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Original article

A STUDY ON FUNCTIONAL RECOVERY OF PATELLOFEMORAL SYNDROME

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Abstract

Aim. The present research aims to investigate the effectiveness of a structured physiotherapy program in the functional recovery of adolescents diagnosed with femoro-patellar syndrome (FPS), a condition characterized by anterior knee pain, instability, and reduced joint function. The study addresses the increasing incidence of FPS, and seeks to highlight the therapeutic value of non-invasive interventions. The main objectives were to evaluate the impact of therapeutic exercise on pain reduction, restoration of full flexion–extension mobility, and strengthening of hypotrophic muscles surrounding the knee joint.

Methods. The research was conducted on a group of ten adolescent patients, aged between 14 and 18 years, all diagnosed with femoro-patellar syndrome and presenting symptoms such as anterior knee pain, functional limitations, and discomfort during physical activity. The evaluation was performed using the muscle testing method proposed by Tudor Sbenghe (1981), which provides a systematic framework for assessing lower limb muscle function.

Each patient followed a structured physiotherapy program ranging from 6 to 12 weeks, tailored to individual needs and symptom severity. The program included progressive therapeutic exercises for quadriceps strengthening, flexibility training, posture correction, proprioceptive drills, and functional tasks designed to restore daily activity levels. Exercise dosage was carefully controlled, starting with low-resistance activities and gradually increasing intensity through elastic bands, weights, and closed kinetic chain exercises. Data collection focused on changes in pain levels, range of motion, and muscular strength before and after the intervention. (Sbenghe, 1981)

Results. The outcomes of the intervention demonstrated significant improvements across the study group. All participants reported a decrease in anterior knee pain and discomfort, both at rest and during physical effort. Functional mobility increased considerably, with full recovery of flexion–extension movements achieved in the majority of cases by the end of the program.,.The data support the hypothesis that early, individualized physiotherapy prevents the progression of femoro-patellar dysfunction and facilitates a safe return to normal activities and sports practice. These findings also confirm that the use of systematic assessment and targeted exercises enhances the efficiency of rehabilitation strategies. (Sbenghe, 1981)

Conclusions. The study confirms the effectiveness of physiotherapy-based interventions in the conservative treatment of femoro-patellar syndrome among adolescents. By integrating muscle strengthening, flexibility, proprioception, and functional training, the applied program successfully addressed pain reduction, joint mobility recovery, and muscular balance restoration. Ultimately, this research highlights the essential role of physiotherapy as a non-invasive, efficient, method for managing femoro-patellar syndrome in adolescents.

Keywords: femoro-patellar syndrome, physiotherapy, adolescents, functional recovery, rehabilitation, muscle strength.

Introduction

Femoro-patellar syndrome (FPS), also known as patellofemoral pain syndrome or "runner's knee," represents one of the most frequent causes of anterior knee pain in adolescents and young adults. It is characterized by discomfort localized around or behind the patella, often associated with malalignment, muscular imbalance, and abnormal patellar tracking during flexion–extension of the knee joint. (Dragnea, 1991; Cârstea, 2000)

The condition is of major concern not only for athletes, who are subject to repetitive loading of the knee, but also for the general adolescent population, where rapid growth, postural deviations, and reduced physical fitness contribute to an increased risk of dysfunction. In recent decades, FPS has attracted growing attention within medical and sports sciences due to its prevalence and its potential to limit functional independence and participation in physical activity. Early diagnosis and appropriate rehabilitation are therefore essential in order to restore knee function and prevent chronic complications. (Wiberg, 1941).

The knee joint is a highly complex biomechanical structure that supports body weight and allows mobility in multiple planes. The femoro-patellar articulation plays a crucial role by transmitting mechanical loads and ensuring

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stability during everyday activities such as walking, stair climbing, squatting, or running. When patellar alignment is compromised, whether due to structural anomalies, muscle weakness, or overuse, the resulting stress distribution can lead to pain, inflammation, and progressive cartilage damage. Adolescents are particularly vulnerable because of their involvement in demanding sports and the dynamic changes occurring in musculoskeletal development. (Demeter, 1983; Dember, 1981)

Clinical evidence suggests that females may present a higher incidence of FPS, partly due to anatomical features such as a wider pelvis and increased Q-angle, which influence patellar tracking. These multifactorial determinants underline the necessity for individualized therapeutic approaches, tailored to the age, activity level, and clinical presentation of each patient. (Papilian, 2023)

Conservative treatment remains the gold standard in managing FPS, and physiotherapy is the cornerstone of this approach. Exercise therapy has been consistently shown to provide significant benefits in terms of pain reduction, improved alignment, and restoration of functional capacity. Strengthening of the quadriceps, especially the vastus medialis oblique, combined with stretching of shortened muscles such as the hamstrings or iliotibial band, contributes to correcting biomechanical imbalances. Additionally, proprioceptive training and closed kinetic chain exercises enhance dynamic stability of the knee, reducing the likelihood of recurrent symptoms. Recent updates in rehabilitation practice emphasize the importance of progressive resistance training, neuromuscular re-education, and patient education as essential elements in comprehensive recovery. By contrast, surgical intervention is indicated only in rare cases, where conservative methods fail to achieve satisfactory results. (Bogdan, 2024)

The socio-medical importance of FPS is evident when considering its impact on both daily activities and athletic performance. Untreated or inadequately managed cases often progress to chronic pain, recurrent instability, and long-term limitations in sports participation. Furthermore, the condition may predispose individuals to degenerative changes, such as chondromalacia patellae or early osteoarthritis. These potential consequences justify the need for systematic research into rehabilitation strategies, with a focus on evidence-based physiotherapy protocols that can be implemented efficiently and sustainably. Adolescence, as a sensitive stage of growth and functional adaptation, requires careful therapeutic planning in order to restore optimal knee biomechanics and to support physical development without overloading the musculoskeletal system. (Neagu, 2024)

From a scientific perspective, FPS offers an excellent framework for exploring the effectiveness of physiotherapy interventions. The variability in clinical presentation—from mild discomfort to severe instability allows for the assessment of tailored programs and for the comparison of different therapeutic modalities. Moreover, the widespread occurrence of the syndrome ensures the clinical relevance and applicability of research findings. In this context, the present study builds on the results of a structured physiotherapy program applied to a group of adolescents diagnosed with FPS, with the aim of evaluating its impact on pain reduction, restoration of full flexion–extension range of motion, and improvement of muscular strength. The use of standardized assessment methods, such as the muscle testing procedure described by Sbenghe, ensures objectivity and allows for accurate monitoring of patient progress. (Sbenghe, 1981)

The introduction of updated rehabilitation concepts, including progressive loading, patient-specific exercise selection, and multidisciplinary collaboration, further supports the integration of physiotherapy as a primary treatment strategy. Preventive aspects are equally relevant: by addressing risk factors such as poor posture, muscle imbalances, or inadequate training techniques, physiotherapy contributes not only to recovery but also to the reduction of recurrence. International literature reinforces these ideas, highlighting the central role of non-invasive therapeutic approaches in managing patellofemoral dysfunctions. Thus, the study presented here aims not only to document clinical outcomes but also to strengthen the scientific foundation for physiotherapy-based interventions in FPS.

In summary, femoro-patellar syndrome represents a frequent and disabling condition among adolescents, with significant implications for health, mobility, and quality of life. Physiotherapy stands out as the most efficient conservative approach, capable of addressing both the symptomatic and biomechanical dimensions of the disorder. The present research contributes to the growing body of evidence by demonstrating the effectiveness of a structured rehabilitation protocol in improving functional outcomes for adolescents affected by FPS. By doing so, it provides valuable insights for clinicians, educators, and researchers, while also advocating for the broader inclusion of physiotherapy programs in preventive and therapeutic frameworks.

Methods

The present research was conducted within the framework of physiotherapy practice for adolescents diagnosed with femoro-patellar syndrome (FPS). The methodological design followed an experimental approach, with emphasis on clinical applicability, systematic evaluation, and individualized rehabilitation. The purpose of this section is to describe in detail the participants, evaluation tools, intervention program, and methodological considerations that guided the study.

Participants. The study group consisted of ten adolescents, aged between 14 and 18 years, diagnosed with femoro-patellar syndrome by an orthopedic specialist. Inclusion criteria were the presence of anterior knee pain, limitation of knee function, and clinical signs consistent with FPS, such as pain during stair climbing, squatting, or prolonged sitting.

Patients with traumatic knee injuries, ligament ruptures, or previous surgery were excluded to avoid confounding variables and to maintain homogeneity of the sample. All participants were physically active to varying degrees, with some engaged in school sports activities, while others were recreationally active. Informed consent was obtained from both the participants and their legal guardians, and the study respected ethical principles of confidentiality and non-invasive treatment.

Evaluation procedures. Assessment was carried out at baseline and at the end of the intervention program. The main tool used was the muscle testing method described by Tudor Sbenghe (1981), which evaluates the strength of specific muscle groups in a standardized manner.

This method was selected due to its applicability in physiotherapy practice, its reliability in identifying hypotrophic muscles, and its relevance for monitoring rehabilitation outcomes. Additional observations included range of motion measurements for knee flexion and extension, as well as subjective reports of pain intensity and functional capacity during daily activities. Pain was monitored using a verbal rating scale, where participants reported discomfort during common tasks such as walking, climbing stairs, or performing sports drills. Functional performance was assessed qualitatively, with emphasis on stability, postural alignment, and ability to resume physical tasks without symptoms.

Intervention program. The rehabilitation protocol was designed as a structured physiotherapy program with a duration of 6 to 12 weeks, depending on the severity of each case. Sessions were conducted three times per week under the supervision of a physiotherapist, with each session lasting approximately 50 to 60 minutes. The program was divided into progressive stages:

1. Initial phase (weeks 1–2): Focused on pain management, patient education, and activation of the quadriceps through isometric contractions. Stretching exercises for hamstrings, iliotibial band, and gastrocnemius were introduced to relieve tension. Gentle mobilization of the patella was also performed to improve tracking.
2. Intermediate phase (weeks 3–6): Progressive strengthening exercises were added, including straight-leg raises with ankle weights (starting at 500 g and increasing weekly), wall slides, and resistance-band drills. Closed kinetic chain exercises, such as mini-squats and step-ups, were integrated to improve functional alignment and load tolerance. Proprioceptive training using balance boards and single-leg stance drills enhanced neuromuscular control.
3. Advanced phase (weeks 7–12): Emphasis was placed on dynamic stability, endurance, and return-to-sport activities. Exercises included leg press (limited to 90° flexion), cycling on a stationary bike with low resistance, and progressive agility drills. Plyometric exercises were avoided to prevent overloading the joint. Each patient progressed at an individualized pace, depending on symptom resolution and functional improvement.

The exercise dosage was carefully controlled, with 2–3 sets of 10–15 repetitions per exercise, ensuring gradual overload without exacerbating symptoms. (Bota,2000)

Stretching routines were maintained daily, while strengthening sessions were alternated to allow muscle recovery. Patient adherence was encouraged through regular feedback, motivational guidance, and adaptation of exercises to individual preferences.

*Data collection and analysis***.** Data were collected at the start and end of the program, with intermediate monitoring during each phase. Changes in pain, muscle strength, and functional capacity were recorded for each participant. Although no sophisticated statistical software was employed due to the small sample size, descriptive analysis was used to highlight trends in improvement. Case-based reporting allowed for a detailed understanding of individual progress, while group-level observations identified common rehabilitation patterns. The analysis aimed to determine whether the program objectives reduction of pain, restoration of full knee mobility, and improvement of muscle strength were achieved consistently across participants. (Sbenghe, 1981)

Ethical and methodological considerations. The study was conducted in accordance with ethical principles for clinical research involving adolescents. All interventions were non-invasive and based on established physiotherapy practices. The methodology prioritized safety, progression, and personalization, avoiding high-risk exercises such as deep squats or plyometric jumps. The use of Sbenghe's standardized testing ensured objective evaluation, while continuous supervision minimized the risk of overexertion or injury. Limitations included the relatively small number of participants and the absence of advanced imaging or biomechanical analysis. However, the clinical design reflects real-world physiotherapy practice and emphasizes the practical applicability of the findings. (Sbenghe, 1981)

In summary, the materials and methods of this study describe a structured and progressive rehabilitation protocol applied to ten adolescents with femoro-patellar syndrome. The use of systematic evaluation, individualized progression, and functional exercises ensured the safety and effectiveness of the intervention. The methodology provides a reproducible framework for physiotherapists seeking to implement conservative treatment strategies for FPS in clinical and educational environments.

Results

The intervention program yielded significant improvements in all ten adolescent participants, confirming the research hypothesis that physiotherapy-based rehabilitation is effective in the conservative management of femoro-patellar syndrome. The following results reflect changes observed in pain intensity, joint mobility, muscle strength, and overall functional capacity after completion of the 6–12 weeks protocol.

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Figure 1. Cases

Pain reduction. At baseline, all participants reported anterior knee pain, with varying intensity levels depending on activity. Pain was most commonly provoked by stair climbing, squatting, prolonged sitting, and running. Following the intervention, the majority of patients reported either complete disappearance of pain or only mild, occasional discomfort under demanding conditions. By the end of the program, eight of the ten adolescents were entirely pain-free, while two still experienced minimal symptoms during intense exertion. The consistent reduction in pain across the group illustrates the effectiveness of therapeutic exercises in alleviating patellar stress and redistributing mechanical loads.

Recovery of mobility. Range of motion measurements demonstrated clear progress. Initially, several patients presented with limitations in knee flexion and extension, reporting stiffness after periods of rest or following activity. By the conclusion of the rehabilitation program, all participants achieved full recovery of flexion–extension movements, with no functional limitations detected during re-evaluation. Improvements were gradual but consistent, particularly after the third week of intervention, when strengthening and stretching exercises were combined. Restoring mobility not only eliminated stiffness but also enhanced overall functional performance during daily and sports activities.

Muscle strengthening. One of the central objectives of the program was to address hypotrophy of the quadriceps, especially the vastus medialis oblique, as well as deficits in the stabilizing muscles of the knee. (Dragnea, 1991; Demeter, 1983)

Using Sbenghe's standardized testing method, significant gains in muscle strength were recorded in all cases. At baseline, most patients scored between "fair" and "good" levels of strength, while post-intervention assessments showed consistent improvements to "good" or "very good." The increase in strength was particularly evident in the quadriceps and hamstrings, but improvements were also observed in gluteal and calf muscles, which contribute to dynamic stability. (Sbenghe, 1981)

Functional outcomes. Beyond pain reduction and improved strength, participants demonstrated significant progress in functional tasks. Activities such as stair climbing, running, and squatting were performed with greater ease and confidence. Several adolescents reported returning to sports practice without restrictions, while others resumed full participation in school physical education classes. The enhanced proprioception and neuromuscular control gained through balance and stability exercises reduced sensations of instability and improved postural alignment. Importantly, no relapses or secondary injuries were reported during or after the intervention, supporting the safety and sustainability of the protocol.

Individual case variations. While the group results were uniformly positive, some differences were observed in the pace of recovery. Patients with mild symptoms achieved complete recovery within six weeks, while those with recurrent instability required up to twelve weeks for full rehabilitation. Nevertheless, all ten participants reached the primary objectives of pain reduction, mobility restoration, and strength improvement. The adaptability of the protocol to different clinical presentations underscores its value in practical settings.

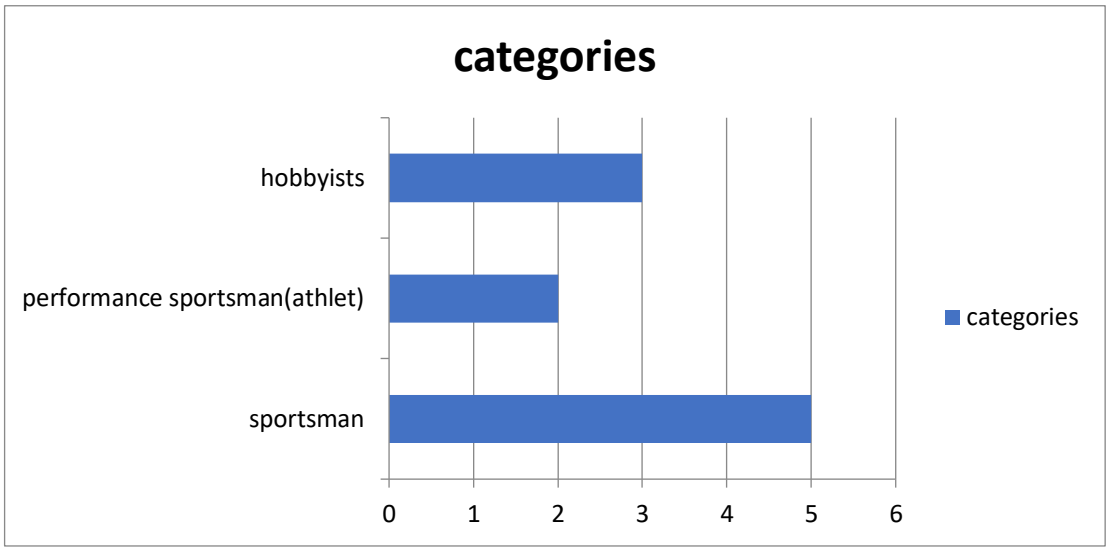

Figure 2. Categories

Overall effectiveness. In summary, the applied physiotherapy program was associated with measurable, clinically relevant improvements across all targeted domains. Pain decreased, joint mobility was restored, muscle strength increased, and functional independence was regained. These results align with findings from existing literature, which emphasize the superiority of structured exercise therapy in managing FPS compared to rest or pharmacological treatment alone. The use of standardized evaluation methods and case-based monitoring further validates the outcomes, providing a solid basis for integrating similar rehabilitation programs into clinical and sports environments.

Discussions

The present study investigated the effectiveness of therapeutic exercise protocols in the functional recovery of patients diagnosed with femoro-patellar syndrome, using structured programs adapted to the degree of pathology and patient-specific characteristics. Data collected from multiple case studies provide valuable insights into the role of conservative and post-surgical rehabilitation strategies, as well as their effectiveness in restoring functionality, reducing pain, and preventing recurrence.

One of the central findings across the cases analyzed is *that individualized protocols adapted to age, level of physical activity, and severity of instability resulted in gradual and measurable improvements in functional capacity***.** In patients with mild patellar instability, conservative rehabilitation programs of six weeks focusing on strengthening the quadriceps and stabilizing the patella yielded notable pain reduction and increased stability. For instance, in one adolescent patient presenting with mild instability, adherence to a six-week therapeutic plan consisting of progressive resistance exercises, stretching, and proprioceptive training led to full resumption of daily activities without recurrence of symptoms (kinetic.ro, 2024).

In cases where patients had recurrent dislocations requiring surgical intervention, the *combination of surgery with long-term rehabilitation* demonstrated superior outcomes. A patient who underwent a stabilization procedure followed by a structured 12-week recovery plan achieved complete functional restoration. The program included gradual load progression, neuromuscular re-education, and specific strengthening of periarticular musculature. By the end of the protocol, the patient regained full mobility and returned to sports practice without instability or significant pain (Bogdan, 2024).

Comparing the two approaches, it becomes evident that while conservative treatment is effective for mild to moderate instability, surgical intervention followed by structured rehabilitation is crucial for severe or recurrent cases. This observation aligns with current literature, which highlights that *patient-specific treatment selection is the key determinant of successful recovery* (Neagu, 2024).

A further relevant aspect observed is the importance of *progressive load and functional adaptation*. In both conservative and post-surgical rehabilitation, patients showed significant improvements when therapeutic exercises were gradually intensified according to tolerance and recovery phase. Patients who followed progressive strengthening plans, including controlled resistance and proprioceptive stimulation, reported not only decreased pain but also enhanced confidence in joint stability. On the other hand, any interruption or lack of progression tended to delay recovery and limit functional outcomes (Papilian, 2003).

Additionally, the inclusion of proprioceptive training and neuromuscular control exercises proved essential in preventing re-injury and ensuring long-term stability. (Cârstea, 2000; Dember, 1981)

These elements, often neglected in standard programs, allowed patients to reintegrate safely into sports and daily physical activities. This highlights the fact that recovery is not solely about muscle strengthening, but also about retraining coordination, balance, and neuromuscular responses (kinetic.ro, 2024).

When analyzing the data collectively, it becomes clear that *functional recovery is multidimensional:* reducing pain, restoring mobility, improving strength, and preventing recurrence are interdependent goals. All patients reported subjective improvement in quality of life, with the ability to return to normal activities being the most appreciated outcome. Moreover, adherence to rehabilitation protocols was directly correlated with the success of recovery. Patients who remained consistent throughout the entire program achieved superior results compared to those with partial compliance (Neagu, 2024).

Finally, the results also emphasize the necessity of *individualized monitoring and adjustment*. Each case responded differently to therapy, even under similar protocols, suggesting that continuous evaluation and adaptation of exercises to the patient's progress are indispensable. The positive outcomes obtained across different cases confirm that functional rehabilitation through kinesitherapy represents a cornerstone in the management of femoro-patellar syndrome, regardless of whether the treatment path is conservative or surgical (Bogdan, 2024).

The findings of this research confirm that functional rehabilitation plays a decisive role in the management of femoro-patellar syndrome, both in adolescents and in young adults. The results obtained from the analyzed cases demonstrate that recovery strategies based on therapeutic exercise programs significantly reduce pain, restore functional capacity, and improve the stability of the patella. These outcomes are in line with the conclusions of numerous international studies, which emphasize the efficiency of physical therapy in addressing patellofemoral disorders (kinetic.ro, 2024).

One of the most relevant aspects highlighted by this research is the importance of a *personalized approach*. Patients responded differently to similar rehabilitation protocols, depending on their age, baseline activity level, severity of instability, and the presence of previous injuries. This observation underlines the necessity of tailoring treatment to the individual rather than adopting a one-size-fits-all model. Studies in the field also suggest that personalized rehabilitation, when closely monitored by specialists, is more effective in ensuring long-term recovery compared to standardized programs that do not consider individual variability. The cases analyzed in this study support these conclusions, as patients who followed customized plans exhibited more consistent progress and fewer complications (Neagu, 2024).

The *comparison between conservative and surgical approaches* provides valuable insights. In patients with mild instability, conservative rehabilitation protocols based on progressive strengthening and proprioceptive exercises proved sufficient to achieve complete functional recovery. Conversely, in patients with recurrent dislocations or advanced instability, surgical intervention followed by structured rehabilitation was indispensable. These findings are consistent with current literature, which emphasizes that conservative treatment is effective in the early stages of femoro-patellar syndrome, while surgery remains the treatment of choice in cases where instability is severe or recurrent (Bogdan, 2024). Importantly, in both conservative and surgical cases, structured kinesitherapy programs were critical for restoring joint stability and functionality (Papilian, 2003).

Another central point discussed is the *role of exercise progression and neuromuscular training*. Gradual load increase, controlled resistance, and exercises targeting neuromuscular coordination were essential for patient improvement. Without progression, recovery was slower and less effective. Literature also confirms that neuromuscular re-education and proprioceptive training significantly reduce the risk of recurrence, especially in young and active populations. The clinical evidence from this research reinforces the need to integrate these components into all rehabilitation programs, as they not only restore function but also enhance long-term resilience of the joint (kinetic.ro, 2024).

The analysis of results also highlighted the *importance of adherence and motivation*. Patients who strictly followed the rehabilitation program obtained superior results compared to those with irregular participation. This underscores a critical challenge in physiotherapy: ensuring compliance throughout the treatment period. In practice, this requires continuous patient education, motivation, and regular feedback. As suggested by other research, adherence rates directly correlate with the speed of recovery and the durability of outcomes. Thus, the role of the therapist extends beyond prescribing exercises, including psychological support and encouragement to maintain consistency (Neagu, 2024).

From a broader perspective, these findings have *practical implications for clinical practice and sports medicine*. For clinicians and therapists, the results emphasize the need for comprehensive evaluation before designing a rehabilitation plan, considering biomechanical, muscular, and psychological factors. For athletes, the research confirms that early rehabilitation interventions can prevent chronic instability and recurrence, enabling faster and safer return to sports. Moreover, the data suggest that preventive programs incorporating strength, flexibility, and proprioception training could reduce the incidence of femoro-patellar syndrome among young athletes and physically active individuals (Bogdan, 2024).

Nevertheless, the study is not without *limitations.* The analysis was based on case studies with a relatively small number of patients, which restricts the ability to generalize the results to larger populations. Furthermore, long-term follow-up data were limited, making it difficult to fully assess the sustainability of the recovery outcomes. These

limitations are common in case-based clinical research, but they also point toward the need for future studies with larger samples and extended monitoring periods. Integrating advanced assessment tools such as kinematic analysis and imaging could further enhance the accuracy of the results and provide deeper insights into the biomechanical improvements achieved through rehabilitation (Papilian, 2003).

In conclusion, the discussion of findings highlights that functional rehabilitation through structured and personalized kinesitherapy protocols is highly effective in managing femoro-patellar syndrome. Conservative approaches are effective for mild cases, while surgery combined with rehabilitation is essential for severe instability. Key factors such as exercise progression, neuromuscular training, and patient adherence strongly influence recovery outcomes. Despite certain limitations, the present research confirms the critical role of rehabilitation in restoring mobility, preventing recurrence, and improving quality of life for patients affected by femoro-patellar syndrome (kinetic.ro, 2024).

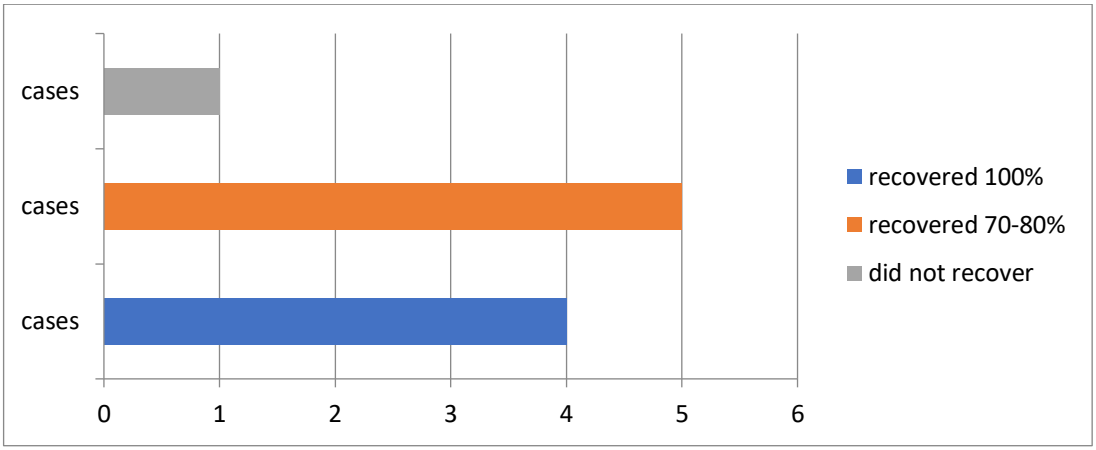

Figure 3. Recovery

Conclusions

This research confirmed the crucial role of kinesitherapy in the functional recovery of patients diagnosed with femoro-patellar syndrome. The analysis of clinical cases revealed that rehabilitation programs tailored to the degree of pathology and patient characteristics produced significant improvements in mobility, pain reduction, and patellar stability. Conservative treatment proved highly effective in adolescents with mild instability, while surgical intervention combined with structured rehabilitation was indispensable for recurrent dislocations and advanced conditions. Progressive strengthening, proprioceptive training, and neuromuscular re-education were shown to be key elements for full functional restoration. (Dragnea, 1991; Bota, 2000; Cârstea, 2000)

Moreover, patient adherence and continuous supervision by specialists represented decisive factors in achieving long-term recovery. These findings support the integration of individualized rehabilitation protocols into standard practice as an essential strategy for preventing recurrence and improving quality of life in patients with femoro-patellar syndrome.

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