

Review Paper

Non-surgical Approaches to Chronic Hip Pain: A Mini-review of Current Evidence and Emerging Therapies



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ABSTRACT

Chronic hip pain is a prevalent problem that significantly impacts daily functional activities, and its management often requires a tailored, non-surgical approach. This article examines various non-operative treatment strategies for managing chronic hip pain, with a focus on conditions such as osteoarthritis (OA), iliopsoas bursitis, labral tears, and greater trochanteric pain syndrome. Traditional therapies, including physical therapy, pharmacological treatments like non-steroidal anti-inflammatory drugs and corticosteroid injections, and lifestyle modifications, remain the first-line options. Emerging modalities such as biologics, platelet-rich plasma (PRP) injections, and shockwave therapy are gaining attention for their potential to improve outcomes in certain hip pathologies. The effectiveness and safety of these interventions are discussed, with an emphasis on evidence-based practices. This review aims to provide clinicians with a comprehensive framework for optimizing non-surgical management of chronic hip pain, thereby minimizing the need for invasive procedures.

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Introduction

Hip pain affects approximately 10% of the general population, and its prevalence increases with age [1, 2]. Hip pain is associated with challenges in executing fundamental movements, such as sitting and standing, which can result in chronic pain and negatively impact functional performance and overall quality of life (QoL) [3, 4].

The differential diagnosis of hip pain is largely influenced by its location. Anterior hip pain may result from conditions such as osteoarthritis (OA), iliopsoas bursitis, proximal femur fractures, hip flexor muscle strain, inflammatory arthritis, avascular necrosis of the femoral head, or acetabular labral tears. Posterior hip pain is often associated with piriformis syndrome, sacroiliac joint (SIJ) dysfunction, referred pain from the lumbar spine, or strain of the hip extensor or rotator muscles. Lateral hip pain is typically related to meralgia paresthetica, greater trochanteric bursitis, iliotibial band syndrome, or gluteus medius muscle dysfunction [4-9].

For each condition, non-operative management strategies offer effective relief and play a vital role in addressing chronic hip pain. These methods include physical therapy to improve strength and flexibility, pharmacological interventions such as non-steroidal anti-inflammatory drugs (NSAIDs) or corticosteroid injections to manage inflammation, activity modifications to reduce mechanical stress on the hip, and targeted rehabilitation exercises tailored to the specific diagnosis. Advanced approaches, including the use of biologics like platelet-rich plasma (PRP) or shockwave therapy, are emerging as valuable adjuncts in managing certain chronic hip conditions. By aligning the treatment modality with the underlying pathology and site of pain, clinicians can optimize outcomes while avoiding the risks associated with surgical intervention.

In this article, we aim to explore the diverse nonsurgical treatment options available for managing chronic hip pain. By categorizing the underlying conditions based on the site of pain—anterior, posterior, or lateral—we will provide a detailed review of evidence-based approaches tailored to each diagnosis. Our focus will be on evaluating conventional therapies, such as physical rehabilitation, pharmacological interventions, and lifestyle modifications, as well as examining emerging modalities, including biologics and advanced physiotherapeutic techniques. Through this comprehensive analysis, we seek to offer a practical framework for clinicians to effectively manage chronic hip pain while minimizing the need for surgical intervention.

OA

OA is a chronic, progressive degenerative disease affecting the joints [10, 11]. Approximately 10% of the population experiences symptomatic OA of the hip [11-17]. The expected growth in demand for joint replacement surgeries emphasizes the necessity for more effective and reliable conservative treatment strategies for hip OA [11, 17].

OA, a major contributor to global disability, demands a diverse array of effective treatment strategies to alleviate pain and impede the progression of the disease [10]. NSAIDs are the most widely endorsed non-surgical treatment for hip OA. As a primary therapeutic option, NSAIDs help decrease inflammation, thereby providing pain relief [18].

NSAIDs continue to be among the most frequently prescribed and thoroughly researched medications for hip OA [11, 19-26]. NSAIDs are analgesic medications that alleviate pain by reducing inflammation [18]. NSAIDs can be administered orally or applied topically and are recognized for their analgesic (pain-relieving) and antipyretic (fever-reducing) properties [18]. Although NSAIDs are effective for short-term, intermittent use, prolonged consumption can present risks to patients [21]. NSAIDs are linked to gastrointestinal and cardiovascular side effects. To reduce these risks, they may be combined with a prostaglandin analog or proton pump inhibitor, or substituted with a COX-2 selective inhibitor [13, 18, 27]. NSAIDs have been proven to alleviate pain and improve function in individuals with OA of the knee or hip [19-26]. Among the various NSAIDs, celecoxib, etoricoxib, rofecoxib, and diclofenac have demonstrated promising efficacy in treating hip OA. Specifically, diclofenac at a dose of 150 mg/day is more effective than ibuprofen, naproxen, and celecoxib [25]. NSAIDs continue to be the most commonly endorsed and recommended non-surgical treatment for OA [28-31]. While there is literature supporting the use of NSAIDs for hip OA, most studies have primarily concentrated on their effects in the knee [21].

In addition to NSAIDs, alternative medications for hip pain include acetaminophen (paracetamol), tramadol, glucosamine, chondroitin, and traditional opioids. Similar to NSAIDs, acetaminophen has both analgesic and antipyretic effects but does not possess anti-inflammatory properties. It is widely available as an over-the-counter medication [32]. Similarly, tramadol is an atypical opioid analgesic that is sometimes used in combination with acetaminophen for managing hip OA [33]. As an

atypical opioid, tramadol has a reduced affinity for the μ -opioid receptor, leading to fewer and less severe adverse effects compared to conventional opioids [34-36]. Evidence supporting the use of acetaminophen or tramadol in the treatment of hip OA is limited, with several studies demonstrating little to no significant improvement in pain and physical function compared to control groups [31, 33].

Glucosamine and chondroitin are nutritional supplements composed of amino acids that are integral to cartilage and synovial fluid. These compounds are believed to help maintain cartilage and inhibit its degeneration. However, current evidence does not sufficiently support their use in managing hip OA [11, 37]. When used alone or in combination with glucosamine, chondroitin has demonstrated modest improvements in knee pain associated with OA compared to control groups [37]. However, the studies presenting these findings are of low quality, highlighting the need for further research specifically targeting OA in both the knee and hip [37]. Typical opioids constitute another class of analgesic agents. However, due to the elevated risk of adverse effects, such as addiction, overdose, impaired functioning, and physiological dependence, the potential benefits are frequently overshadowed by these considerable risks [30, 38-40].

As hip OA progresses and NSAIDs, along with other medications, become less effective, more potent treatment options may be required. Injectable therapies, which remain classified as non-surgical, offer a targeted method for managing hip OA. To improve the precision of hip joint injections and ensure correct needle placement without exposing the patient to radiation, the use of fluoroscopic or ultrasound guidance is recommended [41]. In the absence of image guidance, the accuracy of intra-articular injection placement ranges from 67% to 88%, but this increases notably to 97% when ultrasound guidance is utilized [42, 43].

Intra-articular corticosteroid injections are frequently used for the knee due to the relative ease of accessing and injecting a single joint. However, for the hip, image guidance is necessary to ensure precise needle placement during the injection procedure [43]. Corticosteroid injections into an arthritic hip have been shown to offer short-term benefits in pain relief, functional improvement, and range of motion [44-46]. Based on these findings, clinical guidelines endorse corticosteroid injections as an effective non-surgical treatment for individuals with symptomatic hip OA [30, 47]. However, as many studies on hip corticosteroid injections were neither randomized

nor blinded, further research is required to assess their safety and efficacy with greater rigor [44]. Interestingly, studies on knee OA have demonstrated that steroid injections provide no more benefit than a placebo after three months and are less effective than physical therapy at the one-year follow-up [48, 49]. As such, while corticosteroid injections are recommended for short-term relief in the knee, there is inadequate evidence to establish the duration of their effectiveness in the hip [28].

Corticosteroid injections carry risks such as subchondral fractures and osteonecrosis, and may accelerate arthritis progression. Furthermore, they can elevate the risk of infection and potentially have adverse effects on cartilage [50, 51]. Locally, corticosteroid injections may result in fatty atrophy, worsen pain, or increase the risk of septic arthritis [52-54]. While most studies have concentrated on the knee, further research is required to validate the efficacy of corticosteroid injections for hip OA before they can be considered a standard non-surgical treatment option [30, 47, 48, 50, 55].

Viscosupplementation is an alternative injectable treatment to intra-articular corticosteroids. This procedure involves injecting hyaluronic acid (HA), a glycosaminoglycan found in synovial fluid and various tissues, into the affected joint to help alleviate pain and reduce swelling associated with arthritis [56, 57]. While some studies report beneficial outcomes following HA injections, other research suggests that HA is no more effective than a placebo or saline control [58, 59]. One study suggested a potential improvement with HA injections; however, the observed benefit was limited, and the sample size was insufficient to draw definitive conclusions [46, 55]. In knee studies, viscosupplementation has been strongly linked to an elevated risk of serious adverse events, which has led to its exclusion from clinical guidelines as a recommended treatment option [30, 60].

PRP is another injectable treatment option. As an orthobiologic therapy, PRP utilizes the patient's own blood components, which are processed and concentrated for therapeutic use. The growth factors naturally present in the concentrate support tissue healing at the injection site. PRP also has anti-inflammatory properties and is most effective when prepared in leukocyte-poor formulations [61-63]. Compared to HA and corticosteroid injections, PRP intra-articular injections have been less extensively studied, resulting in their more limited use in the treatment of hip OA [64]. The literature suggests that PRP injections may lead to reductions in hip pain, accompanied by improvements in function and mobility [65]. However, these outcomes do not surpass those

achieved with HA injections, and comparable positive results have been observed with a placebo [55, 59, 66].

Iliopsoas bursitis

The initial management of iliopsoas bursitis has typically involved rest, stretching and strengthening exercises, oral anti-inflammatory medications, and localized physical therapy. Ultrasound-guided lidocaine challenge or corticosteroid injections may be used as part of conservative management. In cases where the diagnosis remains uncertain, a bone scan, magnetic resonance imaging (MRI), or plain x-ray may be conducted. If the bone scan is normal, but symptoms persist, continued non-operative management may be recommended. If the MRI results are abnormal, further interventions or treatment may be necessary. In cases where non-operative management fails, a surgical opinion may be sought for long-term relief [67]. In another study, seven individuals who experienced symptoms during sports or dancing were advised to avoid activities that aggravated their condition and undergo physiotherapy. The physiotherapy program included assisted hip extension exercises and ultrasound therapy. This approach aimed to alleviate symptoms and promote recovery by addressing the mechanical and inflammatory components of the condition [68]. The results of this regimen were not significant. Hucherson and Denman outlined a treatment program that included bed rest, diathermy to the hip region, Buck's extension, and sodium salicylate, which proved successful in relieving pain and restoring a full range of motion for two patients. This approach demonstrated potential effectiveness in managing symptoms and improving function, though its applicability to a broader patient population remains uncertain [69]. Conservative measures proposed in a review article emphasized the use of ultrasound targeting the femoral triangle and post-isometric stretching of the iliopsoas muscle. These approaches aim to alleviate pain and improve mobility by enhancing muscle flexibility and reducing inflammation in the affected area. Ultrasound guidance ensures precise treatment application, while post-isometric stretching helps restore muscle function and reduce muscle tightness, potentially offering an effective non-invasive treatment option for iliopsoas bursitis [70].

Injection of the iliopsoas bursa or tendon with corticosteroids is another treatment option for iliopsoas bursitis. In three case studies, an injection was administered after the diagnosis was confirmed. Two patients received an injection of an anesthetic and steroid directly into the iliopsoas tendon. This approach aimed to provide immediate pain relief and reduce inflammation, offering

a targeted intervention for managing the condition. The use of corticosteroid injections in these cases resulted in symptom alleviation, though further studies are necessary to determine the long-term efficacy of this treatment [71-73]. In one patient, the corticosteroid injection resulted in immediate pain relief and a reduction in symptoms for two months. However, after this period, the symptoms recurred, suggesting that the benefits were temporary. The outcome for the other patient was unspecified, indicating that the response to the injection may vary among individuals. This outcome highlights the need for further investigation into the long-term effectiveness and recurrence rates associated with corticosteroid injections for iliopsoas bursitis [71, 72]. In another case report, a patient's symptoms persisted despite receiving a steroid injection into the iliopsoas bursa.

In all three cases, surgery was ultimately performed after the symptoms recurred, indicating that conservative treatments, including corticosteroid injections, may not always provide long-term relief for iliopsoas bursitis. This finding suggests that in some cases, surgical intervention may be necessary when conservative approaches fail to control symptoms or when there is a recurrence of pain and dysfunction. Further research is needed to understand better the most effective treatment strategies for this condition [74]. In a case series by Taylor and Clarke, three patients received steroid injections into the iliopsoas tendon region. The effectiveness of these injections, particularly when administered simultaneously with arthrography in two patients, was not clearly established. This result suggests that while the use of corticosteroid injections may provide some relief for iliopsoas bursitis, the lack of definitive outcomes and the need for arthrography highlight the requirement for further investigation into the combined treatment approach. More research is necessary to determine the optimal methods and effectiveness of steroid injections for iliopsoas tendon-related conditions [68].

In another study, one patient who received a steroid injection into the hip region remained symptomatic. In contrast, another patient who was injected at the lesser trochanter experienced symptom resolution and became asymptomatic after a period of rest. This finding suggests that the location of the injection may influence the outcome, with the injection at the lesser trochanter potentially offering better results for some individuals. The contrasting outcomes emphasize the need for more targeted approaches in treatment and further investigation into the optimal injection sites for effective management of iliopsoas bursitis or related hip conditions [75]. The most extensive and well-documented series of injections

was conducted by Vaccaro et al. who performed injections of the iliopsoas bursa with an anesthetic and steroid in 8 patients immediately following iliopsoas bursa imaging. This series provided valuable insights into the effectiveness of this treatment approach. The results demonstrated significant improvements in pain relief and function for many patients, offering evidence for the utility of corticosteroid injections in managing iliopsoas bursitis. However, as with other studies, the potential for recurrence of symptoms following the initial improvement underscores the need for ongoing evaluation and the consideration of alternative or adjunctive treatments for long-term relief [76].

In contrast, Broadhurst proposed a different approach that did not rely on prior imaging. This technique involved injection into the lesser trochanter, using an approach just below the gluteal fold and aimed toward the greater trochanter. This approach suggests a simpler method for targeting the iliopsoas region, potentially reducing the need for complex imaging procedures. However, further studies would be required to compare the effectiveness and safety of this approach with imaging-guided methods [70]. Similar to conservative management, it is hoped that future studies will provide more detailed information on the methods and outcomes of steroid injections, with or without anesthetic. Such studies could clarify the efficacy, safety, and long-term effects of these injections in the treatment of iliopsoas bursitis. Additionally, exploring the optimal injection technique, dosage, and patient selection criteria will be crucial for improving treatment outcomes and minimizing potential complications. This finding could help guide clinical decisions and provide clearer recommendations for practitioners managing patients with iliopsoas bursitis [73]. In any case, these injections may provide temporary or even permanent symptomatic relief, allowing for hip muscle retraining and potentially postponing or avoiding the need for surgical intervention. By alleviating pain and inflammation, injections can create a window of opportunity for patients to engage in rehabilitation exercises, strengthen the surrounding muscles, and improve joint function. This conservative approach may thus contribute to better long-term outcomes and minimize the need for more invasive procedures, particularly in cases where symptoms are manageable and surgery is not immediately required [73].

Proximal femur fractures

One study highlights the complex decision-making process involved in managing fragility hip fractures, particularly in older adults with significant comorbidities.

While surgical intervention remains the preferred approach for improving long-term survival and mobility, it is clear that non-surgical management must be optimized for those who are medically unfit for surgery. The findings highlight that although in-hospital mortality rates are similar between the two groups, the long-term outcomes, particularly one-year mortality, are worse for those managed non-surgically, emphasizing the need for strategies to enhance survival in these patients. The higher proportion of female patients in the non-surgical cohort and their greater dependence on assistance for mobility further suggests that gender and functional status may be important factors to consider in treatment planning. Additionally, the comparable rates of in-hospital complications and readmissions suggest that while surgical intervention may prevent mortality, non-surgical care can still effectively manage short-term complications. Study suggests that more tailored, patient-centered approaches should be pursued, especially when dealing with older adults with fragile health. Further research into enhancing non-surgical treatments, including pain management, rehabilitation, and mobility support, will be crucial for improving outcomes in this patient population. Future studies should focus on identifying key factors that can help predict which patients will benefit most from non-surgical management, ensuring they receive the best possible care based on their individual health profiles [77].

This comprehensive approach to non-operative management of intracapsular fractures highlights the critical role of individualized care for patients who may not be suitable candidates for surgery. As outlined, the two-stage management protocol focuses on preventing complications associated with immobility during the acute phase, followed by rehabilitation aimed at restoring functional independence. The emphasis on a multidisciplinary approach, involving healthcare professionals from various specialties, is crucial in ensuring that the patient's physical, psychological, and social needs are met throughout the recovery process. The non-operative approach is especially valuable for a diverse range of patients, including those with severe comorbidities or cognitive impairments, as well as individuals who prefer conservative treatment. While the majority of patients with intracapsular fractures benefit from surgical intervention, this protocol provides a viable alternative for select individuals, offering a structured plan to manage their condition and enhance QoL despite the absence of surgery. The involvement of paramedical services in both inpatient care and post-discharge rehabilitation is pivotal for achieving successful outcomes. The tailored rehabilitation efforts, which include gradual mobilization and the use of assis-

tive devices, reflect a patient-centered philosophy aimed at enhancing strength, mobility, and independence. The active participation of patients and their families in setting rehabilitation goals is also a key aspect that aligns the treatment with the patient's expectations and personal circumstances. Despite the promise of non-operative management, it is clear that further research is needed to refine these protocols and identify the best predictors for success in this population. Understanding the factors that influence recovery in conservatively managed patients will help optimize care plans and improve long-term outcomes, ensuring that this treatment approach continues to serve as an effective alternative for those who cannot undergo surgery [78].

Hip flexor muscle strain

For more severe strains, treatment may involve additional interventions. In these cases, the focus is on promoting healing and minimizing further damage. Physical therapy plays a critical role in rehabilitation, with a progression of exercises that target flexibility, strength, and stability. Initially, gentle stretching and range-of-motion exercises may be incorporated to prevent stiffness. As the muscle heals, strengthening exercises will help to restore function and prevent future injuries.

In some cases, especially with more severe strains or those that do not respond to conservative management, an MRI may be necessary to assess the extent of the muscle damage. An MRI can help identify any tears or significant damage to muscle fibers that may need more intensive treatment or even surgical intervention, though this is rare. If rehabilitation and conservative measures fail to provide relief, corticosteroid injections or other medical interventions may be considered to reduce inflammation and promote healing. However, these should be used sparingly to avoid potential side effects, such as tissue weakening or further injury. Preventative measures are essential, particularly for individuals with a history of hip strains or those engaged in high-risk activities, such as athletes. Proper warm-up routines, gradual progression of exercise intensity, and maintaining flexibility and strength in the hip muscles can help minimize the risk of strains. Overall, the management of hip muscle strains emphasizes rest, rehabilitation, and gradual recovery, with surgical intervention reserved for the most severe or persistent cases [79].

Avascular necrosis

Non-traumatic osteonecrosis of the femoral head results from compromised blood supply to the femoral

head, leading to structural and functional damage to the surrounding articular cartilage, subchondral bone, and blood vessels. This disruption ultimately causes subchondral osteonecrosis, collapse of the femoral head, and subsequent hip joint pain [80-82].

Non-traumatic osteonecrosis of the femoral head occurs due to impaired blood circulation to the femoral head, which leads to damage in the surrounding articular cartilage, subchondral bone, and blood vessels. This disturbance results in subchondral osteonecrosis, femoral head collapse, and hip joint pain [83]. Research has demonstrated that local non-weight bearing can help mitigate the progression of femoral head deformity following ischemic osteonecrosis by promoting revascularization and reducing bone resorption in the affected epiphysis. However, it does not promote new bone formation [83, 84]. Consequently, weight-bearing may help prevent the onset and progression of osteonecrosis, particularly femoral head collapse, in individuals with early-stage disease and small lesions [85, 86].

Lipid-lowering agents, anticoagulants, vasoactive substances, statins, and bisphosphonates have been used to prevent and manage femoral head necrosis in its early stages [87-93].

Prostacyclin, a vasodilatory agent and thromboxane antagonist, improves blood circulation by inhibiting platelet aggregation. While the short-term use of prostacyclin has demonstrated significant improvements in clinical and radiological outcomes in early-stage osteonecrosis of the femoral head, its long-term efficacy remains to be studied [94]. One study suggested that combining intravenous prostacyclin with core decompression may help reduce the symptoms of osteonecrosis [95]. Iloprost, a synthetic analog of prostacyclin typically used for pulmonary arterial hypertension, has also been shown to be effective in treating bone marrow edema and osteonecrosis of the femoral head [96, 97]. A combination of enoxaparin, ginkgo biloba extract (both vasodilators), and sildenafil has been shown to enhance femoral head perfusion in an animal model of steroid-induced osteonecrosis of the femoral head [96, 97].

Research has demonstrated that the progression of osteonecrosis of the femoral head in the hip joint is associated with an increase in both the quantity and size of circulating adipocytes [98, 99]. Consequently, lipid-lowering statins, which are commonly prescribed for steroid-induced inflammatory conditions, may hold promise as a potential therapeutic approach for treating osteonecrosis of the femoral head [98, 99]. In fact, lovas-

tatin has demonstrated the ability to reduce adipogenesis and bone necrosis in a chicken model of steroid-induced osteonecrosis of the femoral head, while also promoting the expression of osteogenic genes in bone marrow cells [100]. Furthermore, Rb1 has been found to decrease inflammation, oxidative stress, total cholesterol, as well as both low- and high-density lipoprotein levels. It also reduces alkaline phosphatase activity and bone calcium loss in rats with steroid-induced avascular necrosis of the femoral head [101].

Extracorporeal shock wave therapy (ESWT), a non-invasive treatment method, has been employed in the management of osteonecrosis of the femoral head since the late 20th century [102, 103]. ESWT offers a promising non-invasive alternative to the more invasive surgical approaches typically used to treat osteonecrosis of the femoral head at various stages [104]. However, other studies suggest that ESWT is mainly effective in managing early-stage osteonecrosis of the femoral head [105].

It has been found that pulsed electromagnetic fields (PEMF) can facilitate fracture healing. Further research has shown that PEMF can also help manage inflammation and support the repair of articular cartilage in patients with OA, as well as those undergoing joint surgery [101, 106-108]. Reports have described two patients with Ficat stage II osteonecrosis of the femoral head who underwent daily PEMF therapy for 10 hours over six months, resulting in significant improvements in their condition [109].

Hyperbaric oxygen therapy (HBO) has proven to be particularly effective in managing the early stages of femoral head necrosis, with notable success observed in Asian populations [110-114]. The clinical effectiveness of HBO is primarily due to its ability to stimulate the production of growth factors that facilitate wound healing and mitigate post-ischemic and post-inflammatory damage [115, 116]. Furthermore, the rise in hydrostatic pressure during HBO compresses all gas-filled spaces in the body, as described by Boyle's law, potentially aiding in the reversal of decompression-related disorders [117, 118]. HBO helps reduce edema, improve tissue oxygenation, and restore venous drainage in the affected bone region by stimulating the proliferation of endothelial progenitor cells, promoting neo-angiogenesis, and enhancing local microcirculation [119-124].

Acetabular labral tears

Peterson first introduced the concept of labral tears in 1957, documenting two cases that resulted from poste-

rior hip dislocations [125-127]. Labral tears are most frequently associated with femoroacetabular impingement (FAI), a condition marked by deformities in either the acetabulum, the femoral head, or both [128]. If a torn labrum and its underlying cause are not addressed, the hip joint may experience a faster progression to OA [129, 130]. Labral repair is becoming increasingly preferred, as preserving the labrum yields improved outcomes compared to labral debridement [131-133]. With advancements in techniques and instrumentation, labral reconstruction has emerged as a more promising option than debridement when the labrum is considered irreparable due to hypertrophy or prior debridement. However, long-term follow-up is required to provide further evidence of its efficacy [134, 135].

Patients experiencing groin pain suspected to be due to an acetabular labral tear may first undergo conservative management. This approach typically includes rest, NSAIDs, pain relief measures as needed, activity modification, physical therapy, and intra-articular injections [136]. Although the pain may be temporarily relieved, it frequently returns once the patient resumes their regular activities [137]. A 12-week physical therapy regimen has demonstrated favorable results in four patients, including pain reduction, enhanced strength, and improved functional ability [138, 139].

The favorable response to the anesthetic helps confirm that the labral tear is the primary source of pain, distinguishing it from other extra-articular conditions, such as psoas bursitis. Additionally, the anti-inflammatory effects of the corticosteroid can help alleviate acute flare-ups [140]. Indicates that the coexistence of FAI with hip labral tears raises the probability of needing surgical intervention following non-operative treatment [139, 141].

Piriformis syndrome

The piriformis muscle is a triangular, flattened structure situated deep within the proximal posterior thigh, adjacent to the short external rotators of the hip [142]. The L5-S2 nerve roots innervate the muscle through the sciatic nerve. Piriformis syndrome typically results from trauma to the buttocks, leading to soft tissue inflammation, muscle spasms, and compression of the sciatic nerve [143]. Like other overuse injuries, microtrauma of the piriformis muscle can occur from activities such as walking or running long distances. Repetitive movements and prolonged strain can lead to muscle fatigue, inflammation, and ultimately, injury, contributing to conditions such as piriformis syndrome [144]. Ultimately, overuse injuries, hypertrophy, and inflammation

of the piriformis muscle can lead to compression of the sciatic nerve. This compression results in the characteristic neuropathic pain typically experienced along the distribution of the sciatic nerve, often radiating through the buttocks, thigh, and down the leg [145].

Currently, the standard approach is to start with conservative treatment for piriformis syndrome, progressing to more invasive interventions if symptoms do not improve. Conservative measures typically include rest, physical therapy, anti-inflammatory medications, and, in some cases, corticosteroid injections. If these methods fail to provide relief, surgical options may be considered [146]. In a study involving 42 patients with suspected piriformis syndrome, 41 patients experienced complete resolution of symptoms either spontaneously or through conservative treatment within 35 days [147]. For patients without significant alarm symptoms, conservative management can be initiated, with a relatively high success rate. Initially, brief rest (limited to no more than 48 hours) may provide symptom relief [148]. Before resorting to medical management, additional strategies focus on mobilizing the affected area. Techniques aimed at addressing soft tissue restrictions and trigger points may help alleviate symptoms. However, these methods should be avoided in patients with highly irritable symptoms, as they could potentially worsen discomfort [149]. If motion is restricted, mobilizing the hip and lumbosacral region can help improve flexibility, reduce tension, and alleviate pressure on the piriformis muscle. This approach can help restore normal movement patterns and relieve pain associated with piriformis syndrome. However, it should be performed cautiously, especially in patients with acute symptoms or significant irritability [149].

NSAIDs are commonly used to alleviate the symptoms of piriformis syndrome by reducing inflammation caused by repetitive movements. While they offer effective short-term pain relief, their potential side effects, such as stomach ulcers, should be discussed with patients. In cases where NSAIDs are insufficient, neuropathic agents like gabapentin and pregabalin may be considered. These medications are particularly useful for patients who experience neuropathic pain and have not responded to traditional anti-inflammatory treatments [150].

The combination of mannitol and vitamin B has shown promising outcomes in alleviating symptoms of piriformis syndrome. These findings suggest that this combined therapy may serve as an effective treatment option

for managing the symptoms associated with piriformis syndrome [151].

Although medical management can provide symptomatic relief, physical therapy is also essential in treating piriformis syndrome. Traditional stretching techniques for this condition typically involve exercises that promote external rotation, hip flexion, and adduction [152, 153]. The study by Gullledge et al. found that both the external rotation and adduction stretches resulted in a 12% elongation of the piriformis muscle. However, when the hip joint was placed at specific angles of hip flexion, external rotation, and adduction, the elongation was significantly greater. In particular, positioning the hip at 115° of hip flexion, 40° of external rotation, and 25° of adduction, or at 120° of hip flexion, 50° of external rotation, and 30° of adduction, resulted in a significantly greater increase in muscle length. These specific positions produced a 30-40% elongation of the piriformis muscle, suggesting that targeted stretching at these angles could be more effective in addressing piriformis syndrome [152]. By incorporating external rotation and adduction stretches at the recommended angles, patients can enhance their physical therapy regimen, potentially optimizing clinical outcomes in the management of piriformis syndrome [153].

Acupuncture has held promises as an effective treatment for piriformis syndrome [154]. Compared to conventional acupuncture, the triple acupuncture technique is associated with a higher likelihood of recovery following treatment. Another technique investigated for piriformis syndrome is dry needling, which focuses on targeting specific "point" locations rather than the meridian pathways used in acupuncture [155]. A similar set of findings was reported in a randomized controlled trial conducted in 2019 [156].

Neural therapy is another treatment option for piriformis syndrome, involving the injection of local anesthetics and commonly used for managing painful musculoskeletal disorders. Specifically, lidocaine has proven to be effective in alleviating refractory chronic pain [157].

Steroid injections are typically reserved for patients who do not respond to conservative treatments, such as NSAIDs or physical therapy [158, 159]. While steroid injections are not universally recommended, recent studies have shown their effectiveness in treating piriformis syndrome [160, 161].

Although steroid injections have shown clinical benefits, a 2015 study found that they may not provide any significant advantage over local anesthetic injections [162].

Piriformis injections can be performed using various techniques, including ultrasound, fluoroscopy, CT scan, electromyography, and MRI [163]. No statistically significant differences were found between the two injection methods in terms of functional outcomes, pain scores, patient satisfaction, or procedure duration [164].

A 2019 study examined the use of sciatic perineural hydrodissection before ultrasound-guided corticosteroid injection as a treatment for piriformis syndrome [165]. Hydrodissection is a minimally invasive technique that involves injecting fluid to separate the perineural tissue space. This process helps reduce adhesions and increases the tissue space, enabling more accurate targeting of anesthetic and corticosteroid injections [165].

Botulinum toxin type A (BoNT-A) disrupts the exocytosis of excitatory neurotransmitters in peripheral and sensory neurons by cleaving SNARE (soluble N-ethylmaleimide-sensitive factor activating protein receptor) proteins, effectively inhibiting their function [166, 167]. The disruption of sodium channel function by botulinum toxin contributes to the reduction in pain transmission. Abnormal sodium channels are, in fact, involved in pain disorders such as erythromelalgia [166]. This results in the presynaptic inhibition of acetylcholine release at the neuromuscular junction, leading to muscle paralysis [168].

Several factors are known to sensitize muscular nociceptors and initiate muscle and myofascial pain, including calcitonin gene-related peptide, substance P, bradykinin, serotonin, potassium, and prostaglandin E2 [169, 170]. The primary mechanism of action of BoNT-A is the inhibition of substance P release and other inflammatory mediators [166, 170]. Studies have demonstrated that BoNT-A inhibits the release of substance P from cultured embryonic dorsal root ganglion neurons. Furthermore, it reduces the release of calcitonin gene-related peptide from cultured trigeminal ganglion neurons [166, 170]. It is proposed that BoNT-A injections similarly block the release of these neuropeptides in vivo, while also lowering lactate levels in the contracted muscle. This, in turn, results in a reduction in the release of sensitizing mediators [167, 169].

Proper technique for BoNT-A injection is essential due to the small size and deep location of the piriformis muscle, as well as its proximity to critical neurovascular structures [169, 171]. Ultrasound guidance is a non-invasive technique, and its effective use during BoNT-A administration for piriformis syndrome is well-established in the literature [167, 169, 172].

Alternative guidance methods for piriformis muscle injections include CT, MRI, and fluoroscopy. MRI improves targeting accuracy, especially when the piriformis muscle is abnormally thin or when the patient is overweight. It is also particularly useful for performing combination injections into the infrapiriform foramen at the greater sciatic notch [171]. An intramuscular injection of 100 to 200 units of BoNT-A induces weakness and atrophy of the targeted muscle, potentially aiding in the reversal of any nerve compression that may have occurred [168].

Several recent case reports in the literature have documented the resolution of pain and the restoration of function following BoNT-A injections [167, 173-175].

Adverse events reported in the literature include pain at the injection site, flu-like symptoms, stiff neck, anterior thigh pain and weakness, and severe buttock pain [176]. Muscle atrophy and the development of fat tissue have been reported following botulinum toxin injection in the treatment of piriformis syndrome [174].

SIJ dysfunction

There is no single, universally effective noninvasive treatment or combination of treatments for SIJ pain, which typically presents as a progressive condition with fluctuating symptoms, often triggered by specific daily activities, sports, or exercise. In the acute or sub-acute phases, reducing inflammation may be beneficial through a brief course of NSAIDs for up to two weeks, along with regular icing [177, 178].

Once pain is managed, healthcare providers often recommend consulting with a physical therapist to use therapeutic exercises aimed at correcting functional biomechanical deficits and restoring motion, thereby reducing pain. A home exercise program is usually recommended to promote meaningful improvements and prevent future recurrences of SIJ pain. Therapeutic exercise plays a critical role in addressing the underlying dysfunction that contributes to the pain. However, the literature on this subject is limited, leaving healthcare providers to rely on their training, personal experience, and patient

outcomes to inform treatment decisions [179, 180]. Multiple case reports focusing on therapeutic exercise alone, as well as a case series involving a combination of therapeutic exercise and manipulation, have demonstrated a reduction in pain and an improvement in function following treatment [181-186].

When addressing SIJ pain and dysfunction, particular attention must be given to several important muscles and muscle groups. The hamstring, in particular, plays a significant role in SIJ stability due to its direct attachment or fascial connections to the sacrotuberous ligament, an extrinsic ligament contributing to joint stability. Treatment should focus on evaluating the pelvic muscles for tightness, length, or stiffness, as this assessment will inform the choice of interventions. After addressing muscle length and stiffness, strengthening exercises can be implemented for muscles weakened by biomechanical deficits. Neuromuscular reeducation and facilitation techniques are valuable throughout this process. Initially, closed kinetic chain strengthening should be emphasized, followed by integration into lumbopelvic stabilization exercises [187].

Manual medicine techniques are often included in the treatment plan for SIJ pain. However, as with any therapeutic modality, it is essential to carefully select the appropriate patient with the correct condition to ensure the most favorable outcome [177].

Greater trochanter bursitis

For an extended period, localized lateral hip pain with specific tenderness over the greater trochanter has commonly been clinically diagnosed as trochanteric bursitis [188, 189]. The diagnosis of trochanteric bursitis may be uncertain, as three of the four cardinal signs of inflammation—rubor, erythema, and edema—are rarely observed, with pain being the only consistent symptom [190, 191]. Radiological findings in patients with greater trochanteric pain syndrome (GTPS) exhibit variable incidence, with bursitis observed in 4% to 46% of cases and gluteal tendinopathy in 18% to 50% of cases [192, 194].

In the early stages, treatment for GTPS typically involves a variety of conservative interventions, including physiotherapy, local corticosteroid injections, PRP injections, shockwave therapy, activity modification, pain management, anti-inflammatory medications, and weight reduction. The majority of cases improve with these conservative approaches, with success rates surpassing 90% [195, 196].

Various interventions have been suggested for managing GTPS. Conservative treatment options include pain-relief medications, NSAIDs, physiotherapy, shockwave therapy, and corticosteroid injections, either as stand-alone therapies or in combination [197]. Regenerative injection therapy is an additional potential treatment option for GTPS. However, most patients achieve symptom resolution through conservative management strategies [196, 198].

No research was found that directly investigated physiotherapy interventions for GTPS. Conventional approaches to managing GTPS typically emphasize alleviating pain and inflammation rather than addressing changes in tendon structure [199]. Evidence supporting the effectiveness of commonly used physiotherapy modalities for tendinopathies and tendinitis, such as deep transverse friction massage, therapeutic ultrasound, and acupuncture, is generally lacking [199, 200].

Exercise is the primary treatment for tendinopathy, with eccentric exercise demonstrating greater effectiveness compared to general exercise programs. Eccentric exercise incorporates targeted movements, significant loading, and resistance training, which not only alleviates pain but may also facilitate the restoration of normal tendon structure [199].

Local corticosteroid injections are commonly employed in the treatment of GTPS. While the precise mechanism through which they relieve tendon pain is not fully understood, it is likely linked to their influence on inflammatory and nociceptive pathways [190, 201-204]. Studies have shown no significant difference in outcomes between image-guided injections and blind injections [190, 205]. Patients who received ultrasound-guided injections reported greater benefits. However, fluoroscopic-guided injections for the trochanteric bursa are not recommended for GTPS due to concerns regarding outcomes, cost, and potential treatment delays [202, 205]. One study reported greater improvement in patients with GTPS who received corticosteroid injections to the greater trochanteric bursa compared to those receiving injections to the subgluteal bursa at a 2-week follow-up. However, not all patients showed clinical signs of bursitis, indicating a weak correlation between ultrasound diagnosis and pain reduction after corticosteroid injection [206]. Corticosteroid injections may be most effective in reducing pain, which in turn can enhance the outcomes of physiotherapy [196, 198]. However, a concern associated with CSI is the potential for long-term weakening of the tendon structure [201].

Shockwave therapy has demonstrated effectiveness in treating tendinopathy, particularly in cases of GTPS [198, 207]. Shockwave therapy protocols vary in terms of energy density, shockwave frequency, and the number of sessions. Although the precise mechanism by which shockwave therapy influences GTPS is not fully elucidated, it is thought to facilitate healing, possibly through the stimulation of cellular activity and an increase in blood circulation [197, 198, 207].

PRP or whole blood injections have been employed in treating tendinopathies by enhancing natural healing through the provision or modulation of cellular mediators, including growth factors. While evidence on the efficacy of PRP or blood injections for tendinopathies remains limited, no direct studies have focused on GTPS. However, early findings are promising, suggesting that these injections could serve as a potential treatment option before considering surgical intervention [198, 201].

Advancements in non-surgical treatments for tendinopathy are emerging, fueled by a more comprehensive understanding of the underlying pathological processes. These treatments encompass topical glycerol trinitrate therapy, matrix metalloproteinase inhibitor injections, gene or stem cell therapy, autologous tenocyte injections, and sclerosant injections. However, evidence supporting the clinical use of these interventions remains limited, and controlled trials are needed to assess their efficacy and safety in treating tendinopathies [198, 200, 201].

Conclusion

The management of chronic hip pain through non-surgical interventions offers significant potential for improving patient outcomes without resorting to invasive procedures. Evidence supports the use of traditional therapies such as physical rehabilitation, pharmacological interventions, and lifestyle modifications for various hip pathologies. Emerging treatment modalities, including biologics like PRP and shockwave therapy, show promise in managing conditions that are resistant to conventional treatments. As the landscape of non-surgical therapies continues to evolve, clinicians must adopt a personalized, evidence-based approach that aligns with the specific diagnosis and individual patient needs. Continued research and well-designed clinical trials are essential further to establish the efficacy and safety of these emerging treatments, ensuring that chronic hip pain can be managed effectively with minimal risk.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

Conceptualization: Kaveh Gharanizadeh and Arash Aris; Writing the original draft: Khatere Mokhtari; Review & editing: Kaveh Gharanizadeh and Arash Aris; Supervision and project administration: Arash Aris; Investigation: All authors.

Conflict of interest

The authors declared no conflict of interest.

References

- [1] Picavet HS, Schouten JS. Musculoskeletal pain in the Netherlands: Prevalences, consequences and risk groups, the DMC(3)-study. *Pain*. 2003; 102(1-2):167-78. [DOI:10.1016/s0304-3959(02)00372-x] [PMID]
- [2] Christmas C, Crespo CJ, Franckowiak SC, Bathon JM, Bartlett SJ, Andersen RE. How common is hip pain among older adults? Results from the Third National Health and Nutrition Examination Survey. *J Fam Pract*. 2002; 51(4):345-8. [PMID]
- [3] Wilson JJ, Furukawa M. Evaluation of the patient with hip pain. *Am Fam Physician*. 2014; 89(1):27-34. [PMID]
- [4] Ahuja V, Thapa D, Patial S, Chander A, Ahuja A. Chronic hip pain in adults: Current knowledge and future perspective. *J Anaesthesiol Clin Pharmacol*. 2020; 36(4):450-7. [DOI:10.4103/joacp.JOACP_170_19] [PMID]
- [5] Bhatia A, Hoydonckx Y, Peng P, Cohen SP. Radiofrequency procedures to relieve chronic hip pain: An evidence-based narrative review. *Reg Anesth Pain Med*. 2018; 43(1):72-83. [DOI:10.1097/AAP.0000000000000694] [PMID]
- [6] Margo K, Drezner J, Motzkin D. Evaluation and management of hip pain: An algorithmic approach. *J Fam Pract*. 2003; 52(8):607-17. [PMID]
- [7] Breivik H, Borchgrevink PC, Allen SM, Rosseland LA, Romundstad L, Hals EK, et al. Assessment of pain. *Br J Anaesth*. 2008; 101(1):17-24. [DOI:10.1093/bja/aen103] [PMID]

- [8] Dick AG, Houghton JM, Banks MJ. An approach to hip pain in a young adult. *BMJ*. 2018; 361:k1086. [DOI:10.1136/bmj.k1086] [PMID]
- [9] Baniassadi M, Talebi S, Mokhtari K, Zabolian AH, Khosroshahi EM, Entezari M, et al. Role of non-coding RNAs in osteoporosis. *Pathol Res Pract*. 2024; 253:155036. [DOI:10.1016/j.prp.2023.155036] [PMID]
- [10] Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, et al. The global burden of hip and knee osteoarthritis: estimates from the global burden of disease 2010 study. *Ann Rheum Dis*. 2014; 73(7):1323-30. [DOI:10.1136/annrheumdis-2013-204763]
- [11] Shakeri M, Aminian A, Mokhtari K, Bahaeddini M, Tabrizian P, Farahani N, et al. Unraveling the molecular landscape of osteoarthritis: A comprehensive review focused on the role of non-coding RNAs. *Pathol Res Pract*. 2024; 260:155446. [DOI:10.1016/j.prp.2024.155446] [PMID]
- [12] Jordan JM, Helmick CG, Renner JB, Luta G, Dragomir AD, Woodard J, et al. Prevalence of hip symptoms and radiographic and symptomatic hip osteoarthritis in African Americans and Caucasians: The Johnston County Osteoarthritis Project. *J Rheumatol*. 2009; 36(4):809-15. [DOI:10.3899/jrheum.080677] [PMID]
- [13] Katz JN, Arant KR, Loeser RF. Diagnosis and treatment of hip and knee osteoarthritis: A review. *JAMA*. 2021; 325(6):568-78. [DOI:10.1001/jama.2020.22171] [PMID]
- [14] Hermans J, Koopmanschap MA, Bierma-Zeinstra SM, van Linge JH, Verhaar JA, Reijman M, et al. Productivity costs and medical costs among working patients with knee osteoarthritis. *Arthritis Care Res (Hoboken)*. 2012; 64(6):853-61. [DOI:10.1002/acr.21617] [PMID]
- [15] Hunter DJ, Schofield D, Callander E. The individual and socioeconomic impact of osteoarthritis. *Nat Rev Rheumatol*. 2014; 10(7):437-41. [DOI:10.1038/nrrheum.2014.44] [PMID]
- [16] Sharif B, Garner R, Hennessy D, Sanmartin C, Flanagan WM, Marshall DA. Productivity costs of work loss associated with osteoarthritis in Canada from 2010 to 2031. *Osteoarthritis Cartilage*. 2017; 25(2):249-58. [DOI:10.1016/j.joca.2016.09.011] [PMID]
- [17] Nho SJ, Kymes SM, Callaghan JJ, Felson DT. The burden of hip osteoarthritis in the United States: Epidemiologic and economic considerations. *J Am Acad Orthop Surg*. 2013; 21:S1-6. [DOI:10.5435/00124635-201300001-00003]
- [18] Dugowson CE, Gnanashanmugam P. Nonsteroidal anti-inflammatory drugs. *Phys Med Rehabil Clin N Am*. 2006; 17(2):347-54, vi. [DOI:10.1016/j.pmr.2005.12.012] [PMID]
- [19] Bocanegra TS, Weaver AL, Tindall EA, Sikes DH, Ball JA, Wallemark CB, et al. Diclofenac/misoprostol compared with diclofenac in the treatment of osteoarthritis of the knee or hip: a randomized, placebo controlled trial. *Arthrotec Osteoarthritis Study Group. J Rheumatol*. 1998; 25(8):1602-11. [PMID]
- [20] Cannon GW, Caldwell JR, Holt P, McLean B, Seidenberg B, Bolognese J, et al. Rofecoxib, a specific inhibitor of cyclooxygenase 2, with clinical efficacy comparable with that of diclofenac sodium: Results of a one-year, randomized, clinical trial in patients with osteoarthritis of the knee and hip. *Rofecoxib Phase III Protocol 035 Study Group. Arthritis Rheum*. 2000; 43(5):978-87. [DOI:10.1002/1529-0131(20005)43:5<978::AID-ANR4>3.0.CO;2-0] [PMID]
- [21] da Costa BR, Reichenbach S, Keller N, Nartey L, Wandel S, Jüni P, et al. Retracted: Effectiveness of non-steroidal anti-inflammatory drugs for the treatment of pain in knee and hip osteoarthritis: A network meta-analysis. *Lancet*. 2016; 387(10033):2093-105. [DOI:10.1016/S0140-6736(16)30002-2] [PMID]
- [22] Gibofsky A, Hochberg MC, Jaros MJ, Young CL. Efficacy and safety of low-dose submicron diclofenac for the treatment of osteoarthritis pain: a 12 week, phase 3 study. *Curr Med Res Opin*. 2014; 30(9):1883-93. [DOI:10.1185/03007995.2014.946123] [PMID]
- [23] Gore M, Tai KS, Sadosky A, Leslie D, Stacey BR. Use and costs of prescription medications and alternative treatments in patients with osteoarthritis and chronic low back pain in community-based settings. *Pain Pract*. 2012; 12(7):550-60. [DOI:10.1111/j.1533-2500.2012.00532.x] [PMID]
- [24] Kivitz AJ, Moskowitz RW, Woods E, Hubbard RC, Verburg KM, Lefkowitz JB, et al. Comparative efficacy and safety of celecoxib and naproxen in the treatment of osteoarthritis of the hip. *J Int Med Res*. 2001; 29(6):467-79. [DOI:10.1177/147323000102900602] [PMID]
- [25] Puljak L, Marin A, Vrdoljak D, Markotic F, Utrobovic A, Tugwell P. Celecoxib for osteoarthritis. *Cochrane Database Syst Rev*. 2017; 5(5):CD009865. [DOI:10.1002/14651858.CD009865.pub2] [PMID]
- [26] Yocum D, Fleischmann R, Dalgin P, Caldwell J, Hall D, Roszko P. Safety and efficacy of meloxicam in the treatment of osteoarthritis: A 12-week, double-blind, multiple-dose, placebo-controlled trial. *The Meloxicam Osteoarthritis Investigators. Arch Intern Med*. 2000; 160(19):2947-54. [DOI:10.1001/archinte.160.19.2947] [PMID]
- [27] Scheiman JM. The use of proton pump inhibitors in treating and preventing NSAID-induced mucosal damage. *Arthritis Res Ther*. 2013; 15 Suppl 3(Suppl 3):S5. [DOI:10.1186/ar4177] [PMID]
- [28] Bannuru RR, Osani MC, Vaysbrot EE, Arden NK, Bennell K, Bierma-Zeinstra SMA, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthritis Cartilage*. 2019; 27(11):1578-89. [DOI:10.1016/j.joca.2019.06.011] [PMID]
- [29] Geenen R, Overman CL, Christensen R, Åsenlöf P, Capela S, Huisinga KL, et al. EULAR recommendations for the health professional's approach to pain management in inflammatory arthritis and osteoarthritis. *Ann Rheum Dis*. 2018; 77(6):797-807. [DOI:10.1136/annrheumdis-2017-212662] [PMID]
- [30] Kolasinski SL, Neogi T, Hochberg MC, Oatis C, Guyatt G, Block J, et al. 2019 American College of Rheumatology/Arthritis Foundation Guideline for the Management of Osteoarthritis of the Hand, Hip, and Knee. *Arthritis Rheumatol*. 2020; 72(2):220-33. [DOI:10.1002/art.41142] [PMID]

- [31] Towheed TE, Maxwell L, Judd MG, Catton M, Hochberg MC, Wells G. Acetaminophen for osteoarthritis. *Cochrane Database Syst Rev*. 2006; 2006(1):CD004257. [DOI:10.1002/14651858.CD004257.pub2] [PMID]
- [32] Clissold SP. Paracetamol and phenacetin. *Drugs*. 1986; 32 (Suppl 4):46-59. [DOI:10.2165/00003495-198600324-00005] [PMID]
- [33] Toupin April K, Bisailon J, Welch V, Maxwell LJ, Jüni P, Rutjes AW, et al. Tramadol for osteoarthritis. *Cochrane Database Syst Rev*. 2019; 5(5):CD005522. [PMID]
- [34] Grond S, Sablotzki A. Clinical pharmacology of tramadol. *Clin Pharmacokinet*. 2004; 43(13):879-923. [DOI:10.2165/00003088-200443130-00004] [PMID]
- [35] Marks DM, Shah MJ, Patkar AA, Masand PS, Park GY, Pae CU. Serotonin-norepinephrine reuptake inhibitors for pain control: Premise and promise. *Curr Neuropharmacol*. 2009; 7(4):331-6. [DOI:10.2174/157015909790031201] [PMID]
- [36] Paredes S, Cantillo S, Candido KD, Knezevic NN. An association of serotonin with pain disorders and its modulation by estrogens. *Int J Mol Sci*. 2019; 20(22):5729. [DOI:10.3390/ijms20225729] [PMID]
- [37] Singh JA, Noorbaloochi S, MacDonald R, Maxwell LJ. Chondroitin for osteoarthritis. *Cochrane Database Syst Rev*. 2015; 1(1):CD005614. [DOI:10.1002/14651858.CD005614.pub2] [PMID]
- [38] Vowles KE, McEntee ML, Julnes PS, Frohe T, Ney JP, van der Goes DN. Rates of opioid misuse, abuse, and addiction in chronic pain: A systematic review and data synthesis. *Pain*. 2015; 156(4):569-76. [DOI:10.1097/01.j.pain.0000460357.01998.f1] [PMID]
- [39] Devez LA, Hunter DJ, Van Spil WE. Too much opioid, too much harm. *Osteoarthritis Cartilage*. 2018; 26(3):293-5. [DOI:10.1016/j.joca.2017.12.003] [PMID]
- [40] da Costa BR, Nüesch E, Kasteler R, Husni E, Welch V, Rutjes AW, et al. Oral or transdermal opioids for osteoarthritis of the knee or hip. *Cochrane Database Syst Rev*. 2014; 2014(9):CD003115. [DOI:10.1002/14651858.CD003115.pub4] [PMID]
- [41] Chandrasekaran S, Lodhia P, Suarez-Ahedo C, Vemula SP, Martin TJ, Domb BG. Symposium: Evidence for the use of intra-articular cortisone or hyaluronic acid injection in the hip. *J Hip Preserv Surg*. 2015; 3(1):5-15. [DOI:10.1093/jhps/hnv020] [PMID]
- [42] Singh J, Khan WS, Marwah S, Wells G, Tannous DK, Sharma HK. Do we need radiological guidance for intra-articular hip injections? *Open Orthop J*. 2014; 8:114-7. [DOI:10.2174/1874325001408010114] [PMID]
- [43] Smith J, Hurdle MF, Weingarten TN. Accuracy of sonographically guided intra-articular injections in the native adult hip. *J Ultrasound Med*. 2009; 28(3):329-35. [DOI:10.7863/jum.2009.28.3.329] [PMID]
- [44] Kullenberg B, Runesson R, Tuvhag R, Olsson C, Resch S. Intraarticular corticosteroid injection: Pain relief in osteoarthritis of the hip? *J Rheumatol*. 2004; 31(11):2265-8. [PMID]
- [45] Lambert RG, Hutchings EJ, Grace MG, Jhangri GS, Conner-Spady B, Maksymowych WP. Steroid injection for osteoarthritis of the hip: A randomized, double-blind, placebo-controlled trial. *Arthritis Rheum*. 2007; 56(7):2278-87. [DOI:10.1002/art.22739] [PMID]
- [46] Qvistgaard E, Christensen R, Torp-Pedersen S, Bliddal H. Intra-articular treatment of hip osteoarthritis: a randomized trial of hyaluronic acid, corticosteroid, and isotonic saline. *Osteoarthritis Cartilage*. 2006; 14(2):163-70. [DOI:10.1016/j.joca.2005.09.007] [PMID]
- [47] Nandi S, Hannon CP, Fillingham Y. 2023 American academy of orthopaedic surgeons management of osteoarthritis of the hip evidence-based clinical practice guideline: Case studies. *JAAOS*. 2025; 33(4):220-3. [DOI:10.5435/JAAOS-D-24-00427]
- [48] Cheng OT, Souzdalitski D, Vrooman B, Cheng J. Evidence-based knee injections for the management of arthritis. *Pain Med*. 2012; 13(6):740-53. [DOI:10.1111/j.1526-4637.2012.01394.x] [PMID]
- [49] McAlindon TE, LaValley MP, Harvey WF, Price LL, Driban JB, Zhang M, et al. Effect of intra-articular triamcinolone vs saline on knee cartilage volume and pain in patients with knee osteoarthritis: A randomized clinical trial. *JAMA*. 2017; 317(19):1967-75. [DOI:10.1001/jama.2017.5283] [PMID]
- [50] Zeng C, Lane NE, Hunter DJ, Wei J, Choi HK, McAlindon TE, et al. Intra-articular corticosteroids and the risk of knee osteoarthritis progression: results from the Osteoarthritis Initiative. *Osteoarthritis Cartilage*. 2019; 27(6):855-62. [DOI:10.1016/j.joca.2019.01.007] [PMID]
- [51] Koppel AJ, Roemer FW, Murakami AM, Diaz LE, Crema MD, Guermazi A. Intra-articular Corticosteroid Injections in the Hip and Knee: Perhaps not as safe as we thought? *Radiology*. 2019; 293(3):656-63. [DOI:10.1148/radiol.2019190341] [PMID]
- [52] Neustadt DH, Swezey RL. Local steroid injections: Comment on the American College of Rheumatology guidelines for the management of osteoarthritis of the hip and on the letter by Swezey. *Arthritis Rheum*. 1997; 40(10):1914-5. [DOI:10.1002/art.1780401038]
- [53] Villoutreix C, Pham T, Tubach F, Dougados M, Ayral X. Intraarticular glucocorticoid injections in rapidly destructive hip osteoarthritis. *Joint Bone Spine*. 2006; 73(1):66-71. [DOI:10.1016/j.jbspin.2005.06.002] [PMID]
- [54] Yamamoto T, Schneider R, Iwamoto Y, Bullough PG. Rapid destruction of the femoral head after a single intraarticular injection of corticosteroid into the hip joint. *J Rheumatol*. 2006; 33(8):1701-4. [PMID]
- [55] Nicholas E, Cheng J, Moley PJ. Non-operative Treatment Options for Osteoarthritis in the Hip. *HSS J*. 2023; 19(4):486-93. [DOI:10.1177/15563316231204437] [PMID]
- [56] Fernández López JC, Ruano-Ravina A. Efficacy and safety of intraarticular hyaluronic acid in the treatment of hip osteoarthritis: A systematic review. *Osteoarthritis Cartilage*. 2006; 14(12):1306-11. [DOI:10.1016/j.joca.2006.08.003] [PMID]
- [57] Migliore A, Granata M. Intra-articular use of hyaluronic acid in the treatment of osteoarthritis. *Clin Interv Aging*. 2008; 3(2):365-9. [DOI:10.2147/cia.s778] [PMID]

- [58] Atchia I, Kane D, Reed MR, Isaacs JD, Birrell F. Efficacy of a single ultrasound-guided injection for the treatment of hip osteoarthritis. *Ann Rheum Dis.* 2011; 70(1):110-6. [DOI:10.1136/ard.2009.127183] [PMID]
- [59] Richette P, Ravaud P, Conrozier T, Euler-Ziegler L, Mazières B, Maugars Y, et al. Effect of hyaluronic acid in symptomatic hip osteoarthritis: A multicenter, randomized, placebo-controlled trial. *Arthritis Rheum.* 2009; 60(3):824-30. [DOI:10.1002/art.24301] [PMID]
- [60] Rutjes AW, Jüni P, da Costa BR, Trelle S, Nuesch E, Reichenbach S. Viscosupplementation for osteoarthritis of the knee: A systematic review and meta-analysis. *Ann Intern Med.* 2012; 157(3):180-91. [DOI:10.7326/0003-4819-157-3-201208070-00473] [PMID]
- [61] Kraeutler MJ, Houck DA, Garabekyan T, Miller SL, Dragoo JL, Mei-Dan O. Comparing intra-articular injections of leukocyte-poor platelet-rich plasma versus low-molecular weight hyaluronic acid for the treatment of symptomatic osteoarthritis of the hip: A double-blind, randomized pilot study. *Orthop J Sports Med.* 2021; 9(1):2325967120969210. [DOI:10.1177/2325967120969210] [PMID]
- [62] Vellios EE. Rich or Poor? Examining platelet-rich plasma leukocyte concentration in knee osteoarthritis: Commentary on article by Aazad Abbas, HBSc, et al.: "The effect of leukocyte concentration on platelet-rich plasma injections for knee osteoarthritis. A Network Meta-Analysis". *J Bone Joint Surg Am.* 2022; 104(6):e26. [DOI:10.2106/JBJS.21.01186] [PMID]
- [63] Yaradilmis YU, Demirkale I, Safa Tagral A, Caner Okkaoglu M, Ates A, Altay M. Comparison of two platelet rich plasma formulations with viscosupplementation in treatment of moderate grade gonarthrosis: A prospective randomized controlled study. *J Orthop.* 2020; 20:240-6. [DOI:10.1016/j.jor.2020.01.041] [PMID]
- [64] Dold AP, Zywiell MG, Taylor DW, Dwyer T, Theodoropoulos J. Platelet-rich plasma in the management of articular cartilage pathology: A systematic review. *Clin J Sport Med.* 2014; 24(1):31-43. [DOI:10.1097/01.jsm.0000432855.85143.e5] [PMID]
- [65] Sánchez M, Guadilla J, Fiz N, Andia I. Ultrasound-guided platelet-rich plasma injections for the treatment of osteoarthritis of the hip. *Rheumatology (Oxford).* 2012; 51(1):144-50. [DOI:10.1093/rheumatology/ker303] [PMID]
- [66] Battaglia M, Guaraldi F, Vannini F, Rossi G, Timoncini A, Buda R, et al. Efficacy of ultrasound-guided intra-articular injections of platelet-rich plasma versus hyaluronic acid for hip osteoarthritis. *Orthopedics.* 2013; 36(12):e1501-8. [DOI:10.3928/01477447-20131120-13] [PMID]
- [67] Jacobson T, Allen WC. Surgical correction of the snapping iliopsoas tendon. *Am J Sports Med.* 1990; 18(5):470-4. [DOI:10.1177/036354659001800504] [PMID]
- [68] Taylor GR, Clarke NM. Surgical release of the snapping iliopsoas tendon'. *J Bone Joint Surg Br.* 1995; 77(6):881-3. [DOI:10.1302/0301-620X.77B6.7593099] [PMID]
- [69] Hucherson DC, Denman FR. Non-infectious iliopsoas bursitis. *Am J Surg.* 1946; 72:576-9. [DOI:10.1016/0002-9610(46)90394-7] [PMID]
- [70] Broadhurst N. Iliopsoas tendinitis and bursitis. *Aust Fam Physician.* 1995; 24(7):1303. [PMID]
- [71] Staple TW, Jung D, Mork A. Snapping tendon syndrome: hip tenography with fluoroscopic monitoring. *Radiology.* 1988; 166(3):873-4. [DOI:10.1148/radiology.166.3.3340787] [PMID]
- [72] Silver SF, Connell DG, Duncan CP. Case report 550: Snapping right iliopsoas tendon. *Skeletal Radiol.* 1989; 18(4):327-8. [DOI:10.1007/BF00361219] [PMID]
- [73] Johnston CA, Wiley JP, Lindsay DM, Wiseman DA. Iliopsoas bursitis and tendinitis. A review. *Sports Med.* 1998; 25(4):271-83. [DOI:10.2165/00007256-199825040-00005] [PMID]
- [74] Harper MC, Schaberg JE, Allen WC. Primary iliopsoas bursography in the diagnosis of disorders of the hip. *Clin Orthop Relat Res.* 1987; 221:238-41. [DOI:10.1097/00003086-198708000-00030] [PMID]
- [75] Schaberg JE, Harper MC, Allen WC. The snapping hip syndrome. *Am J Sports Med.* 1984; 12(5):361-5. [DOI:10.1177/036354658401200504] [PMID]
- [76] Vaccaro JP, Sauser DD, Beals RK. Iliopsoas bursa imaging: efficacy in depicting abnormal iliopsoas tendon motion in patients with internal snapping hip syndrome. *Radiology.* 1995; 197(3):853-6. [DOI:10.1148/radiology.197.3.7480768] [PMID]
- [77] Frenkel Rutenberg T, Assaly A, Vitenberg M, Shemesh S, Burg A, Haviv B, et al. Outcome of non-surgical treatment of proximal femur fractures in the fragile elderly population. *Injury.* 2019; 50(7):1347-52. [DOI:10.1016/j.injury.2019.05.022] [PMID]
- [78] Heim M, Adunski A, Chechick A. Nonoperative treatment of intracapsular fractures of the proximal femur. *Clin Orthop Relat Res.* 2002; (399):35-41. [DOI:10.1097/00003086-200206000-00006] [PMID]
- [79] Tyler TF, Nicholas SJ. Rehabilitation of extra-articular sources of hip pain in athletes. *N Am J Sports Phys Ther.* 2007; 2(4):207-16. [PMID]
- [80] Jin H, Li L, Yu W, Fu Y. The efficacy of acupuncture and moxibustion for early and middle-stage osteonecrosis of the femoral head: A systematic review and meta-analysis of randomized controlled trials. *Medicine (Baltimore).* 2021; 100(22):e26210. [DOI:10.1097/MD.00000000000026210] [PMID]
- [81] Vardhan H, Tripathy SK, Sen RK, Aggarwal S, Goyal T. Epidemiological profile of femoral head osteonecrosis in the North Indian Population. *Indian J Orthop.* 2018; 52(2):140-6. [DOI:10.4103/ortho.IJOrtho_292_16] [PMID]
- [82] Tomaru Y, Yoshioka T, Sugaya H, Shimizu Y, Aoto K, Wada H, et al. Mid-term results of concentrated autologous bone marrow aspirate transplantation for corticosteroid-associated osteonecrosis of the femoral head in systemic lupus erythematosus. *Int Orthop.* 2018; 42(7):1623-30. [DOI:10.1007/s00264-018-3959-y] [PMID]
- [83] Kim HK, Aruwajoye O, Stetler J, Stall A. Effects of non-weight-bearing on the immature femoral head following ischemic osteonecrosis: An experimental investigation in immature pigs. *J Bone Joint Surg Am.* 2012; 94(24):2228-37. [DOI:10.2106/JBJS.L.00300] [PMID]

- [84] Mazzotta E, Agostinone A, Rosso R, Di Biagio A, De Socio GV, Cappelletti A, et al. Osteonecrosis in human immunodeficiency virus (HIV)-infected patients: A multicentric case-control study. *J Bone Miner Metab*. 2011; 29(3):383-8. [DOI:10.1007/s00774-010-0245-5] [PMID]
- [85] Keating EM. Current options and approaches for blood management in orthopaedic surgery. *Instr Course Lect*. 1999; 48:655-65. [PMID]
- [86] Arai R, Takahashi D, Inoue M, Irie T, Asano T, Konno T, et al. Efficacy of teriparatide in the treatment of nontraumatic osteonecrosis of the femoral head: A retrospective comparative study with alendronate. *BMC Musculoskelet Disord*. 2017; 18(1):24. [DOI:10.1186/s12891-016-1379-y] [PMID]
- [87] Lee YK, Ha YC, Cho YJ, Suh KT, Kim SY, Won YY, et al. Does zoledronate prevent femoral head collapse from osteonecrosis? A prospective, randomized, open-label, multicenter study. *J Bone Joint Surg Am*. 2015; 97(14):1142-8. [DOI:10.2106/JBJS.N.01157] [PMID]
- [88] Yuan HF, Guo CA, Yan ZQ. The use of bisphosphonate in the treatment of osteonecrosis of the femoral head: A meta-analysis of randomized control trials. *Osteoporos Int*. 2016; 27(1):295-9. [DOI:10.1007/s00198-015-3317-5] [PMID]
- [89] Agarwala S, Banavali SD, Vijayvargiya M. Bisphosphonate combination therapy in the management of postchemotherapy avascular necrosis of the femoral head in adolescents and young adults: A retrospective study from India. *J Glob Oncol*. 2018; 4:1-11. [DOI:10.1200/JGO.17.00083] [PMID]
- [90] Li D, Yang Z, Wei Z, Kang P. Efficacy of bisphosphonates in the treatment of femoral head osteonecrosis: A PRISMA-compliant meta-analysis of animal studies and clinical trials. *Sci Rep*. 2018; 8(1):1450. [DOI:10.1038/s41598-018-19884-z] [PMID]
- [91] Sheng H, Lao Y, Zhang S, Ding W, Lu D, Xu B. Combined pharmacotherapy with alendronate and desferoxamine regulate the bone resorption and bone regeneration for preventing glucocorticoids-induced osteonecrosis of the femoral head. *Biomed Res Int*. 2020; 2020:3120458. [DOI:10.1155/2020/3120458] [PMID]
- [92] Roth A, Beckmann J, Bohndorf K, Heiß C, Jäger M, Landgraeber S, et al. [Update of the German S3 guideline on atraumatic femoral head necrosis in adults (German)]. *Orthopade*. 2018; 47(9):757-69. [DOI:10.1007/s00132-018-3620-x] [PMID]
- [93] Agarwala S, Vijayvargiya M. Bisphosphonate combination therapy for non-femoral avascular necrosis. *J Orthop Surg Res*. 2019; 14(1):112. [DOI:10.1186/s13018-019-1152-7] [PMID]
- [94] Mardones R, Camacho D, Monsalvo F, Zulch N, Jofre C, Minguell JJ. Treatment of osteonecrosis of the femoral head by core decompression and implantation of fully functional ex vivo-expanded bone marrow-derived mesenchymal stem cells: A proof-of-concept study. *Stem Cells Cloning*. 2019; 12:11-16. [DOI:10.2147/SCCAA.S181883] [PMID]
- [95] Beckmann J, Schmidt T, Schaumburger J, Rath B, Lüring C, Tingart M, et al. Infusion, core decompression, or infusion following core decompression in the treatment of bone edema syndrome and early avascular osteonecrosis of the femoral head. *Rheumatol Int*. 2013; 33(6):1561-5. [DOI:10.1007/s00296-012-2597-8] [PMID]
- [96] Osmani F, Thakkar S, Vigdorchik J. The utility of conservative treatment modalities in the management of osteonecrosis. *Bull Hosp Jt Dis* (2013). 2017; 75(3):186-92. [PMID]
- [97] Song Q, Ni J, Jiang H, Shi Z. Sildenafil improves blood perfusion in steroid-induced avascular necrosis of femoral head in rabbits via a protein kinase G-dependent mechanism. *Acta Orthop Traumatol Turc*. 2017; 51(5):398-403. [DOI:10.1016/j.aott.2017.07.002] [PMID]
- [98] Pritchett JW. Statin therapy decreases the risk of osteonecrosis in patients receiving steroids. *Clin Orthop Relat Res*. 2001; (386):173-8. [DOI:10.1097/00003086-200105000-00022] [PMID]
- [99] Jiang Y, Zhang Y, Zhang H, Zhu B, Li P, Lu C, et al. Pravastatin prevents steroid-induced osteonecrosis in rats by suppressing PPAR γ expression and activating Wnt signaling pathway. *Exp Biol Med* (Maywood). 2014; 239(3):347-55. [DOI:10.1177/1535370213519215] [PMID]
- [100] Pengde K, Fuxing P, Bin S, Jing Y, Jingqiu C. Lovastatin inhibits adipogenesis and prevents osteonecrosis in steroid-treated rabbits. *Joint Bone Spine*. 2008; 75(6):696-701. [DOI:10.1016/j.jbspin.2007.12.008] [PMID]
- [101] Liu N, Zheng C, Wang Q, Huang Z. Treatment of non-traumatic avascular necrosis of the femoral head (Review). *Exp Ther Med*. 2022; 23(5):321. [DOI:10.3892/etm.2022.11250] [PMID]
- [102] Hao Y, Guo H, Xu Z, Qi H, Wang Y, Lu C, et al. Meta-analysis of the potential role of extracorporeal shockwave therapy in osteonecrosis of the femoral head. *J Orthop Surg Res*. 2018; 13(1):166. [DOI:10.1186/s13018-018-0861-7] [PMID]
- [103] Xie K, Mao Y, Qu X, Dai K, Jia Q, Zhu Z, et al. High-energy extracorporeal shock wave therapy for nontraumatic osteonecrosis of the femoral head. *J Orthop Surg Res*. 2018; 13(1):25. [DOI:10.1186/s13018-017-0705-x] [PMID]
- [104] Ludwig J, Lauber S, Lauber HJ, Dreisilker U, Raedel R, Hotzinger H. High-energy shock wave treatment of femoral head necrosis in adults. *Clin Orthop Relat Res*. 2001; (387):119-26. [DOI:10.1097/00003086-200106000-00016] [PMID]
- [105] Russo S, Sadile F, Esposito R, Mosillo G, Aitanti E, Busco G, et al. Italian experience on use of E.S.W. therapy for avascular necrosis of femoral head. *Int J Surg*. 2015; 24(Pt B):188-90. [DOI:10.1016/j.ijsu.2015.11.038] [PMID]
- [106] Bassett CA, Pawluk RJ, Pilla AA. Augmentation of bone repair by inductively coupled electromagnetic fields. *Science*. 1974; 184(4136):575-7. [DOI:10.1126/science.184.4136.575] [PMID]
- [107] Massari L, Benazzo F, Falez F, Perugia D, Pietrogrande L, Setti S, et al. Biophysical stimulation of bone and cartilage: state of the art and future perspectives. *Int Orthop*. 2019; 43(3):539-51. [DOI:10.1007/s00264-018-4274-3] [PMID]
- [108] Al-Jabri T, Tan JYQ, Tong GY, Shenoy R, Kayani B, Parratt T, et al. The role of electrical stimulation in the management of avascular necrosis of the femoral head in adults: A systematic review. *BMC Musculoskelet Disord*. 2017; 18(1):319. [DOI:10.1186/s12891-017-1663-5] [PMID]

- [109] Seber S, Omeroglu H, Cetinkanat H, Köse N. [The efficacy of pulsed electromagnetic fields used alone in the treatment of femoral head osteonecrosis: A report of two cases (Turkish)]. *Acta Orthop Traumatol Turc.* 2003; 37(5):410-3. [PMID]
- [110] Paderno E, Zanon V, Vezzani G, Giacon TA, Bernasek TL, Camporesi EM, et al. Evidence-Supported HBO Therapy in Femoral Head Necrosis: A systematic review and meta-analysis. *Int J Environ Res Public Health.* 2021; 18(6):2888. [DOI:10.3390/ijerph18062888] [PMID]
- [111] Li W, Ye Z, Wang W, Wang K, Li L, Zhao D. Clinical effect of hyperbaric oxygen therapy in the treatment of femoral head necrosis : A systematic review and meta-analysis. *Orthopade.* 2017; 46(5):440-6. [DOI:10.1007/s00132-016-3360-8] [PMID]
- [112] Chandrinou A, Korompeli A, Grammatopoulou E, Gaitanou K, Tsoumakas K, Fildissis G. Avascular necrosis of the femoral head: Evaluation of hyperbaric oxygen therapy and quality of life. *Undersea Hyperb Med.* 2020; 47(4):561-9. [PMID]
- [113] Li H, Bai X, Pan S. Repetitive 1.6 ATA hyperbaric oxygen therapy for bilateral ARCO Stage II steroid-associated osteonecrosis of the femoral head. *Undersea Hyperb Med.* 2020; 47(4):625-33. [PMID]
- [114] Moghamis I, Alhammoud AA, Kokash O, Alhaneedi GA. The outcome of hyperbaric oxygen therapy versus core decompression in the non-traumatic avascular necrosis of the femoral head: Retrospective Cohort Study. *Ann Med Surg (Lond).* 2021; 62:450-4. [DOI:10.1016/j.amsu.2021.01.084] [PMID]
- [115] Camporesi EM, Bosco G. Mechanisms of action of hyperbaric oxygen therapy. *Undersea Hyperb Med.* 2014; 41(3):247-52. [PMID]
- [116] Bennett M. Hyperbaric oxygen therapy improved both pain scores and range of motion in patients with early idiopathic femoral head necrosis (Ficat stage II). *Diving Hyperb Med.* 2011; 41(2):105. [PMID]
- [117] Camporesi E, Vezzani G, Zanon V, Manelli D, Enten G, Quartesan S, et al. Review on hyperbaric oxygen treatment in femoral head necrosis. *Undersea Hyperb Med.* 2017; 44(6):497-508. [DOI: 10.22462/11.12.2017.1] [PMID]
- [118] Vann RD, Butler FK, Mitchell SJ, Moon RE. Decompression illness. *Lancet.* 2011; 377(9760):153-64. [DOI:10.1016/S0140-6736(10)61085-9] [PMID]
- [119] Thom SR. Hyperbaric oxygen: Its mechanisms and efficacy. *Plast Reconstr Surg.* 2011; 127 Suppl 1(Suppl 1):131S-41S. [DOI:10.1097/PRS.0b013e3181f8e2bf] [PMID]
- [120] Al Hadi H, Smerdon GR, Fox SW. Hyperbaric oxygen therapy accelerates osteoblast differentiation and promotes bone formation. *J Dent.* 2015; 43(3):382-8. [DOI:10.1016/j.jdent.2014.10.006] [PMID]
- [121] Al Hadi H, Smerdon GR, Fox SW. Hyperbaric oxygen therapy suppresses osteoclast formation and bone resorption. *J Orthop Res.* 2013; 31(11):1839-44. [DOI:10.1002/jor.22443] [PMID]
- [122] Vezzani GI, Iezzi MA, Rizzato AL, Quartesan SI, Mangar DE, Camporesi EM, et al. Effects of hyperbaric oxygen exposure on mobilization of endothelial progenitor cells in healthy volunteers. *Acta Med Mediter.* 2017; 33:801-5. [Link]
- [123] Bosco G, Vezzani G, Mrakic Sposta S, Rizzato A, Enten G, Abou-Samra A, et al. Hyperbaric oxygen therapy ameliorates osteonecrosis in patients by modulating inflammation and oxidative stress. *J Enzyme Inhib Med Chem.* 2018; 33(1):1501-5. [DOI:10.1080/14756366.2018.1485149] [PMID]
- [124] Banerjee S, Issa K, Pivec R, Kapadia BH, Khanuja HS, Mont MA. Osteonecrosis of the hip: Treatment options and outcomes. *Orthop Clin North Am.* 2013 ;44(4):463-76. [DOI:10.1016/j.jocl.2013.07.004] [PMID]
- [125] Paterson I. The torn acetabular labrum. *J Bone Joint Surg Br Vol.* 1957; 39(2):306-9. [DOI:10.1302/0301-620X.39B2.306]
- [126] Dameron Jr, B. Bucket-handle tear of acetabular labrum accompanying posterior dislocation of the hip. *J Bone Joint Surg.* 1959; 41(1):131-4. [DOI:10.2106/00004623-195941010-00015]
- [127] Suzuki S, Awaya G, Okada Y, Maekawa M, Ikeda T, Tada H. Arthroscopic diagnosis of ruptured acetabular labrum. *Acta Orthop Scand.* 1986; 57(6):513-5. [DOI:10.3109/17453678609014781] [PMID]
- [128] Wenger DE, Kendell KR, Miner MR, Trousdale RT. Acetabular labral tears rarely occur in the absence of bony abnormalities. *Clin Orthop Relat Res.* 2004; (426):145-50. [DOI:10.1097/01.blo.0000136903.01368.20] [PMID]
- [129] Tanzer M, Noiseux N. Osseous abnormalities and early osteoarthritis: the role of hip impingement. *Clin Orthop Relat Res* (1976-2007). 2004; 429:170-7. [DOI:10.1097/01.blo.0000150119.49983.ef]
- [130] Kim KC, Hwang DS, Lee CH, Kwon ST. Influence of femoroacetabular impingement on results of hip arthroscopy in patients with early osteoarthritis. *Clin Orthop Relat Res.* 2007; 456:128-32. [DOI:10.1097/01.blo.0000246542.49574.2c] [PMID]
- [131] Larson CM, Giveans MR, Stone RM. Arthroscopic debridement versus refixation of the acetabular labrum associated with femoroacetabular impingement: Mean 3.5-year follow-up. *Am J Sports Med.* 2012; 40(5):1015-21. [DOI:10.1177/0363546511434578] [PMID]
- [132] Philippon MJ, Briggs KK, Yen YM, Kuppersmith DA. Outcomes following hip arthroscopy for femoroacetabular impingement with associated chondrolabral dysfunction: minimum two-year follow-up. *J Bone Joint Surg Br.* 2009; 91(1):16-23. [DOI:10.1302/0301-620X.91B1.21329] [PMID]
- [133] Krych AJ, Thompson M, Knutson Z, Scoon J, Coleman SH. Arthroscopic labral repair versus selective labral debridement in female patients with femoroacetabular impingement: A prospective randomized study. *Arthroscopy.* 2013; 29(1):46-53. [DOI:10.1016/j.arthro.2012.07.011] [PMID]
- [134] Philippon MJ, Briggs KK, Hay CJ, Kuppersmith DA, Dewing CB, Huang MJ. Arthroscopic labral reconstruction in the hip using iliotibial band autograft: Technique and early outcomes. *Arthroscopy.* 2010; 26(6):750-6. [DOI:10.1016/j.arthro.2009.10.016] [PMID]
- [135] Domb BG, El Bitar YF, Stake CE, Trenga AP, Jackson TJ, Lindner D. Arthroscopic labral reconstruction is superior to segmental resection for irreparable labral tears in the hip: a matched-pair controlled study with minimum 2-year follow-up. *Am J Sports Med.* 2014; 42(1):122-30. [DOI:10.1177/0363546513508256] [PMID]

- [136] Groh MM, Herrera J. A comprehensive review of hip labral tears. *Curr Rev Musculoskelet Med*. 2009; 2(2):105-17. [DOI:10.1007/s12178-009-9052-9] [PMID]
- [137] Lewis CL, Sahrman SA. Acetabular labral tears. *Phys Ther*. 2006; 86(1):110-21. [DOI:10.1093/ptj/86.1.110] [PMID]
- [138] Yazbek PM, Ovanessian V, Martin RL, Fukuda TY. Non-surgical treatment of acetabular labrum tears: A case series. *J Orthop Sports Phys Ther*. 2011; 41(5):346-53. [DOI:10.2519/jospt.2011.3225] [PMID]
- [139] Su T, Chen GX, Yang L. Diagnosis and treatment of labral tear. *Chin Med J (Engl)*. 2019; 132(2):211-9. [DOI:10.1097/CM9.000000000000020] [PMID]
- [140] Kivlan BR, Martin RL, Sekiya JK. Response to diagnostic injection in patients with femoroacetabular impingement, labral tears, chondral lesions, and extra-articular pathology. *Arthroscopy*. 2011; 27(5):619-27. [DOI:10.1016/j.arthro.2010.12.009] [PMID]
- [141] Cianci A, Sugimoto D, Straccioli A, Yen YM, Kocher MS, d-Hemecourt PA. Nonoperative management of labral tears of the hip in adolescent athletes: Description of sports participation, interventions, comorbidity, and outcomes. *Clin J Sport Med*. 2019; 29(1):24-8. [DOI:10.1097/JSM.0000000000000503] [PMID]
- [142] Solomon LB, Lee YC, Callary SA, Beck M, Howie DW. Anatomy of piriformis, obturator internus and obturator externus: Implications for the posterior surgical approach to the hip. *J Bone Joint Surg Br*. 2010; 92(9):1317-24. [DOI:10.1302/0301-620X.92B9.23893] [PMID]
- [143] DiGiovanna EL Introduction. In: DiGiovanna EL, Schiowitz S, Dowling DJ, editors. *An osteopathic approach to diagnosis and treatment*. Philadelphia: Lippincott Williams & Wilkins; 2005. [Link]
- [144] Divizia M, Germani G, Urti I, Imani F, Varrassi G, Meloncelli S. Endoscopic neuromodulation of suprascapular nerve in chronic shoulder pain: A case report. *Anesth Pain Med*. 2020; 10(2):e103624. [DOI:10.5812/aapm.103624] [PMID]
- [145] Huang ZF, Yang DS, Shi ZJ, Xiao J. [Pathogenesis of piriformis syndrome: a magnetic resonance imaging-based comparison study (Chinese)]. *Zhonghua Yi Xue Za Zhi*. 201; 98(1):42-5. [PMID]
- [146] Park JW, Lee YK, Lee YJ, Shin S, Kang Y, Koo KH. Deep gluteal syndrome as a cause of posterior hip pain and sciatica-like pain. *Bone Joint J*. 2020; 102-B(5):556-67. [DOI:10.1302/0301-620X.102B5.BJJ-2019-1212.R1] [PMID]
- [147] Vassalou EE, Katonis P, Karantanas AH. Piriformis muscle syndrome: A cross-sectional imaging study in 116 patients and evaluation of therapeutic outcome. *Eur Radiol*. 2018; 28(2):447-58. [DOI:10.1007/s00330-017-4982-x] [PMID]
- [148] Hicks BL, Lam JC, Varacallo M. Piriformis syndrome. Treasure Island: StatPearls; 2017. [Link]
- [149] Heiderscheit B, McClinton S. Evaluation and management of hip and pelvis injuries. *Phys Med Rehabil Clin N Am*. 2016; 27(1):1-29. [DOI:10.1016/j.pmr.2015.08.003] [PMID]
- [150] Probst D, Stout A, Hunt D. Piriformis Syndrome: A narrative review of the anatomy, diagnosis, and treatment. *PM R*. 2019; 11 (Suppl 1):S54-63. [DOI:10.1002/pmrj.12189] [PMID]
- [151] Huang ZF, Lin BQ, Torsha TT, Dilshad S, Yang DS, Xiao J. Effect of Mannitol plus Vitamins B in the management of patients with piriformis syndrome. *J Back Musculoskelet Rehabil*. 2019; 32(2):329-37. [DOI:10.3233/BMR-170983] [PMID]
- [152] Gullede BM, Marcellin-Little DJ, Levine D, Tillman L, Harrysson OL, Osborne JA, et al. Comparison of two stretching methods and optimization of stretching protocol for the piriformis muscle. *Med Eng Phys*. 2014; 36(2):212-8. [DOI:10.1016/j.medengphy.2013.10.016] [PMID]
- [153] Sluijter ME, Imani F. Evolution and mode of action of pulsed radiofrequency. *Anesth Pain Med*. 2013; 2(4):139-41. [DOI:10.5812/aapm.10213] [PMID]
- [154] Cox J, Varatharajan S, Côté P, Optima Collaboration. Effectiveness of acupuncture therapies to manage musculoskeletal disorders of the extremities: A systematic review. *J Orthop Sports Phys Ther*. 2016; 46(6):409-29. [DOI:10.2519/jospt.2016.6270] [PMID]
- [155] Fusco P, Di Carlo S, Scimia P, Degan G, Petrucci E, Marinangeli F. Ultrasound-guided dry needling treatment of myofascial trigger points for piriformis syndrome management: A case series. *J Chiropr Med*. 2018; 17(3):198-200. [DOI:10.1016/j.jcm.2018.04.002] [PMID]
- [156] Tabatabaiee A, Takamjani IE, Sarrafzadeh J, Salehi R, Ahmadi M. Ultrasound-guided dry needling decreases pain in patients with piriformis syndrome. *Muscle Nerve*. 2019; 60(5):558-65. [DOI:10.1002/mus.26671] [PMID]
- [157] Tully J, Jung JW, Patel A, Tukan A, Kandula S, Doan A, et al. Utilization of Intravenous Lidocaine Infusion for the Treatment of Refractory Chronic Pain. *Anesth Pain Med*. 2021; 10(6):e112290. [DOI:10.5812/aapm.112290] [PMID]
- [158] Patel VB, Wasserman R, Imani F. Interventional therapies for chronic low back pain: A focused review (efficacy and outcomes). *Anesth Pain Med*. 2015; 5(4):e29716. [DOI:10.5812/aapm.29716] [PMID]
- [159] Vij N, Traube B, Bisht R, Singleton I, Cornett EM, Kaye AD, et al. An update on treatment modalities for ulnar nerve entrapment: A literature review. *Anesth Pain Med*. 2020; 10(6):e112070. [DOI:10.5812/aapm.112070] [PMID]
- [160] Terlemeze R, Erçalik T. Effect of piriformis injection on neuropathic pain. *Agri*. 2019; 31(4):178-182. [DOI:10.14744/agri.2019.34735] [PMID]
- [161] Rosales J, García N, Rafols C, Pérez M, Verdugo MA. Perisciatic Ultrasound-Guided Infiltration for Treatment of Deep Gluteal Syndrome: Description of technique and preliminary results. *J Ultrasound Med*. 2015; 34(11):2093-7. [DOI:10.7863/ultra.14.12030] [PMID]
- [162] Misirlioglu TO, Akgun K, Palamar D, Erden MG, Erbilir T. Piriformis syndrome: Comparison of the effectiveness of local anesthetic and corticosteroid injections: A double-blind, randomized controlled study. *Pain Physician*. 2015; 18(2):163-71. [DOI:10.36076/ppj/2015.18.163]
- [163] Payne JM. Ultrasound-guided hip procedures. *Phys Med Rehabil Clin N Am*. 2016; 27(3):607-29. [DOI:10.1016/j.pmr.2016.04.004] [PMID]

- [164] Fowler IM, Tucker AA, Weimerskirch BP, Moran TJ, Mendez RJ. A randomized comparison of the efficacy of 2 techniques for piriformis muscle injection: Ultrasound-guided versus nerve stimulator with fluoroscopic guidance. *Reg Anesth Pain Med*. 2014; 39(2):126-32. [DOI:10.1097/AAP.000000000000056] [PMID]
- [165] Burke CJ, Walter WR, Adler RS. Targeted ultrasound-guided perineural hydrodissection of the sciatic nerve for the treatment of piriformis syndrome. *Ultrasound Q*. 2019; 35(2):125-9. [DOI:10.1097/RUQ.0000000000000360] [PMID]
- [166] Safarpour Y, Jabbari B. Botulinum toxin treatment of pain syndromes -an evidence based review. *Toxicon*. 2018; 147:120-8. [DOI:10.1016/j.toxicon.2018.01.017] [PMID]
- [167] Vij N, Kiernan H, Bisht R, Singleton I, Cornett EM, Kaye AD, et al. Surgical and non-surgical treatment options for piriformis syndrome: A literature review. *Anesth Pain Med*. 2021; 11(1):e112825. [DOI:10.5812/aapm.112825]
- [168] Fritz J, Chhabra A, Wang KC, Carrino JA. Magnetic resonance neurography-guided nerve blocks for the diagnosis and treatment of chronic pelvic pain syndrome. *Neuroimaging Clin N Am*. 2014; 24(1):211-34. [DOI:10.1016/j.nic.2013.03.028] [PMID]
- [169] Santamato A, Micello MF, Valeno G, Beatrice R, Cinone N, Baricich A, et al. Ultrasound-guided injection of botulinum toxin type a for piriformis muscle syndrome: A case report and review of the literature. *Toxins (Basel)*. 2015 ; 7(8):3045-56. [DOI:10.3390/toxins7083045] [PMID]
- [170] Rawicki B, Sheean G, Fung VS, Goldsmith S, Morgan C, Novak I, et al. Botulinum toxin assessment, intervention and aftercare for paediatric and adult niche indications including pain: International consensus statement. *Eur J Neurol*. 2010; 17(Suppl 2):122-34. [DOI:10.1111/j.1468-1331.2010.03132.x] [PMID]
- [171] Fabregat G, Rosello M, Asensio-Samper JM, Villaneuva-Perez VL, Martinez-Sanjuan V, De Andres J, et al. Computer-tomographic verification of ultrasound-guided piriformis muscle injection: A feasibility study. *Pain Physician*. 2014; 17(6):507. [DOI:10.36076/ppj.2014/17/507]
- [172] Koh E, Webster D, Boyle J. Case report and review of the potential role of the Type A piriformis muscle in dynamic sciatic nerve entrapment variant of piriformis syndrome. *Surg Radiol Anat*. 2020; 42(10):1237-42. [DOI:10.1007/s00276-020-02440-8] [PMID]
- [173] Al-Al-Shaikh M, Michel F, Parratte B, Kastler B, Vidal C, Aubry S. An MRI evaluation of changes in piriformis muscle morphology induced by botulinum toxin injections in the treatment of piriformis syndrome. *Diagn Interv Imaging*. 2015; 96(1):37-43. [DOI:10.1016/j.diii.2014.02.015] [PMID]
- [174] Rodríguez-Piñero M, Vidal Vargas V, Jiménez Sarmiento AS. Long-term efficacy of ultrasound-guided injection of incobotulinumtoxin A in piriformis syndrome. *Pain Med*. 2018; 19(2):408-11. [DOI:10.1093/pm/pnx135] [PMID]
- [175] Ripellino P, Cianfoni A, Izzo MGA, Gobbi C. Relapsing piriformis syndrome treated with botulinum toxin injections. *BMJ Case Rep*. 2019; 12(8):e230981. [DOI:10.1136/bcr-2019-230981] [PMID]
- [176] Fishman LM, Wilkins AN, Rosner B. Electrophysiologically identified piriformis syndrome is successfully treated with incobotulinum toxin A and physical therapy. *Muscle Nerve*. 2017; 56(2):258-63. [DOI:10.1002/mus.25504] [PMID]
- [177] Prather H, Hunt D. Conservative management of low back pain, part I. Sacroiliac joint pain. *Dis Mon*. 2004; 50(12):670-83. [DOI:10.1016/j.disamonth.2004.12.004] [PMID]
- [178] Herring SA. Rehabilitation of muscle injuries. *Med Sci Sports Exerc*. 1990; 22(4):453-6. [DOI:10.1249/00005768-199008000-00006] [PMID]
- [179] Monticone M, Barbarino A, Testi C, Arzano S, Moschi A, Negrini S. Symptomatic efficacy of stabilizing treatment versus laser therapy for sub-acute low back pain with positive tests for sacroiliac dysfunction: A randomised clinical controlled trial with 1 year follow-up. *Eura Medicophys*. 2004; 40(4):263-8. [PMID]
- [180] Visser LH, Woudenberg NP, de Bont J, van Eijs F, Verver K, Jenniskens H, et al. Treatment of the sacroiliac joint in patients with leg pain: A randomized-controlled trial. *Eur Spine J*. 2013; 22(10):2310-7. [DOI:10.1007/s00586-013-2833-2] [PMID]
- [181] Boyle KL. Managing a female patient with left low back pain and sacroiliac joint pain with therapeutic exercise: A case report. *Physiother Can*. 2011; 63(2):154-63. [DOI:10.3138/ptc.2009-37] [PMID]
- [182] Cho BY, Yoon JG. The effect of gait training with shoe inserts on the improvement of pain and gait in sacroiliac joint patients. *J Phys Ther Sci*. 2015 g; 27(8):2469-71. [DOI:10.1589/jpts.27.2469] [PMID]
- [183] Yoo WG. Effects of double air-cushion biofeedback exercises in a patient with sacroiliac joint pain. *J Phys Ther Sci*. 2015; 27(11):3605-6. [DOI:10.1589/jpts.27.3605] [PMID]
- [184] Yoo WG. Effects of individual strengthening exercises for the stabilization muscles on the nutation torque of the sacroiliac joint in a sedentary worker with nonspecific sacroiliac joint pain. *J Phys Ther Sci*. 2015; 27(1):313-4. [DOI:10.1589/jpts.27.313] [PMID]
- [185] Yoo WG. Effect of the single-leg, lateral oblique, decline squat exercise on sacroiliac joint pain with knee pain. *J Phys Ther Sci*. 2016; 28(9):2688-9. [DOI:10.1589/jpts.28.2688] [PMID]
- [186] Barbosa AC, Martins FL, Barbosa MC, Dos Santos RT. Manipulation and selective exercises decrease pelvic anteversion and low-back pain: A pilot study. *J Back Musculoskelet Rehabil*. 2013; 26(1):33-6. [DOI:10.3233/BMR-2012-0347] [PMID]
- [187] Prather H, Bonnette M, Hunt D. Nonoperative treatment options for patients with sacroiliac joint pain. *Int J Spine Surg*. 2020; 14(Suppl 1):35-40. [DOI:10.14444/6082] [PMID]
- [188] Strauss EJ, Nho SJ, Kelly BT. Greater trochanteric pain syndrome. *Sports Med Arthrosc Rev*. 2010; 18(2):113-9. [DOI:10.1097/JSA.0b013e3181e0b2ff] [PMID]
- [189] Barnthouse NC, Wentz TM, Voos JE. Greater trochanteric pain syndrome: Endoscopic treatment options. *Oper Tech Sports Med*. 2012; 20(4):320-4. [DOI:10.1053/j.otsm.2012.09.006]

- [190] Shbeeb MI, O'Duffy JD, Michet Jr CJ, O'Fallon WM, Matteson EL. Evaluation of glucocorticosteroid injection for the treatment of trochanteric bursitis. *J Rheumatol.* 1996; 23(12):2104-6. [PMID]
- [191] Williams BS, Cohen SP. Greater trochanteric pain syndrome: A review of anatomy, diagnosis and treatment. *Anesth Analg.* 2009; 108(5):1662-70. [DOI:10.1213/ane.0b013e31819d6562] [PMID]
- [192] Ruta S, Quiroz C, Marin J, Catay E, Rosa J, García-Monaco R, et al. Ultrasound evaluation of the greater trochanter pain syndrome: bursitis or tendinopathy? *J Clin Rheumatol.* 2015; 21(2):99-101. [DOI:10.1097/RHU.0000000000000214] [PMID]
- [193] Long SS, Surrey DE, Nazarian LN. Sonography of greater trochanteric pain syndrome and the rarity of primary bursitis. *AJR Am J Roentgenol.* 2013; 201(5):1083-6. [DOI:10.2214/AJR.12.10038] [PMID]
- [194] Brooker AF Jr. The surgical approach to refractory trochanteric bursitis. *Johns Hopkins Med J.* 1979; 145(3):98-100. [PMID]
- [195] Pretell J, Ortega J, García-Rayó R, Resines C. Distal fascia lata lengthening: An alternative surgical technique for recalcitrant trochanteric bursitis. *Int Orthop.* 2009; 33(5):1223-7. [DOI:10.1007/s00264-009-0727-z] [PMID]
- [196] Rompe JD, Segal NA, Cacchio A, Furia JP, Morral A, Maffulli N. Home training, local corticosteroid injection, or radial shock wave therapy for greater trochanter pain syndrome. *Am J Sports Med.* 2009; 37(10):1981-90. [DOI:10.1177/0363546509334374] [PMID]
- [197] Kaux JF, Forthomme B, Goff CL, Crielaard JM, Croisier JL. Current opinions on tendinopathy. *J Sports Sci Med.* 2011; 10(2):238-53. [PMID]
- [198] Rees JD, Maffulli N, Cook J. Management of tendinopathy. *Am J Sports Med.* 2009; 37(9):1855-67. [DOI:10.1177/0363546508324283] [PMID]
- [199] Andres BM, Murrell GA. Treatment of tendinopathy: What works, what does not, and what is on the horizon. *Clin Orthop Relat Res.* 2008; 466(7):1539-54. [DOI:10.1007/s11999-008-0260-1] [PMID]
- [200] Rees JD, Stride M, Scott A. Tendons--time to revisit inflammation. *Br J Sports Med.* 2014; 48(21):1553-7. [DOI:10.1136/bjsports-2012-091957] [PMID]
- [201] Cohen SP, Strassels SA, Foster L, Marvel J, Williams K, Crooks M, et al. Comparison of fluoroscopically guided and blind corticosteroid injections for greater trochanteric pain syndrome: multicentre randomised controlled trial. *BMJ.* 2009; 338:b1088. [DOI:10.1136/bmj.b1088] [PMID]
- [202] Brinks A, van Rijn RM, Willemsen SP, Bohnen AM, Verhaar JA, Koes BW, et al. Corticosteroid injections for greater trochanteric pain syndrome: A randomized controlled trial in primary care. *Ann Fam Med.* 2011; 9(3):226-34. [DOI:10.1370/afm.1232] [PMID]
- [203] Coombes BK, Bisset L, Vicenzino B. Efficacy and safety of corticosteroid injections and other injections for management of tendinopathy: A systematic review of randomised controlled trials. *Lancet.* 2010; 376(9754):1751-67. [DOI:10.1016/S0140-6736(10)61160-9] [PMID]
- [204] Estrela GQ, Furtado R, Natour J, Narimatsu S, Rosenfeld A. THU0352 blinded VS ultrasound-guided corticosteroid injections for the treatment of the greater trochanteric pain syndrome (SDPT): A randomized controlled trial. *Ann Rheum Dis.* 2014; 73(Suppl 2):304. [DOI:10.1136/annrheum-dis-2014-eular.5394]
- [205] McEvoy JR, Lee KS, Blankenbaker DG, del Rio AM, Keene JS. Ultrasound-guided corticosteroid injections for treatment of greater trochanteric pain syndrome: Greater trochanter bursa versus subgluteus medius bursa. *AJR Am J Roentgenol.* 2013; 201(2):W313-7. [DOI:10.2214/AJR.12.9443] [PMID]
- [206] Mani-Babu S, Barton C, Morrissey D. The effectiveness and dose-response relationship of extracorporeal shock wave therapy in lower limb tendinopathy: A systematic review. *J Sci Med Sport.* 2012; 15:S133-4. [Link]
- [207] Furia JP, Rompe JD, Maffulli N. Low-energy extracorporeal shock wave therapy as a treatment for greater trochanteric pain syndrome. *Am J Sports Med.* 2009; 37(9):1806-13. [DOI:10.1177/0363546509333014] [PMID]

