Optimising Surgical Outcomes of Paediatric Chronic Patello-Femoral Joint Instability Cases: Utilising Gait Analysis Data and Planning Software to Guide Realignment Osteotomies

Emma Fossett, Damini Jha, Dimitris Karanikas, Arash Afsharpad

INTRODUCTION:

Patella mal-tracking refers to the incongruent movement of the patella against the trochlea groove during the gait cycle and as the knee joint cycles through flexion and extension. Patella mal-tracking is multi-factorial and complex, comprising of bony structural abnormalities, soft tissue abnormalities and muscular imbalance. Causes of patella mal-tracking include: patella alta, trochlea dysplasia, increased TT-TG (tibial tuberosity-trochlear groove) distance, compromised dynamic constraints (such as medial patello-femoral ligament (MPFL) injury), coronal plane deformities and torsional mal-alignment. Patella mal-tracking is an ever-increasing presentation in paediatric orthopaedics, particularly in the growing teenager, often resulting in decline in sporting abilities, withdrawal from sports and decreased quality of life. This study reviews the clinical outcomes of paediatric patients with patella mal-tracking, who underwent surgical management with lower limb osteotomies to restore normal patella tracking.

METHODS:

Paediatric patients ≤18 years who underwent lower limb de-rotation/realignment osteotomies for patella mal-tracking between 2020 and 2024, in a tertiary paediatric centre, were prospectively included in the study. All patients had undergone clinical assessment, plain radiographs, computed tomography (CT) rotational profiles and gait analysis. These were used to assess biomechanical abnormalities and plan surgical intervention. Electronic health records were used to retrieve demographic, radiographic, gait analysis and operative data.

Patient reported outcome measures were collected pre-operatively and 6 months post-operatively. The Paediatric International Knee Documentation Committee (Pedi- IKDC) score and Knee Injury and Osteoarthritis Outcome Score for Children (KOOS-Child LK2.0) and Visual Analog Pain Scale (VAPS) were used.

RESULTS:

42 patients (50 knees) were included with a mean age of 16 years. 7 patients had bilateral surgery. All osteotomies were de-rotation/realignment. 23 patients had double level osteotomies with tibial tuberosity transfers (TTT), 10 patients had single level osteotomies with TTT, seven patients had double level osteotomies alone, six patients had single level osteotomies with TTT, trochleoplasty and MPFL augmentation, two patients had single level osteotomies alone, one patient had double level osteotomies with TTT, trochleoplasty and MPFL augmentation and one patient had femoral osteotomy with roux-goldthwait procedure.

All patients had resolution of patella instability and all osteotomies successfully united.

The mean Pedi-IKDC score improve from 49.62% (SD16.20) pre-operatively to 83.38% (SD12.9) postoperatively ($p<0.00001$), whilst the mean KOOS-Child LK2.0 score improved from 49.66 (SD14.5) to 83.24 (SD14.6, $p<0.00001$).
The mean Quality of Life score improved from 39.32 (SD= 16.8) to 75.87 (SD= 15.26),. $p< 0.00001$. 56% of patients were able to commence high impact activities post-operatively, something that they previously were unable to do. 100% patients expressed satisfaction with their outcome.

DISCUSSION AND CONCLUSION:

Existing gait data shows that healthy individuals have a combined internal rotation of 10-15 degrees past neutral position of the greater trochanter, at the hip joint. This allows for optimal abductor muscles tension with minimal compromise of the abductor lever arm. Performing gait analysis prior to osteotomies enables the identification of subtle lower limb muscle weaknesses that might prevent or exaggerate rotational movement of the hip joint. During pre-operative planning, the de-rotation osteotomy is calculated so that if the distal femur is internally rotated an extra 10-15 degrees beyond neutral position of the GT, the foot will be pointing in a neutral position and the PFJ axial alignment is optimal. As a result, a combined rotation of 15 degrees for femur and tibia is planned and the PFJ alignment is further optimised through a tibial tuberosity transfer.

This study demonstrates that combining rotational and realignment osteotomies with a focus on optimising muscle activation, significantly improves the outcome of patella mal-tracking intervention.

This study has shown excellent clinical outcomes in the management of paediatric patients with patella mal-tracking, with de-rotation and realignment osteotomies and highlights coronal and torsional abnormalities as a cause for patella mal-tracking that should be addressed.

In conclusion, patients with atraumatic PFJ instability are more complex, given the multi-factorial nature of their condition. Given the lack of consensus for management of these patients in the paediatric population and absence of large volume case series, we advocate every patient is treated with an individualised treatment algorithm, addressing individual pathologies as best as possible with consideration of their unique biomechanics.