joint, the combination of osseous stabilizers in the trochlea and medial soft tissue static stabilizers such as the medial patellofemoral ligament function to resist lateral patellar translation and to maintain patellofemoral stability. Patients with chronic instability routinely present with risk factors for recurrent dislocations, including trochlear dysplasia, patella alta, an increased tibial tubercle–trochlear groove (TT-TG) distance, and insufficiencies in the medial retinacular structures.[2]

Trochlear dysplasia is reportedly present in 85% of patients with patellar instability.[3] For patients with chronic instability secondary to trochlear dysplasia, the trochleoplasty procedure can be an effective treatment option to permanently restore stability.[4] This article highlights the basic anatomy and biomechanics of the patellofemoral joint, describes diagnostic imaging techniques to define and classify trochlear dysplasia, presents indications and the surgical technique for a sulcus-deepening trochleoplasty, and summarizes postsurgical outcomes.

NORMAL TROCHLEAR ANATOMY AND BIOMECHANICS

Anatomy

Normal trochlear bony anatomy confers many biomechanical advantages that contribute to patellofemoral joint stability. The trochlea is located on the anterodistal end of the femur and comprises medial and lateral facets and a central trochlear groove. The lateral facet is the larger of the two facets and extends further proximally.[5,6] The trochlear groove courses through the middle of the trochlea and divides the medial and lateral facets.[5,7] The trochlear groove deepens as it courses distally and its alignment deviates laterally with respect to the anatomic axis of the femoral shaft.[6,8,9] The mean angle of this lateral deviation has been reported to be 19° for cartilaginous surfaces and 16.8° for the osseous surfaces. This angle allows the tibiofemoral joint to be parallel with the ground when viewed in the coronal plane.[10,11] The sulcus angle, which reflects the depth of the trochlear groove, averages 138° ± 6° in a normal trochlea[7] and has been correlated with symptoms of patellofemoral instability.[12] Across the general population, the sulcus angle may vary considerably between individuals.[11]

Biomechanics

The trochlea functions as the counterpart to the patella in patellofemoral joint articulation. At first, as the knee transitions from full extension into flexion, the patella translates medially until the knee reaches 20° of flexion, at which point the patella engages the trochlear groove and translates an average of 11.5 mm laterally up to 90° of flexion.[13] The initial medial deflection of the patella into the trochlear groove is commonly referred to as the catching mechanism.[11] Laterally directed patellar tracking can be attributed to the normal off-axis valgus alignment of the trochlear groove relative to the femur.[13]

The patella is most susceptible to dislocation between 0° and 20° of flexion because of disengagement with the trochlea and a slack medial patellofemoral ligament restraint.[13] The dynamic traction force exerted by the quadriceps muscles is minimized in extension, which further contributes to patellar instability in this position. However, beyond 30° of flexion, the quadriceps are again able to exert a sufficient traction force to stabilize the patella within the trochlear groove.[11,14] In addition, in deep knee flexion, the patella becomes further stabilized to pathologic lateral displacement because of the posteriorly directed resultant force of the quadriceps muscles that ensures close contact with the lateral trochlear facet.[11,14]