# REHABILITATION FOR A POST-TRAUMATIC PATELLA DISLOCATION IN A PATIENT WITH HIP DYSPLASIA – A CHALLENGING COMBINATION FOR A PHYSIOTHERAPIST

# RECUPERAREA MEDICALĂ ÎN LUXAȚIA DE ROTULĂ POST-TRAUMATICĂ LA UN PACIENT CU DISPLAZIE DE ȘOLD – O COMBINAȚIE DIFICILĂ PENTRU UN FIZIOTERAPEUT

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**Abstract**

*Introduction:* Hip dysplasia is a well-known cause of hip pain and dysfunction characterized by an increased mechanical load on the hip joint and soft tissues in this region. A common sign of atraumatic hip dysplasia is hyperlaxity caused by repetitive micro traumatic activities, genetic predisposition, or benign hypermobility syndrome. Patellar dislocation is a traumatic disruption of the patella from the femoral trochlear which can result in patellar instability, pain, recurrent dislocations, damage to the medial patellofemoral ligament, and patellofemoral osteoarthritis.

*Case presentation:* A 30-year-old male patient presents to our clinic with a history of patellar dislocation of the right knee after a traumatic event, a direct lateral blow by a car. After conducting a brief examination, we could observe that the patient revealed a painless dislocating hip issue on the right side, the peculiarity in the patient's medical history representing the justification of the study. The association between both pathologies limited exercise applicability of the rehabilitation protocol and, in order to follow the protocol's progressive stages, we adapted some of the weight-bearing exercises. The patient was asked to complete the Knee Injury and Osteoarthritis Outcome Score (KOOS) and the Hip disability and Osteoarthritis Outcome Score (HOOS) at the baseline of the first evaluation, and also after 1 and 2 months after beginning the rehabilitation program.

*Results:* After following The Gundersen Health System Rehabilitation Program and knee-hip targeted exercises to increase posterolateral hip musculature we obtained significant improvements in patient-reported outcomes (quality of life and pain) and functional performance (functionality, sports and recreational activities).

*Conclusion:* Our case highlights the importance of a thorough examination and proper rehabilitation program approach to ensure full recovery. Thus, we can appreciate that a rehabilitation program which addresses the patients' hip dysplasia could cause a considerable decrease in patella dislocation prevalence or recurrence. Using specific instruments as KOOS and HOOS questionnaires to assess patients' opinion about their social, physical, and

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associated problems helps us provide a better and more concise approach to conducting the rehabilitation program.

**Key words:** *patella dislocation; hip dysplasia; hyperlaxity; knee injury; hip injury*

**Rezumat**

*Introducere:* Displazia de șold este o cauză cunoscută a durerii locale și a disfuncției caracterizate printr-o creștere a încărcării mecanice pe articulația șoldului și pe țesuturile moi din această regiune. Un semn comun în displazia non-traumatică a șoldului este reprezentată de hiperlaxitatea cauzată de activități repetitive microtraumatice, predispoziția genetică sau de sindromul benign de hipermobilitate. Dislocarea patelară reprezintă deplasarea traumatică a patelei din trohleea femurală ceea ce determină instabilitate patelară, durere, dislocări recurente, deteriorarea ligamentului patelofemural medial, și artroză patelofemurală.

*Prezentarea cazului:* Un pacient de sex masculin în vârstă de 30 de ani se prezintă în cadrul clinicii noastre cu un istoric clinic de dislocare a rotulei drepte în urma unui incident traumatic, o lovitură din lateral cauzată de un accident rutier. În urma unei evaluări succinte, am observat că pacientul prezenta și o dislocare nedureroasă a șoldului drept, particularitatea istoricului medical reprezentând motivația studiului. Asocierea dintre cele două patologii a limitat aplicabilitatea exercițiilor fizice din protocolul de recuperare și, pentru a urma etapele progresive ale protocolului, am adaptat unele dintre exercițiile cu încărcarea greutății corporale. Pacientul a fost rugat să completeze chestionarul Knee Injury and Osteoarthritis Outcome Score (KOOS) și Hip disability and Osteoarthritis Outcome Score (HOOS) la prima evaluare și de asemenea după 1 și 2 luni de la începerea programului de recuperare.

*Rezultate:* în urma aplicării programului de recuperare The Gundersen Health System și a exercițiilor specifice pentru dezvoltarea musculaturii posterolaterale a șoldului am obținut îmbunătățiri semnificative în rezultatele raportate de către pacient (cu privire la calitatea vieții și nivelul durerii) și performanța funcțională (funcționalitate, sporturi și activități recreative).

*Concluzie:* Acest caz evidențiază importanța unei examinări amănunțite și o abordare adecvată a unui program de recuperare pentru a asigura o recuperare completă. Astfel, putem aprecia că un program de recuperare care se adresează pacienților cu displazie de șold poate favoriza o scădere considerabilă a prevalenței și recurenței dislocării patelare. Folosind instrumente specifice precum chestionarele KOOS și HOOS pentru a evalua opinia pacienților cu referire la probleme lor sociale, fizice și asociate, ne poate oferi o abordare mai potrivită și mai concisă în elaborarea programului de recuperare.

**Cuvinte cheie:** *luxație de rotulă; displazie de șold; hiperlaxitate; traumatism al genunchiului; traumatism al șoldului*

## Introduction

Hip dysplasia, a well-known cause of hip pain and dysfunction is an orthopedic disorder characterized by an increased mechanical load on the hip joint and soft tissues in this region due to

a shallow coverage of the acetabulum [1, 2]. Hip dysplasia is more likely to occur during infancy, but it is also often discovered in adolescence or adulthood under the medical term "acetabular dysplasia" due to a shallow socket, the acetabulum, which does not support the ball, namely the femoral head. Poor congruency in the hip socket may increase stress on the labrum [3]. The acetabular labrum role in hip biomechanicsis to retain a layer of pressurized intra-articular fluid essential in load support, distribution, and stabilization against distractive forces in the hip joint and to better lubricate the joint [4, 5]. During hip dysplasia, the labrum is exposed to 10 times the normal load [5], which exposes it to increased stress and leads to labral hypertrophy [1], degeneration, and tearing [5]. Most common structures implicated in the appearance of hip pain in patients with hip dysplasia are associated with degeneration and hypertrophy of the labrum and the ligamentum teres, increased stress in the cartilaginous surfaces [6], and a decreased function of the muscles surrounding the hip joint which participate in load transfer and hip stability [7]. A common sign of atraumatic hip dysplasia is hyperlaxity caused by repetitive microtraumatic activities (in sports like ballet or gymnastics), genetic predisposition, or benign hypermobility syndrome [8].

Patellar dislocation is a traumatic disruption of the patella from the femoral trochlear, sometimes referred to as primary patellar dislocation, which can result in patellar instability, pain, recurrent dislocations [9, 10], damage to the medial patellofemoral ligament [11], and patellofemoral osteoarthritis. It is considered the second most seen cause of knee hemarthrosis [12, 13]. Primary and recurrent patellar dislocations can be caused by predisposing factors as hyperlaxity of the knee ligaments, increased femoral anteversion, vastus medialis muscle hypotrophy, or genu valgus.

**Case study**

A 30-year-old male patient presents to our clinic with a history of patellar dislocation of the right knee after a traumatic event, a direct lateral blow by a car. After the incident, the patient was taken to the emergency room at the County Hospital of Timisoara, where the doctors applied a long-leg cylinder cast with the recommendations to keep the cast for four weeks. The patient did not have a history of prior knee injury, surgery, or instability. After the removal of the cast, the patient continued to use a knee brace to help stabilize the kneecap. We conducted a brief physical examination and noticed that there was moderate effusion around the knee joint, tightness on the lateral retinaculum, tenderness along the iliotibial band, moderate atrophy of the quadriceps muscle, extension deficiency (knee blocked in flexion at about 10°) and passive knee flexion limited at 80°. During the adjoining joints' evaluation, we could observe that the patient revealed a painless dislocating hip issue on the right side when conducting passive knee and hip flexion (beyond 30-40°) in supine position. When assessing the patient from standing the lower limb posture presented overpronation at the feet level (more visible at the hind foot in the right leg than the left). Altered biomechanics have been observed during gait analysis showing a limping pattern with an external tibial torsion and overpronation more visible in the right leg as the patient was out-toeing during walking on a flat surface. The patient stated that he had increased pain with prolonged standing and difficulties when climbing/descending stairs.

An MRI conducted on the 9$^{th}$ of February 2021 stated that there was intra-articular hematic build-up as well as around the patellar bursae, a lateral subluxation of the patella, anosteochondral fracture on the medial condyle of the femur, osseous edema, a millimetric bone fragment

detachment, medial patellar retinaculum avulsion in the patellar insertion, and mild edema at the insertion of the patellar tendon. At the beginning of the rehabilitation program the patient was using crutches and a knee brace.

The peculiarity in the patient's medical history, which described a hip dysplasia on the same side as the affected knee, represented the justification of this study. The association between both pathologies limited exercise applicability of the rehabilitation protocol that we use for patellar dislocations; to follow the protocol's progressive stages, we adapted some of the weight-bearing (closed kinetic chain and open kinetic chain) exercises.

The patient signed an informed consent regarding his participation in this study.

The patient was asked to complete the Knee Injury and Osteoarthritis Outcome Score [14] and the Hip disability and Osteoarthritis Outcome Score [15]. The Knee injury and Osteoarthritis Outcome Score (KOOS) was developed in the 1990s to evaluate the patients' knee symptoms and functionality. KOOS questionnaire consists of 5 subscales regarding pain, other symptoms, functionality in daily living, sports and recreation, and knee related quality of life [14, 16]. The Hip disability and Osteoarthritis Outcome Score (HOOS) assesses patients' hip symptoms and functionality according to their opinion in cases with or without osteoarthritis and consists of 5 subscales, just like KOOS. Both questionnaires can be used on a weekly or even yearly basis; a normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) is calculated for each subscale for both questionnaires. We also conducted a general hypermobility test using the 9-point Beighton score [17, 18] in which a maximum score for ligament laxity is 9 and a score of 0 is tight. Our patient scored 5 out of 9, which indicates a generalized hypermobility of the joints.

The treatment plan was conducted in a conservative manner following objectives such as resolution of pain, swelling and inflammation, recovery of joint motion and flexibility, recovery of muscle strength, improve proprioception, motor patterns and coordination, and eventually return to sport activity.

As rehabilitation protocol we followed The Gundersen Health System Rehabilitation Program [19], which is an evidence-based and soft tissue healing dependent program. Following clinical practice guidelines recommended by Willy et al. (2019) [20], we also focused on including combined hip-knee targeted exercises as increasing strength on the posterolateral hip musculature in order to improve patient-reported outcomes and functional performance.

Knee rehabilitation protocol (Table I) was described to the patient and structured on 6-8 weeks treatment plan. In the first 2 weeks, the primary objectives were to minimize knee joint effusion and to increase knee range of motion per tolerance. In this phase, the strength exercise program included quad sets, hip abduction with resistance from side-lying position to increase strength in the gluteal muscles, calf raises and balance exercises (standing on the affected leg) with wall/chair support. A significant aim of this phase was the normalization of gait pattern. In the second phase (weeks 2-4), the primary objectives were to return to full range of motion, and improve muscle strength, endurance and balance. The patient regained full weight-bearing normalized gait pattern by the 3$^{rd}$ week. In the last phase (4+ weeks),our major goals followed exercises which promoted muscle strength, endurance, balance activities, single leg stance progressions and cuing the patient to regain proper running pattern and reduce hip adduction while running.

Table I. Rehabilitation program [19]

| Rehabilitation phase | Goals | Exercises |
|---|---|---|
| *0-2 weeks* (acute phase) | - Normalize gait pattern;<br>- Minimize joint effusion;<br>- Increase ROM per tolerance;<br>- Therapeutic exercises for strengthening, stretching and balance;<br>- Improve and increase quadriceps function; | - Emphasis on return to full knee extension: prone hang exercise;<br>- Restore quadriceps strength: single leg raises in all planes (with 1kg ankle weights, progressing to 1.5 kg by 2nd week);<br>- Weight transfer exercises on single leg stance to challenge unilateral balance/proprioception and partial wall-squats bilateral and unilateral on the affected leg;<br>- Flexibility and strengthening exercises for hamstrings (leg curls) and triceps surae muscle;<br>- Multi-angle isometrics for quadriceps, hamstrings and iliopsoas (with resistance band);<br>- Side-lying exercises to increase hip rotator muscles strength: clam shell exercises progressions and variations (with resistance band and/or ankle weights). |
| *2-4 weeks* (minimal protective phase) | - Regain full range of motion;<br>- Increase muscle strength and endurance;<br>- Improve single leg balance; | - Stretching exercises to promote full ROM using wall bars to support the affected leg;<br>- Progression of strengthening exercises in closed kinetic chain: sumo squats (to avoid dislocating hip), partial lunges (with front leg supported on a stepper), hip thrusts (with resistance band above knees and hip externally rotated);<br>- Balance and proprioception exercise: star excursion balance exercise using sliders, on flat surface and on balance board;<br>- Standing glute exercises progressions and variations in closed and open kinetic chain (clam shells and fire hydrants with resistance band around ankles and/or above knees). |
| *4-8 weeks* (return to sport activity) | - Progression to improve muscle strength, endurance and balance; | - Closed and open kinetic chain exercises to increase single leg strengthening: multiple directions lunges (with resistance band above knees), from partial squats to sumo squats (with resistance band above knees), step-ups variations (on flat surface and on wobble board);<br>- Running progression – acceleration and deceleration, controlled change of direction, and basic agility drills (figure eight, carioca and shuttle run);<br>- Impact activities started by 6th week – plyometric exercises (double and single leg directional hops on flat, even surface, 90° to 180° jump, and series jumping from/on height) (patient presented >75% strength compared to the unaffected leg). |

In the acute phase, the patient exercised without knee brace, but continued wearing it throughout the day and night. Gait pattern without crutches was encouraged under supervision with progression to use 1 crutch by the end of 1st week and no crutches by the end of 2nd week. During exercises which promoted knee flexion patient was advised to be aware of his hip dislocation.

In the second phase of the program the patient continued to use the knee brace for long distance walks or prolonged standing daily activities; during all exercises in standing (closed and open kinetic chain manner), the patient was advised to control hip flexion in order to avoid dislocating the hip.

After 4 weeks into the rehabilitation program we used kinesiotaping during impact exercises to stabilize the knee instead of the knee brace.

By the 8th week of the program we conducted a functional testing consisting of 5 items: balance, single hop in place, triple forward hop, jump/land, and single leg squat. The patient did not have any pain during testing and performed all movements with good control and balance (in all

planes of movement), no knee valgus in landing technique, and good trunk stability at contact with the floor. Only during single leg squat, when on the right leg, we did observe a painless mild dislocation of the hip at hip flexion past 60°.

**Results**

In order to assess and measure the outcomes of the individualized exercise protocol which we used with our patient, we analyzed the results of both KOOS and HOOS questionnaires. At the beginning of the rehabilitation program our patient presented a score of 15% after completing the KOOS questionnaire and a score of 89.4% after completing the HOOS questionnaire. After 1 month of individualized exercise protocol for the knee and hip, the patient presented significant improvement in both questionnaires scoring a high of 66% for the KOOS and 95% for the HOOS questionnaire; after 2 months both scores reached a high of 91.1%, respectively 98.1% (Figure 1).

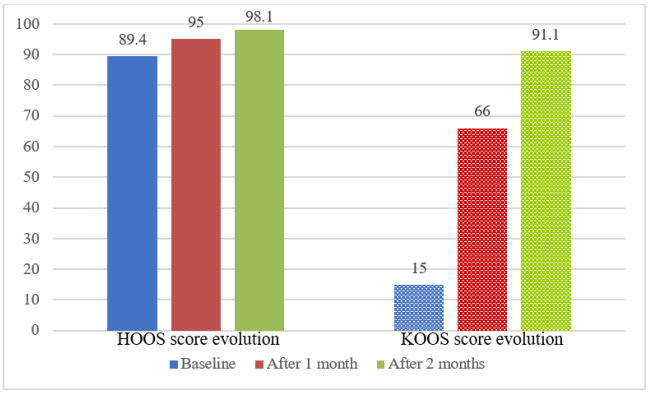


Figure 1. Evolution of KOOS and HOOS at baseline, after 1 month and 2 months of rehabilitation

Between February 22nd (at baseline) and after 2 months, significant improvements were noticed in the quality of life subscale and functionality, and sports and recreational activities subscale for the knee injury, both of them having improved by about 75%, respectively 85%. Pain and symptoms have subsided, and daily living activities improved significantly between baseline evaluation and the evaluation conducted after 2 months (Figure 2).

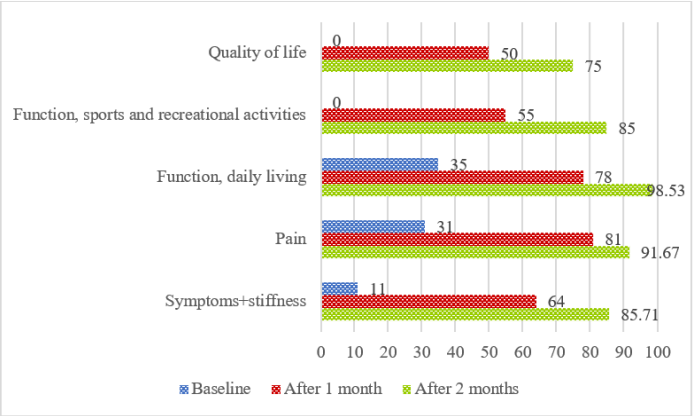


Figure 2. Subscales evolution for Knee injury and Osteoarthritis Outcome Score (KOOS)

Significant improvements were observed regarding the functionality, sports and recreational activities, and quality of life subscales between the first evaluation and after 2 months for the hip (Figure 3).

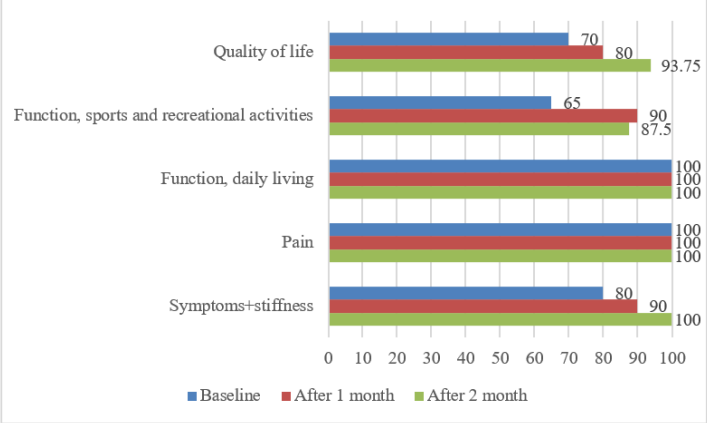


Figure 3. Subscales evolution for Hip disability and Osteoarthritis Outcome Score (HOOS)

**Discussions**

Li et al. (2013)[21] demonstrated in a study conducted on 75 patients with hip dysplasia that there are structural and biomechanical changes in their knees; it has been proven that the anterior femoral condylar angle of the femur and the groove angle was increased, and the trochlear groove was shallower in these patients. The lateral patella shift was also reduced, and the patellar tilt angle was increased in patients with dislocated hips compared with patients with normal hips. The authors observed that the extent of the mentioned changes differed with the degree of dislocation. Hu et al. (2019) [22] have also found patella alignment abnormality in 138 patients with developmental dysplasia of the hip; these patients' patellar instability was correlated with a more significant valgus angle of the lower limbs, a higher femoral neck torsion angle, quadriceps angle, and sulcus angle. In this context, even if the presented patient's patella dislocation was one of traumatic etiology, we must note that hip dysplasia may be a predisposing factor for such pathology of the knee.

We consider that a noticeable fact that made the rehabilitation easier and functionality improve for the patient was the hypermobility score that the patient presents, but at the same time, looking at the findings by Enix et al. (2015) [11], a predisposing factor in patients with a higher risk of patellar dislocations occurrence is hypermobility, especially in the knee region, as well as a mal-positioning of the patella.

Depending on the MRI findings and the evaluation of the supporting structures of the knee, after a displaced patella is reduced, a period of immobilization is preferred in a cast. A study conducted by Mäenpää and Lehto (1997) [23] suggested that by limiting the period of immobilization to three weeks, they could avoid and reduce muscle atrophy, knee joint restrictions, and retro-patellar crepitation. Although our patient was immobilized for four weeks in a long-leg cylinder cast and presented moderate muscle atrophy, especially on the quadriceps muscle (a difference of 2.5 cm between both thighs at the baseline evaluation), after two months from the baseline evaluation when measuring the thigh at the proximal third, we observed only a 1.5 cm difference between limbs. Several studies conducted by Powers et al. (2003) [24], Sillanpää and Mäenpää (2012) [25], and Van Gemert et al. (2012) [26] that followed patients with patellar

dislocations cases, show return to full activity 8-12 weeks from the time of injury. When assessing the patient after eight weeks from the baseline evaluation, the KOOS score improved significantly, especially regarding function and daily activities subscale (from 35% to 98.53%) and functionality, sports and recreational activities (from 0 to 85%).

**Conclusions**

Our case highlights the importance of conducting a brief examination in order to elaborate the rehabilitation program approach and to ensure full recovery and a secondary prevention program.

Conducting a thorough clinical examination and discussing the patient's medical history is essential in creating an individualized exercise protocol. We followed clinical practice guidelines recommended for the pathology and diagnosis accordingly, but clinical outcomes as per the examination required minor modifications and variations of the protocol exercises. Thus, we can appreciate that a rehabilitation program which addresses the patients' hip dysplasia could cause a considerable decrease in patella dislocation prevalence or recurrence.

Using specific instruments as KOOS and HOOS questionnaires to assess patients' opinion about their social, physical, and associated problems helps us provide a better and more concise approach to conduct the rehabilitation program.

**References**

[1] Lewis, C. L., Khuu, A., & Marinko, L. N. (2015). Postural correction reduces hip pain in adult with acetabular dysplasia: A case report. *Manual Therapy*, *20*(3), 508–512.

[2] Mortensen, L., Schultz, J., Elsner, A., Jakobsen, S. S., Søballe, K., Jacobsen, J. S., Kierkegaard, S., Dalgas, U., & Mechlenburg, I. (2018). Progressive resistance training in patients with hip dysplasia: A feasibility study. *Journal of Rehabilitation Medicine*, *50*(8), 751–758

[3] Jacobsen, J. S., Bolvig, L., Hölmich, P., Thorborg, K., Jakobsen, S. S., Søballe, K., & Mechlenburg, I. (2018). Muscle–tendon-related abnormalities detected by ultrasonography are common in symptomatic hip dysplasia. *Archives of Orthopaedic and Trauma Surgery*, *138*(8), 1059–1067

[4] Bsat, S., Frei, H., & Beaulé, P. E. (2016). The acetabular labrum: A review of its function. *Bone and Joint Journal*, *98-B*(6), 730–735

[5] Garabekyan, T., Ashwell, Z., Chadayammuri, V., Jesse, M. K., Pascual-Garrido, C., Petersen, B., & Mei-Dan, O. (2016). Lateral acetabular coverage predicts the size of the hip labrum. *American Journal of Sports Medicine*, *44*(6), 1582–1589

[6] Ross, J. R., Zaltz, I., Nepple, J. J., Schoenecker, P. L., & Clohisy, J. C. (2011). Arthroscopic Disease Classification and Interventions as an Adjunct in the Treatment of Acetabular Dysplasia. *American Journal of Sports Medicine*, *39*(1_suppl), 72S-78S

[7] Dumont, G. D. (2016). Hip Instability: Current Concepts and Treatment Options. *Clinics in Sports Medicine*, *35*(3), 435–447

[8] Johannsen, A. M., Behn, A. W., Shibata, K., Ejnisman, L., Thio, T., & Safran, M. R. (2019). The Role of Anterior Capsular Laxity in Hip Microinstability: A Novel Biomechanical Model. *American Journal of Sports Medicine*, *47*(5), 1151–1158

[9] Smith, T. O., Chester, R., Cross, J., Hunt, N., Clark, A., & Donell, S. T. (2015). Rehabilitation following first-time patellar dislocation: A randomised controlled trial of purported vastus medialis obliquus muscle versus general quadriceps strengthening exercises. *Knee*, *22*(4), 313–320

[10] Stefancin, J. J., & Parker, R. D. (2007). First-time traumatic patellar dislocation: A systematic review. *Clinical Orthopaedics and Related Research*, *455*, 93–101

[11] Enix, D. E., Sudkamp, K., Scali, F., Keating, R., & Welk, A. (2015). Management of Acute Patellar Dislocation: A Case Report. *Journal of Chiropractic Medicine*, *14*(3), 212–219

[12] Buchner, M., Baudendistel, B., Sabo, D., & Schmitt, H. (2005). Acute Traumatic Primary Patellar Dislocation Long-Term Results Comparing Conservative and Surgical Treatment Conclusions: Even with a focus on acute traumatic etiology and. *Clin J Sport Med*, *15*(2), 62–66

[13] Tsai, C. H., Hsu, C. J., Hung, C. H., & Hsu, H. C. (2012). Primary traumatic patellar dislocation. *Journal of Orthopaedic Surgery and Research*, *7*(1), 1–6

[14] Roos, E. M., & Lohmander, L. S. (2003). Health and Quality of Life Outcomes The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis The Knee injury and Osteoarthritis Outcome Score (KOOS). *Health and Quality of Life Outcomes*, *1*(64), 1–8

[15] Klassbo, M., Larsson, E., & Mannevik, E. (2008). Hip disability and osteoarthritis outcome score. *BMC Musculoskeletal Disorders*, *May*, 1–7.

[16] Roos, E. M., & Toksvig-Larsen, S. (2003). *KOOS validation WOMAC TKRA-BMC-03.pdf*. *10*, 1–10.

[17] Cooper, D. J., Scammell, B. E., Batt, M. E., & Palmer, D. (2018). Development and validation of self-reported line drawings of the modified Beighton score for the assessment of generalised joint hypermobility. *BMC Medical Research Methodology*, *18*(1), 1–8

[18] Naal, F. D., Hatzung, G., Müller, A., Impellizzeri, F., & Leunig, M. (2014). Validation of a self-reported Beighton score to assess hypermobility in patients with femoroacetabular impingement. *International Orthopaedics*, *38*(11), 2245–2250

[19] Gundersen Health System (2021, March 22). *Patellofemoral Dislocation Rehabilitation Program – Accelerated.* https://www.gundersenhealth.org/app/files/public/e72f2a70-b6c7-4aa0-81d1-478532d17d2d/Sports-Medicine-Protocol-Patellofemoral-Dislocation-Accelerated.pdf

[20] Willy, R. W., Hoglund, L. T., Barton, C. J., Bolgla, L. A., Scalzitti, D. A., Logerstedt, D. S., Lynch, A. D., Snyder-Mackler, L., & McDonough, C. M. (2019). Patellofemoral pain clinical practice guidelines linked to the international classification of functioning, disability and health from the academy of orthopaedic physical therapy of the American physical therapy association. *Journal of Orthopaedic and Sports Physical Therapy*, *49*(9), CPG1–CPG95

[21] Li, H., Qu, X., Wang, Y., Dai, K., & Zhu, Z. (2013). Morphological analysis of the knee joint in patients with hip dysplasia. *Knee Surgery, Sports Traumatology, Arthroscopy*, *21*(9), 2081–2088

[22] Hu, B., Sang, L., Gao, D., Wu, Y., Zhang, H., & Luo, D. (2019). Patella alignment

abnormality in patients with developmental dysplasia of the hip. *Journal of Orthopaedic Surgery*, *27*(2), 1–7

[23] Mäenpää, H., & Lehto, M. U. K. (1997). Patellar dislocation. The long-term results of nonoperative management in 100 patients. *American Journal of Sports Medicine*, *25*(2), 213–217

[24] Powers, C. M., Ward, S. R., Fredericson, M., Guillet, M., & Shellock, F. G. (2003). Patellofemoral Kinematics during Weight-Bearing and Non-Weight-Bearing Knee Extension in Persons with Lateral Subluxation of the Patella: A Preliminary Study. *Journal of Orthopaedic and Sports Physical Therapy*, *33*(11), 677–685

[25] Sillanpää, P. J., & Mäenpää, H. M. (2012). First-time patellar dislocation: Surgery or conservative treatment? *Sports Medicine and Arthroscopy Review*, *20*(3), 128–135

[26] Van Gemert, J. P., De Vree, L. M., Hessels, R. A. P. A., & Gaakeer, M. I. (2012). Patellar dislocation: Cylinder cast, splint or brace? An evidence-based review of the literature. *International Journal of Emergency Medicine*, *5*(1)