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Case Report

Bilateral Patella Cartilage Debridement and Exercise Rehabilitation for Chondromalacia and Plica Syndrome: A Case Report

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Abstract: A 41-year-old active (exercising >600 min per week) male without a surgical history complained of nine years of intermittent bilateral anterior knee pain after physical activity. He was diagnosed with bilateral chondromalacia (grade IV chondrosis) with plica syndrome, for which he underwent bilateral patella cartilage debridement with medial plica excision (additional removal of lateral retinaculum in the right knee). The patient then performed 12 weeks of an aggressive postoperative rehabilitation program. Each rehabilitation session consisted of disinhibitory modalities (sensory level of transcutaneous electrical stimulation and cryotherapy: focal knee joint cooling and cold-water immersion) and voluntary exercises (aerobic, resistance, and flexibility). During rehabilitation, pain perception, knee joint skin temperature and circumference, and functional outcome measures (Kujala anterior knee pain scale, International Knee Documentation Committee Score, and lower-extremity functional scale) were also recorded. While the patient's pathology and surgical intervention were not extreme, progressions in the rehabilitation components and functional outcome measures in this clinical case could be used as a future reference for postoperative interventions. Additionally, surgery-induced inflammation seemed to last for four weeks.

Keywords: patellofemoral chondrosis; disinhibitory modalities; surgery-related inflammation

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1. Introduction

Chondromalacia is defined as softening and destruction of the patellar cartilage that can be caused either by overuse (microtrauma), retinacular tightness, abnormal patellar positioning, abnormal Q-angle, quadriceps weakness or imbalance, or in combination [1,2]. Plica syndrome is a condition in which synovial plica within the joint capsule at the patellofemoral joint becomes irritated, inflamed, and thickened [3]. Repetitive knee movement and direct trauma are considered the mechanisms of injury [4]. Generally, non-surgical treatment is first attempted for both pathologies, and symptom relief along with strengthening of the quadriceps and other lower-extremity muscles are the main course of conservative treatment [5]. Corticosteroid injections [6] and nonsteroidal anti-inflammatory drugs [7] are often administered as well. If conservative treatment fails, surgical treatment via arthroscopy is performed. We present a case of chondromalacia with medial plica syndrome in a patient who underwent bilateral arthroscopy followed by an aggressive postoperative rehabilitation program.

While the surgical procedures for patients with these pathological conditions are common, the purpose of this study was to report progressions in a 12-week rehabilitation program and changes in postoperative inflammatory response. The results of this study on progressions of functional outcomes and related rehabilitation components such as external loads in resistance exercise and knee flexion range of motion (ROM) would provide future clinical guidelines for patients who underwent similar surgical interventions due to chondromalacia and plica syndrome. This case study also provided new information on change in surgery-related inflammatory response (pain perception, girth measurement, and skin temperature of the knee joint). The institutional review board approved the clinical interventions for the study. The patient gave written informed consent.

2. Case Report

A 41-year-old, active male (177 cm; 74 kg) with no history of past musculoskeletal surgery complained of bilateral anterior knee pain (AKP) for the previous nine years. He had participated in various physical activities: swimming and soccer in middle school (20 months from the age of 13 to 14). In college, he majored in exercise science and played handball (46 months from the ages of 18 to 19 and 22 to 23). After graduating from college, he worked as a physical education teacher and physical activity instructor at a secondary school (24 months from the age of 24 to 25). Afterwards, he had been employed as an administrative assistant. As his new position was not physically demanding, he enjoyed running, weightlifting, tennis, badminton, and baseball in his free times (high intensity and frequency). When his AKP was tolerable (e.g., <3 out of 10 in numeric pain rating scale: NPRS) when attempting to run and jump, he had maintained a high volume of vigorous physical activity (>600 min per week). In addition to knee pain, the patient had a past medical history of taking Naproxen/Esomeprazole for a month due to low back pain at 37. The patient smoked for four years in his early 20s and consumed alcohol once or twice a month. No additional medical conditions were reported. One day, he felt severe right AKP (>5: NPRS) after playing tennis. The patient sought medical attention because of discomfort and swelling at the knee joint that impaired his daily activities.

On initial presentation (performed by an orthopedic surgeon), there was no joint effusion (circumference on both sides: 32 cm measured at the inferior pole of the patella using a tape measure), and knee flexion range of motion (ROM) was within the normal limit (right: 131°, left: 130°; measured using a plastic goniometer). Manual muscle testing of knee extension [8] revealed right and left side strength of 4+/5 and 5/5, respectively. No neurological symptoms (sensation and reflex alterations) [9] were noted, and the special tests [10] related to the knee joint (Lachman's, anterior and posterior drawer, Apley compression/distraction, valgus/varus, and patellar grind test) were negative. After magnetic resonance imaging (Figure 1A,C: Discovery MR750, New York, NY, USA) was taken, bilateral chondromalacia (grade IV chondrosis) with plica syndrome (Figure 1B,D: ConMed Linvatec video system, Largo, FL, USA) was diagnosed.

Two months after the initial evaluation, the patient underwent bilateral arthroscopic knee surgery. Chondromalacia of the medial aspect of the patella, trochlear groove of the femur, and thickened medial plica were first examined. Bilateral debridement was performed to remove articular cartilage from the patella and trochlear groove. Finally, resection of the medial synovial plica was completed using a motorized shaver and basket punch (ConMed Linvatec, Largo, FL, USA). The lateral retinaculum in the right knee was also removed (Figure 1E,F).

One day after surgery, the patient began 12 weeks of intense exercise rehabilitation (Table 1 and Figures 2 and 3). Celecoxib was administered for postoperative pain relief. Three weeks later, at the patient's request, Naproxen/Esomeprazole was prescribed due to low back pain. At each rehabilitation session, the patient received 30 min of disinhibitory modalities (either two channels of sensory transcutaneous electrical nerve stimulation (TENS) [11], knee joint cooling [12] using an ice bag on the patella, or both) prior to performing resistance exercises for the previously suggested "open, then exploit" strategy [13]. When available, cold-water immersion (water temperature less than 20 °C; immersed up to the iliac crest) was applied for postexercise recovery. The external loads (kg) used for knee extension and leg press exercises were determined by the daily adjustable progressive repetitive exercise (DAPRE) technique [14]. Specifically, if the number of repetitions exceeded 7 in any set, working load was added (increments of 10 kg) at the next session. The exercise volumes and external loads for other resistance exercises ranged between body mass and 25 kg (Table 1). Initially, the patient performed an aerobic exercise on a stationary bike, which was also aimed at improving knee flexion angle. Once a knee flexion angle was recovered by 90% of the preoperative level, the patient performed a treadmill jog. Due to the association of hip joint flexibility and knee pain [15], static stretch (especially on hip joint flexion and extension) was performed as a cool-down strategy.

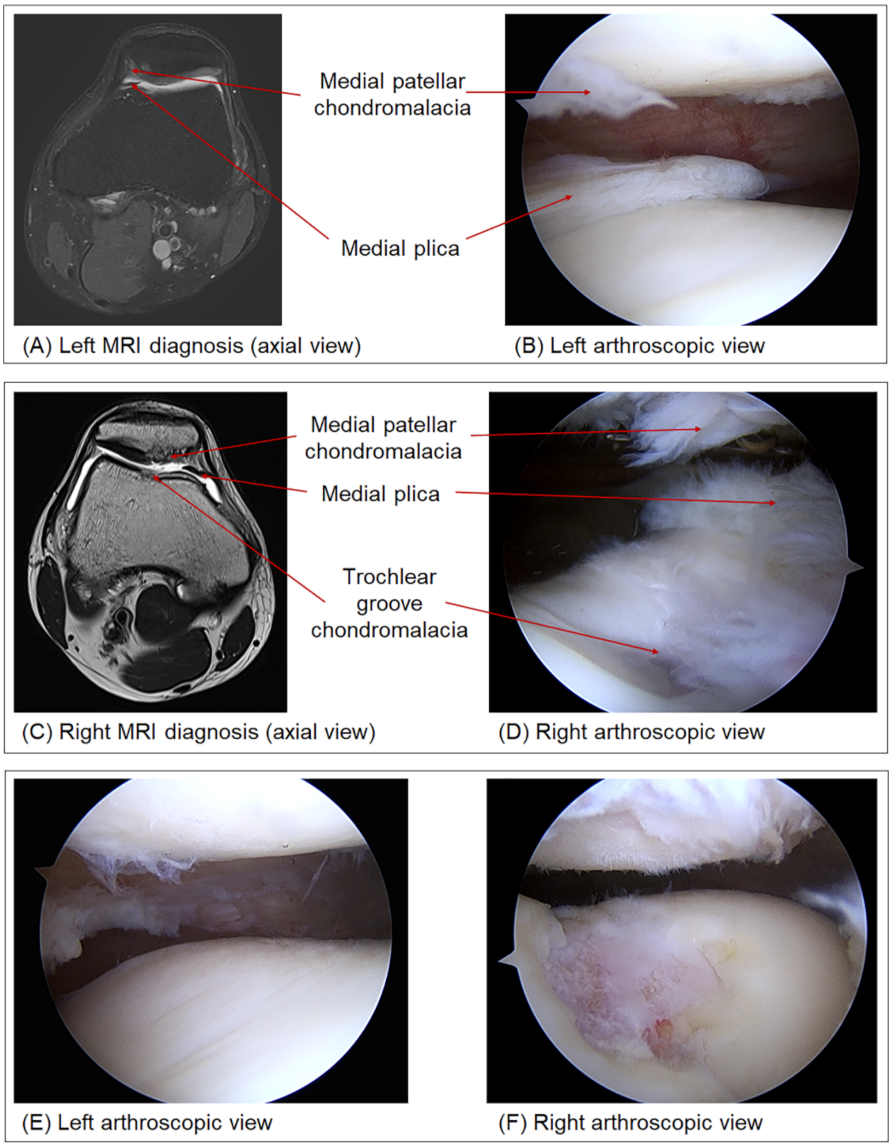

Figure 1. Magnetic resonance images for diagnosis (left: (**A**); right: (**C**)) and arthroscopy images (**B**,**D**–**F**). Note that (**E**,**F**) are images obtained after surgery.

Table 1. Summary of postoperative interventions.

Treatments	Parameters
NSAIDs	• Celecoxib 200 mg per day • Naproxen/Esomeprazole 500/20 mg twice a day
Cryotherapy	• Focal knee joint cooling: an ice bag (filled with 1 L of cubed ice) on top of the patella for 30 min • Cold-water immersion (17–19 °C): up to the iliac crest for 20 min

Table 1. *Cont.*

Treatments	Parameters
Electrotherapy	• NMES: 2500 carrier frequency, burst at 50 Hz, on/off time: 10/20 s, maximum tolerable intensity for 30 min • TENS: 150 µs with 150 Hz for 30 min at sensory level (no visible muscle contraction) for 30 min
Resistance Exercise (intensity)	• Straight leg raises: 10 reps ×3 sets on each leg (5–20 kg) • Standing hip abductions: 15 reps ×2 sets on each leg (5–10 kg) • Knee extensions: 7–8 reps ×3 sets on each leg (DAPRE technique) • Leg presses: 7–8 reps ×3 sets (DAPRE technique) • Half squats: 15 reps ×2–3 sets (5–25 kg) • Dead lifts: 7–8 reps ×3 sets (5–25 kg) • Lunges: 15 reps ×2–3 sets (body mass)
Aerobic exercise	• Stationary bike: within pain-free knee flexion angle for 20 min • Treadmill walk/jog: 2% inclination at 5.5 to 8.7 km/h for 30 min
Stretching Exercise	• Passive stretching using a stretching strap: hamstring, iliopsoas, and hip adductors (a 30-s hold ×3 sets)

The duration of each intervention is presented in Figure 2. Progressions of external loads (kg) for knee extensions and leg presses are presented in Figure 3. DAPRE: daily adjustable progressive resistance exercise; NSAIDs: nonsteroidal anti-inflammatory drugs; NMES: neuromuscular electrical stimulation; reps: repetitions; TENS: transcutaneous electrical nerve stimulation.

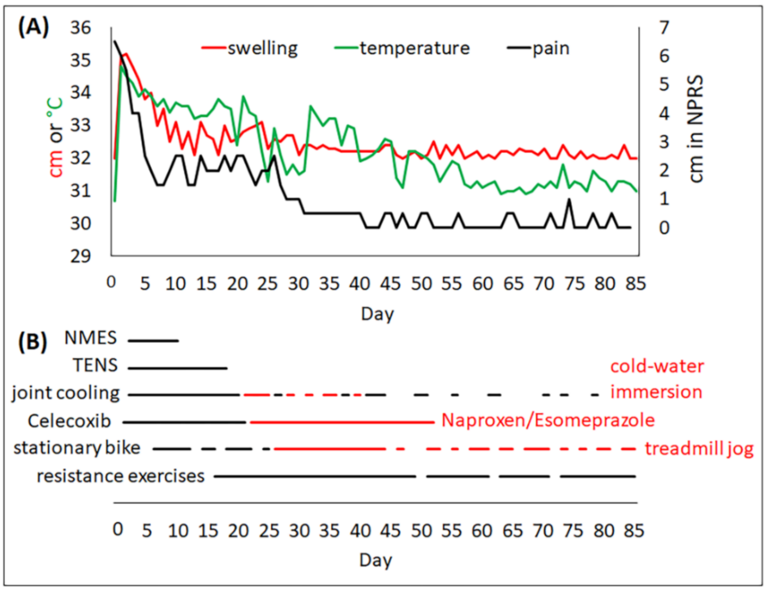

Figure 2. Changes in dependent measurements (**A**), and time course of postoperative interventions (**B**). Note that the line colors correspond to the dependent variables on the y-axes (**A**) and therapeutic interventions (**B**) with the same font colors. The figure (**A**) has left (knee joint circumference in cm and knee joint skin temperature in °C) and right (pain perception during daily activities in cm) axes. The lines in figure (**B**) indicate the days of application in the specific interventions. For example, Celecoxib was administered for the first 21 days, followed by Naproxen/Esomeprazole from day 22 to 52 of rehabilitation. NPRS: numeric pain rating scale; NMES: neuromuscular electrical stimulation; TENS: transcutaneous electrical nerve stimulation.

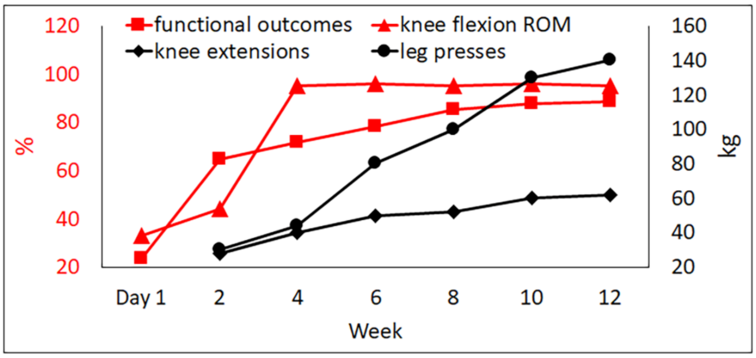

Figure 3. Progression of postoperative interventions (red lines and font) and external loads of resistance exercises (black lines and font). Note that functional outcomes are the average percentages of the scores from the Kujala anterior knee pain scale, International Knee Documentation Committee score, and lower-extremity functional scale. Knee flexion ROM was the percentage of full ROM, 131° measured at initial evaluation and day 0 (the day before surgery). Day 1 indicates the first day of postoperative rehabilitation. ROM: range of motion.

During the rehabilitation period, the NPRS during daily activities and the circumference (same measurement as the initial evaluation) and skin temperature of the right knee joint (on the lateral boarder of the patella) were measured daily. A thermistor probe connected to a digital thermometer logger (N543, NT logger, NKTC, Tokyo, Japan: 60 Hz) and covered with film dressing was used to record skin temperature [16]. Functional outcomes using the Kujala AKP scale [17], International Knee Documentation Committee score [18], and lower-extremity functional scale [19] were obtained biweekly, and a percentage of each outcome score was averaged. Knee flexion ROM (the same measurement as the initial evaluation) and external loads for knee extension and leg press exercises were also recorded every two weeks.

3. Discussion

Long-term repetitive irritations on the patellofemoral hyaline cartilage and subchondral bone by a thickened plica are thought to be the possible mechanisms of injury in the present case. Additionally, impaired load absorption and abnormal load distribution due to morphological deterioration in the patellar cartilage and enlarged plica had probably exacerbated AKP. Patients with chronic AKP (duration of pain: 7.3 years) had 0.4 mm thinner (14% less) patellar cartilage compared with healthy controls [20]. Additionally, the magnitude of quadriceps inhibition and knee pain are associated with low bone marrow lesions [21]. Studies concerning acute femoral cartilage deformation in healthy individuals reported reduced thickness [22] and cross-sectional area [23] following walking or running; the amount of cartilage deformation, and time to return to its original shape after physical activity were linearly related to the magnitude and frequency of joint loading during activity [24]. Our patient had an extended period of AKP (>9 years) and had been participating in high impact physical activities almost every day. For example, one day, he had played soccer and then skied. Therefore, we believe the patient's early development (age of 41) of degenerative joint pathology was attributed to accumulation of exercise-induced fatigue with insufficient rest between physical activities, and long-term effects of quadriceps dysfunction due to arthrogenous muscle response.

The patient had severe bilateral chondrosis (Figure 1A–D) that required surgical intervention. Among the options for surgical procedures (e.g., arthroplasty, allograft transplantation, microfracture), the minimally invasive method (debridement and removal of the thickened medial plica) was chosen in a consideration of the patient's age and the surgeon's preference.

The day after arthroscopic surgery, girth measurement and skin temperature at the right knee joint increased by 3 cm and 4°, respectively (Figure 2A). The joint's inflammatory-related swelling and heat decreased to the baseline level around day 30. Given that the internal temperature in deeper tissues (e.g., 2.5 cm deep) is about 2 °C higher than that on the skin [16], we assumed that the actual temperature in the target area (inside the patellofemoral joint) was higher. Considering the timeline for the patient's reduction in pain and restoration of knee flexion ROM, the inflammatory responses in this particular patient seemed to last four weeks. Because there are very limited data on duration of the inflammatory response after surgery, the data from the present case would be useful for interventions of postoperative knee rehabilitation. It should be noted that the patient in the present case experienced the combined effects in presented therapeutic interventions (Figure 2B) and early voluntary movements (stationary biking and resistance exercising).

The primary goal of postoperative rehabilitation was to restore quadricep function since arthrogenous muscle inhibition is a common consequence in patients with knee pain or surgery [25]. Therefore, joint cooling and TENS were applied for the purpose of quadricep disinhibition prior to voluntary exercise. It is unclear if this particular strategy was successful because the level of quadricep activation was not directly measured, and a small amount of increased external load was recorded during the knee extension exercise (62 kg at week 12, Figure 3). According to the patient, this slow increase in knee extension strength was due to sharp pain, produced by increased patellofemoral joint stress [26], rather than insufficient strength. Therefore, the patient performed isometric quadricep exercise (knee fully extended against external resistance for 30–40 s) to avoid sharp pain and further potential damage to the patellofemoral joint.

In regard to changes in functional outcomes, a score of 78% was achieved for the first six weeks, but only a 10% further improvement was observed for the last six weeks. This could be explained by the surgical procedure that the patient received consisting of removal of supporting structures surrounding the patella. Reduced patellofemoral joint contact area could have increased patellofemoral joint stress and reaction force [27]. The observed rate of external load progression in knee extension (40–62 kg, 35%) was much lower than that for the leg press exercises (44–140 kg, 69%) from weeks 4 to 12. As the external load increased, the amount of pain that the patient had to endure could have been higher during the open- (knee extension) than closed-kinetic chain (leg press) exercises. There was a larger improvement in the external load of the leg press exercise, so that the patient seemed to develop a co-contraction strategy in daily activities. The patient also experienced bilateral quadricep tendon subluxation at around 90° knee flexion, which worsened in weight-bearing positions. Therefore, he was hesitant to perform strenuous activities, such as jumping and landing. This patellofemoral instability due to the absence of cushioning and lubricating structures at the patellofemoral joint could also explain why the functional outcomes reached 78% at week 6 and increased only modestly thereafter (88% at week 12). Co-contractions with knee extensions in multi-joint closed-kinetic chain exercises appeared to be the major contributing factor to restore functional outcomes. While exercising isolated quadriceps is limited, long-term follow-up for this patient would be necessary to observe the effects of the clinical interventions and his progression.

A subjective assessment of the history of past medical conditions and treatments, including the level of symptoms and functional deficits related to knee pain, and the intensity and frequency of physical activity participation, relies on the patient's self-reported information. The patient may have reported symptoms and physical activities severity other than what they had actually been. Therefore, we acknowledge the possibility of recall bias [28] as a study limitation. While the relative contribution of each rehabilitation component is unclear, we assume that a combined therapeutic effect was attributed to functional improvement and pain reduction. The patient reported that NSAIDs and voluntary and aerobic exercises contributed significantly.

4. Conclusions

The patient in the present case underwent 12 weeks of postoperative aggressive rehabilitation (NSAIDs, knee joint cooling and cold-water immersion, sensory TENS, weight-bearing and non-weight-bearing resistance exercise, stationary bike and treadmill jog, and static stretch) after bilateral arthroscopic patella cartilage debridement and plica excision due to bilateral chondromalacia with plica syndrome. While the pathology was not an extreme case, our description of the therapeutic modalities and exercises, as well as other inflammatory-related measurements and exercise progressions, can provide a future reference for clinicians and patients.

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Institutional Review Board Statement: This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of Myungji Hospital (approval #: MJH 202104019).

Informed Consent Statement: Written informed consent has been obtained from the patient to publish this paper.

Data Availability Statement: The data are not publicly available due to privacy.

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Conflicts of Interest: The authors declare no conflict of interest.

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