ISSN: 3033-358X

Case Report

Journal of Orthopedics and Physiotherapy

Complete Resolution of Femoroacetabular Impingement Symptoms Following Combined Double-Coil and Handheld rPMS: A Case Report

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Received: May 15, 2026; **Accepted:** May 22, 2026; **Published:** May 25, 2026

ABSTRACT

Background: Femoroacetabular impingement syndrome (FAI) is characterized by structural abnormalities of the hip joint that may lead to significant functional limitation. In cases of persistent symptoms despite at least six months of conservative treatment, surgical intervention is often considered.

Case Description: A 39-year-old female patient with a two-year history of progressive left hip pain and significant functional limitation, unresponsive to physiotherapy and pharmacological treatment, was evaluated. Clinical examination revealed positive hip provocation tests and a C-sign, suggesting anterior FAI with intra-articular involvement. Sensory changes over the lateral thigh were consistent with meralgia paresthetica. Radiographic findings supported FAI without evidence of degenerative changes. The patient underwent a one-month course of combined repetitive peripheral magnetic stimulation (rPMS), consisting of static double-coil and dynamic handheld application, administered three times per week. Following treatment, complete resolution of symptoms and full functional recovery were observed, with sustained improvement throughout a 9-month follow-up period.

Conclusions: Although these findings must be interpreted with caution given the nature of a single case report, they provide preliminary support for the use of combined rPMS as a non-invasive therapeutic option in selected patients. Further research is required to confirm its clinical effectiveness and to better understand the underlying mechanisms of action.

Keywords: Femoroacetabular impingement syndrome; repetitive peripheral magnetic stimulation; double-coil stimulation; neuromodulation; non-invasive therapy; case report

Introduction

Femoroacetabular impingement syndrome (FAI) is a painful, movement-related hip condition characterized by abnormal contact between the femoral head and the acetabular socket. This repetitive contact during everyday movements - such as hip flexion or rotation - can lead to reduced range of motion and, over time, to the development of hip osteoarthritis [1].

There are two primary types of FAI. The cam type is characterized by an irregularly shaped femoral head, which causes abnormal pressure on the acetabular cartilage and labrum during hip flexion or rotation. The pincer type, on the other hand, involves a deformity of the acetabulum, either excessive depth or the presence of bony overgrowth, leading to impingement between the acetabular rim and the femur during movement. In clinical practice, the mixed type, which combines features of both cam and pincer morphologies, is the most common form - present in up to 86% of patients [2].

Although FAI is frequently associated with significant pain and functional limitation, particularly in young and active individuals, the condition can in some cases be entirely asymptomatic. For this reason, it is not possible to determine a single definitive origin of the disorder [3]. Genetics has been

Citation: Vincenzo Di Modica, Giuseppe J. Sciarrone. Complete Resolution of Femoroacetabular Impingement Symptoms Following Combined Double-Coil and Handheld rPMS: A Case Report. J Ortho Physio. 2026. 4(2): 1-6. DOI: doi.org/10.61440/JOP.2026.v4.55

identified as a significant factor in symptomatic FAI patients, with a reported relative risk of 2.8 for cam morphology and 2.0 for pincer morphology among siblings [4]. Additional factors that may contribute to the development of FAI, particularly in combination with genetic predisposition, include athletic activity, a history of pediatric hip disease, and previous hip surgery [5]. Among sports, those practiced during the adolescent years and involving vigorous hip flexion and rotation, such as basketball, football, and hockey, have been shown to increase the risk of developing cam morphology by up to eight times compared to non-athletic peers [6]. With respect to pediatric hip disorders, the conditions most commonly associated with FAI include slipped capital femoral epiphysis, Legg–Calvé–Perthes disease, femoral neck malunion, and overcorrection of hip dysplasia [5].

Conservative treatment of FAI consists of modifying daily activities to remain within a safe range of motion that prevents mechanical impingement, along with physical therapy focused on core strengthening and addressing compensatory disorders that may arise as a result of pain-induced movement patterns. If conservative management fails to produce improvement after a period of six months, and the patient presents with persistently positive FAI clinical tests in combination with confirmatory radiological findings, surgical intervention is typically recommended [7].

Although early surgical intervention following symptom onset is recommended to achieve optimal outcomes, the waiting period for surgery often spans several months across many healthcare systems, and in the United Kingdom, it frequently exceeds one year [8]. This, combined with the fact that some patients are contraindicated for invasive procedures, highlights the need for the development of novel, non-invasive treatment strategies for managing FAI [7].

One such approach may be repetitive peripheral magnetic stimulation (rPMS). This form of intensive neuromuscular stimulation has demonstrated therapeutic effects primarily in neurology, particularly in the treatment of spasticity. In the context of musculoskeletal disorders, and especially in the management of large joints, clinical evidence remains relatively limited. Specifically for FAI, research is virtually non-existent. Nevertheless, analgesic, muscle relaxation, and myofascial release effects, which are often cited as mechanisms of action in this context, have been demonstrated for rPMS [9,10].

Although rPMS has been known for over 30 years, its application in physiotherapy still largely relies on a single-coil configuration, with the coil positioned perpendicularly to the targeted tissue [11]. Despite its clinically proven effects, this method has inherent limitations, primarily due to the gradual attenuation of magnetic energy with increasing tissue depth [12]. To more effectively target deeper structures, a novel double-coil configuration has been proposed, delivering energy from two coils positioned at an adjustable mutual angle. Theoretical models suggest that at a tissue depth of 4-5 cm, a double-coil setup oriented at a 90-degree angle may achieve magnetic energy levels over 240% higher compared to the traditional single-coil approach [11]. Based on the underlying principles of this method, increased effectiveness can be expected particularly in the treatment of large joints, which not only involve relatively deep anatomical structures but also anatomically allow coil angulation of approximately 90 degrees.

In addition to static double-coil application, dynamic handheld rPMS has recently been explored as a complementary approach, enabling more localized and mobile stimulation of superficial soft tissues. Rather than serving as a standalone intervention, handheld rPMS is typically considered a supportive modality, aimed at enhancing analgesia and muscle relaxation, while allowing dynamic targeting of structures functionally related to the affected region. This approach may be particularly relevant in anatomically complex areas, where adjacent soft tissues contribute to the overall clinical presentation [13,14].

The feasibility and preliminary clinical effectiveness of this approach have been demonstrated in the treatment of large joints and knee osteoarthritis using a double-coil configuration, as well as in conditions such as low back pain and shoulder dysfunction using a combined approach of double-coil and handheld applications [13–16].

To date, no case describing the use of this method in patients with FAI has been reported. This case report presents a physically active female patient suffering from FAI with significant functional limitations, who experienced complete symptom resolution after one month of treatment using a combined rPMS approach consisting of double-coil and handheld application.

Case Report

A 39-year-old female patient, working as a teacher, presented with a two-year history of progressive left hip pain (coxalgia) accompanied by significant functional limitation. The patient had an athletic build with minimal adipose tissue and reported regular participation in physical activity. Her medical history was otherwise unremarkable, with no prior surgeries or relevant comorbidities. The patient reported persistent and severe left hip pain, which had not responded to previous treatment. Previous treatment consisted solely of pharmacological therapy and myofascial release, without sustained improvement. Despite undergoing both medical and physiotherapeutic interventions, her symptoms persisted. Functionally, the patient described an inability to walk long distances and difficulty maintaining an upright (orthostatic) position for prolonged periods, significantly affecting her daily activities and quality of life.

Prior imaging included a pelvic MRI performed on October 10, 2024, which revealed only minimal signs of inflammation in the region of the greater trochanter, without evidence of joint effusion or structural damage. These findings were considered clinically insignificant. A subsequent ultrasound examination of the left hip showed no abnormalities, with preserved tendon, muscle, bursal, and joint structures, and no identifiable source of pain.

On clinical evaluation (July 10, 2025), physical examination revealed multiple positive hip provocation tests. A strongly positive FADDIR test was highly suggestive of anterior FAI, while a positive FABER test indicated involvement of the hip joint and possible intra-articular pathology. McCarthy's test was mildly positive, further supporting the presence of intra-articular irritation. The patient also demonstrated a C-sign, consistent with deep hip joint pain. Neurological assessment using the Wartenberg pinwheel test indicated increased sensitivity in the lateral thigh, consistent with meralgia paresthetica, suggesting involvement of the lateral femoral cutaneous nerve. A complementary pelvic X-ray was performed, demonstrating subtle structural changes suggestive of FAI, in concordance with the clinical findings, while maintaining a preserved joint space and no signs of advanced degenerative changes (Figure 1).

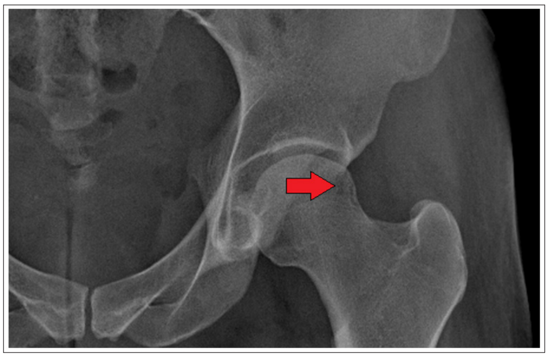

Figure 1: Anteroposterior radiograph of the pelvis showing subtle femoral head–neck asphericity and early acetabular changes on the left side (arrow), suggestive of femoroacetabular impingement morphology.

Pain intensity was reported as 8/10 on the Visual Analogue Scale (VAS). Muscle strength testing revealed reduced strength of the left hip, likely secondary to pain inhibition, while reflexes remained within normal limits.

The patient subsequently underwent a one-month course of rPMS (SIS DUO, BTL Industries Ltd., Prague, Czechia), administered three times per week. The therapy was delivered using a combined approach, consisting of a static double-coil application followed by a dynamic handheld application, targeting both myofascial and neuropathic components of the condition. The intervention consisted of three sequential steps applied during each session:

Step 1: Myofascial release therapy in the lower hip and entire lower limb area, aimed at reducing soft tissue tension and addressing myofascial dysfunction. This phase utilized amplitude- and frequency-modulated trapezoidal stimulation patterns, inducing cyclical muscle contraction followed by relaxation. Stimulation was applied within the low-to-mid frequency range (approximately 10–50 Hz) during activation phases, followed by higher-frequency input (approximately 90–150 Hz) to promote muscle relaxation and reduction of hypertonicity. A short resting and calming phase was included.

Step 2: Targeted treatment of meralgia paresthetica in the lateral thigh, focusing on the course of the lateral femoral cutaneous nerve. This phase utilized a structured sequence combining low-frequency neuromodulatory stimulation (approximately 1–10 Hz) with intermittent higher-frequency components (around 60 Hz) applied in alternating cycles. The protocol was designed to achieve a dual effect, combining analgesic modulation of pain pathways with support of peripheral nerve excitability and trophic function, and concluded with a calming phase.

Both Step 1 and Step 2 were delivered using a double-coil applicator (3D applicator, SIS DUO, BTL Industries) in a static configuration, enabling deeper and more homogeneous stimulation of the hip joint and surrounding structures (Figure 2). Each step was applied for 10 minutes.

Step 3: This was followed by a dynamic application using a handheld applicator, applied across the lower hip, gluteal region, and lower limb, with the aim of achieving analgesia and muscle relaxation. This phase emphasized neuromodulation-based stimulation, combining predominantly low-frequency analgesic input (around 1–10 Hz) with higher-frequency components (up to approximately 60 Hz) to enhance the overall therapeutic effect. The duration of this phase was 9 minutes.

Figure 2: Static double-coil rPMS application during Steps 1 and 2 of the intervention protocol.

Stimulation intensity was adjusted individually according to patient tolerance, aiming to achieve effective neuromuscular activation without discomfort.

After completion of the 1-month rPMS program, the patient continued with a structured rehabilitation, including therapeutic exercise focusing on hip stabilizer strengthening and proprioceptive training, and global postural re-education over the following months.

Following completion of the one-month rPMS intervention, the patient demonstrated complete resolution of symptoms, with no residual pain reported during daily activities. Functionally, the patient regained the ability to walk long distances and maintain an upright (orthostatic) position without limitation, with a full return to normal daily activities. Post-treatment clinical examination revealed normalization of muscle strength, absence of previously positive hip provocation tests, and no signs of intra-articular irritation. In addition, the previously observed sensory disturbance in the lateral thigh resolved completely, with no remaining signs of meralgia paresthetica.

At follow-up evaluation 9 months after the initial intervention (May 2026), the patient remained asymptomatic, with no recurrence of pain or functional limitation. Clinical examination confirmed persistently negative hip provocation tests, normal muscle strength, and absence of sensory abnormalities, indicating sustained therapeutic effect.

A detailed timeline of the clinical course, including diagnostic findings, interventions, and functional outcomes, is presented in Table 1.

Table 1: Timeline of clinical course, diagnostic findings, and intervention.

Date	Event / Intervention	Findings / Outcomes
October 10, 2024	Pelvic MRI	Minimal inflammatory changes near greater trochanter; no effusion or structural damage
2024 (unspecified)	Ultrasound examination	No abnormalities detected in left hip; preserved tendons, muscles, bursa, and joint structures
2023–2025	Conservative management (pharmacological therapy, myofascial release, physiotherapy)	Persistent pain and functional limitation without improvement
July 10, 2025	Baseline clinical evaluation	VAS 8/10; FABER +++; FADDIR +++; McCarthy ++; C-sign ++; Wartenberg +++; MRC 3/5
July 30, 2025	Pelvic X-ray	Preserved joint space; morphology suggestive of FAI
July – August 2025	rPMS therapy (3 sessions/week for 1 month) using double-coil applicator	Progressive symptom reduction during treatment
August 8, 2025	Post-treatment clinical evaluation	VAS 0/10; FABER –; FADDIR –; McCarthy –; C-sign –; Wartenberg –; MRC 5/5
September – December 2025	Proprioceptive re-education, step training, selective strengthening of hip stabilizers (2 sessions/week)	Maintained functional recovery
January – May 2026	Global postural re-education (2 sessions/week)	Sustained asymptomatic status
May 11, 2026	9-month follow-up clinical evaluation	VAS 0/10; FABER –; FADDIR –; McCarthy –; C-sign –; Wartenberg –; MRC 5/5

Abbreviations: VAS, Visual Analogue Scale; MRC, Medical Research Council muscle strength scale; rPMS, repetitive peripheral magnetic stimulation; FABER, Flexion, ABduction, External Rotation test; FADDIR, Flexion, ADduction, Internal Rotation test. McCarthy test indicates intra-articular hip pathology; C-sign reflects patient-indicated deep hip joint pain; Wartenberg test assesses cutaneous sensitivity using a pinwheel. Scoring: +++ strongly positive, ++ moderately positive, – negative. The MRC scale ranges from 0 (no muscle contraction) to 5 (normal muscle strength). The VAS ranges from 0 (no pain) to 10 (worst imaginable pain).

Discussion

This case report presents a patient with FAI who experienced significant functional limitation and persistent symptoms, in the presence of only minimal radiological findings and without improvement following physiotherapy and pharmacological treatment. Following a one-month course of combined rPMS therapy, complete resolution of symptoms and restoration of function were achieved. This improvement was sustained during a 9-month follow-up period.

Although FAI is traditionally considered a mechanical disorder driven by structural abnormalities, this case suggests that, in selected patients, non-structural factors such as neuromuscular dysfunction, myofascial imbalance, and peripheral nerve irritation may play a substantial role in symptom generation. The presence of meralgia paresthetica and multiple positive provocation tests supports the hypothesis of a multifactorial pathophysiological mechanism, extending beyond purely mechanical impingement. In such cases, intensive non-invasive treatment strategies targeting soft tissues and neuromodulation may represent a potential alternative or adjunct to traditional surgical management, particularly in patients with minimal structural changes.

In patients with FAI presenting with severe pain and marked functional limitation, conventional conservative management may be inherently limited. Due to pain and restricted mobility, patients may be unable or insufficiently motivated to engage in active rehabilitation, which is a key component of conservative management, and whose effectiveness depends heavily on patient adherence, often reduced in the presence of pain and functional limitation [17]. Many non-invasive physiotherapeutic modalities are limited by their depth of tissue penetration, which may restrict their ability to effectively target deep-seated anatomical structures. Consequently, such interventions may not fully address the underlying sources of pain and dysfunction, particularly in conditions involving deeper musculoskeletal tissues [18,19].

Single-coil rPMS therapy, widely used in physiotherapy, has demonstrated effectiveness in pain modulation, muscle relaxation, and neuromuscular activation, particularly in the treatment of spasticity and selected musculoskeletal conditions [20–23]. One of its advantages lies in the minimal requirement for active patient participation, allowing treatment to be delivered without the need to overcome pain or restricted mobility [21,22]. However, this conventional approach is associated with limited depth of penetration, as the delivered energy decreases with increasing distance from the coil [24]. In contrast, the double-coil design, recently introduced into physiotherapy, has shown, in theoretical models, a significantly improved ability to deliver energy to deeper tissues, particularly when the coils are positioned at an angle of approximately 90° [11]. Although clinical confirmation of this increased effectiveness is still limited, this configuration appears particularly suitable for the treatment of large joints, such as the knee, hip, and shoulder, due to improved anatomical adaptability and the ability to deliver stimulation from multiple directions. The handheld applicator, on the other hand, primarily targets superficial tissue layers, allowing the therapist to dynamically apply stimulation to adjacent structures that may contribute to the clinical presentation. In this context, it may serve as a complementary modality, enhancing the overall therapeutic effect achieved in deeper structures.

In the present case, the combined application of these rPMS modalities may explain the observed outcome. The double-coil application likely contributed to the modulation of deep joint and periarticular structures, while the dynamic handheld application enabled targeted treatment of surrounding soft tissues and neural components. This combined strategy may have allowed for simultaneous addressing of both deep structural and superficial functional contributors to pain, resulting in complete symptom resolution. To date, this combined approach has been described only in the treatment of low back pain and in a patient with post-traumatic osteoporotic shoulder dysfunction [13,14]. To our knowledge, the present case represents the first reported application of this method in FAI.

Importantly, the sustained clinical improvement observed at follow-up cannot be attributed solely to the initial rPMS intervention. During the follow-up period, the patient underwent a structured rehabilitation program including proprioceptive re-education, strengthening of hip stabilizers, and global postural training. This may have contributed to the long-term outcome. However, it is noteworthy that similar conservative approaches had previously failed over a two-year period prior to rPMS treatment. This suggests that the initial reduction of pain and improvement in neuromuscular function may have acted as a gateway for effective rehabilitation, enabling the patient to engage in subsequent exercise-based therapy.

As this report describes the effect of the intervention in a single patient, the findings cannot be generalized to a broader population. The possibility of spontaneous recovery cannot be entirely excluded; however, given the persistence of symptoms despite ongoing treatment, its contribution is likely limited. Although this case includes mid-term follow-up demonstrating sustained clinical improvement, longer-term data are still needed.

Future research should aim to address these limitations by evaluating the effectiveness of this approach in larger patient cohorts. In particular, investigating its efficacy in patients with more pronounced structural changes, as well as exploring the relationship between treatment outcomes and the extent of structural and functional impairment, may provide valuable insights for clinical decision-making.

Conclusions

The findings of this case suggest the potential of a non-invasive combined rPMS approach in patients with FAI presenting with significant functional limitation despite minimal radiological findings. In this case, a patient who had not responded to conventional physiotherapy and pharmacological treatment over a two-year period experienced complete symptom resolution within one month of therapy, with sustained improvement throughout a 9-month follow-up period. Although these results must be interpreted with caution given the nature of a single case report, they may provide preliminary support for the use of combined rPMS as a therapeutic option in selected patients. Further research is required to confirm its clinical effectiveness and to better understand the underlying mechanisms of action.

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