Review article

Conservative management of tendinopathies around hip

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Summary

***Background*: The anatomy of hip is widely complex and several anatomical structures interact and contribute to its functioning. For position and role, hip and the surrounding tendons, which have their insertion around, are overstressed and often overloaded, especially in athletes. This could lead to the developing of several tendinopathies, among which the differential diagnosis is often complicated. Many conservative treatments are used in clinical practice, while actually, no defined conservative protocol is recommended.**
***Methods*: This is a review article. The aim of this manuscript is to evaluate the current evidences about the effectiveness of conservative management in hip tendinopathies.**
***Conclusion*: Conservative treatment is effective in the management of hip tendinopathies and may be considered the first-line approach for patients affected. However, there is lack of evidences about which is the most effective treatment. Exercise therapy seems to provide long-term pain relief, but the literature is still lacking about the correct type, dose, posology, intensity of exercise prescribed. Further studies about different local approaches, as PRP or hyaluronic acid injections, may be encouraged.**
Level of evidence: I.

KEY WORDS: tendinopathy, conservative management, hip, review.

Introduction

The anatomy of hip is extremely complex and several anatomical structures interact and contribute to its functioning. The wide femoroacetabular range of motion is driven by the high number of muscle groups that surround the hip, including flexors (iliopsoas, rectus femoris, pectineus, and sartorius muscles), extensors (gluteus maximus and hamstrings) and smaller muscles allowing for abduction, adduction, and internal and external rotation, as gluteus medius and minimus, obturator externus and internus, piriformis, and quadratus femoris muscles[1]. There are approximately twenty bursae in the trochanteric area[2] and the peritrochanteric space has been well described[3]. Some bursae may be acquired due to excessive friction[4], while three bursae are consistently present in the majority of individuals. These include the gluteus minimus bursa, located anterosuperiorly to the greater trochanter. The subgluteus medius bursa lies deep to the gluteus medius tendon. The subgluteus maximus bursa is the largest and often described as the "trochanteric bursa". This lies lateral to the greater trochanter between the gluteus medius and maximus. The greater trochanter is a large quadrangular projection at the junction of the femoral neck with the shaft. It is the main attachment for the strong abductor tendons. The gluteus medius and minimus muscles have been referred to as the "rotator cuff of the hip"[5]. For position and role, the hip and the surrounding tendons, which have their insertion around (mainly in the greater trochanter), are overstressed and often overloaded, especially in athletes[6]. It is estimated that injuries to the hip or pelvis represent approximately 2-5% of all sports injuries and up to 11% of running-related injuries, while a real incidence of each single condition is not determined yet[7]. Multiple pathologies often coexist and different tendinopathies can affect the muscles and tendons structures, causing similar symptoms and referred pain to the hip particularly in the trochanteric region[8]. Several names, in the years, have been given to Greater Trocanther Pain Syndrome (GTPS), as "hip periarthritis" and "trochanteric bursitis"[9,10]. However, in most cases the diagnosis of trochanteric bursitis is inappropriate, due to that the cardinal signs of inflammation are absent and isolated bursitis is uncommon[11]. In fact, co-existence of both

bursitis and tendinopathy often occurs[12]. Particularly, GTPS contains a range of causes including gluteal medius and minimus tendinopathy/tears, trochanteric bursitis and external coxa saltans[13,14], while the pathogenesis remains not completely understood[15]. Proximal hamstring tendinopathies (PHT) cause pain in the ischiatic region that may extend to the posterior thigh and are often related to sprinting actions[16]. It seems that a key factor for the development of PHT is represented by poor lumbo-pelvic control and muscle imbalances with hamstring weakness[17].Chronic and recurrent groin pain could be determined by insertional adductor tendinopathies that are frequent in sports involving sudden changes of direction, continuous acceleration and deceleration, sliding tackles and kicking, as in football. The overloading of the pubic symphysis and insertional tendons could be induced by the strength imbalance between the hypertonic adductor muscle and hypotonic large flat muscular sheets of the abdomen[18].

Besides, also iliopsoas tendinopathy, internal snapping hip and iliopectineal bursitis could provoke groin pain and the three pathologies could be collectively indicated as iliopsoas syndrome[19]. While the incidence is not well investigated, an MRI study showed that prevalence of iliopsoas tendon and myotendinous injuries was 0.66% in a large sample of 4862 consecutive hip MRI[20]. This condition not exclusively affect athletes, but could be secondary to hip arthroplasty and arthritis[19].

The complexity of the biomechanics of the hip and the consequent problems of differential diagnosis determine the difficulty for the clinicians to endorse an appropriate treatment protocol. However, conservative treatment should be considered the primary approach, different factors as severity and duration of symptoms, experience of physicians and presumptive diagnosis may be considered.

Several treatments have been proposed and are currently used in clinical practice[21]:

- Rest and modification of activities
- Reduction of the sporting activity
- Cryotherapy
- Hot packs (not in acute phase)
- Oral Medications: nonsteroidal anti-inflammatory drugs, which can relieve pain and decrease inflammation in the acute phase. The intake should be limited to short periods, because prolonged intake may affect tendon healing
- Physiotherapy: exercises and stretching
- Resolution of biomechanical abnormalities of the lower limbs (leg length discrepancy, pes planus/cavus)
- Postural gymnastics
- Strengthening of hip abductors and external rotators muscles
- Improving pelvic lumbar control: core stability and pelvic stabilizers exercises
- Local corticosteroid injection
- Physical therapies.

The aim of this review is to analyze the different treatments proposed in tendon pathologies around the hip and determine the current evidences in the management.

Materials and methods

A comprehensive systematic review of the available literature in the English language was performed using PubMed, PEDro and Google Scholar. It was conducted and reported specifically by defining the study characteristics of interest, information sources, search strategy, selection strategy, data extraction, defining summary measures, and describing the methods of data handling. The selection of the material was concluded in April 2016.

Keywords used were: hip tendinopathy or gluteal tendinopathy or hamstring tendinopathy or trochanteric bursitis or iliotibial syndrome or greater trochanteric pain syndrome and treatment and rehabilitation and conservative management and physiotherapy and shock waves and corticosteroid injections and physical therapy and exercise program and stretching.

Inclusion criteria were: 1) clinical trials of any type about rehabilitation treatment of tendinopathies around the hip; 2) papers published in the past decade; 3) English language; 4) Humans.

Exclusion criteria were: 1) surgical trials; 2) studies whose title and abstract were not related specifically to the search.

All methods used in this study meet the ethical standards of Muscles, Ligaments and Tendons Journal[22].

Results

The initial search yielded 330 articles, of which 15 were identified as relevant after screening of titles/abstract. Full texts were retrieved, and 1 further article was added from searching reference lists and citation tracking.

The 16 studies included 4 evaluating treatment in Proximal Hamstring Tendinopathy, 2 in Adductor Tendinopathy, 3 in Iliopsoas Tendinopathy, 1 in treatment of Acute Calcific Tendinopathy around the hip, 5 in Greater Trochanteric Pain Syndrome and Trochanteric bursitis and 1 in Gluteal Tendinopathy (Table I).

Proximal Tendinopathy of Hamstring

Four studies evaluating conservative management of proximal hamstring tendinopathies were identified. A pilot study and a Double-Blind Randomized Controlled Trial (RCT) focus on PRP injections, a retrospective study evaluates the use of corticosteroid injections and a RCT evaluates the efficacy of Extracorporeal Shock Wave Therapy (ESWT).

Dallaudière B et al.[23] enrolled 408 patients treated with a single intratendinous PRP injection for different site tendinopathies, including 40 patients affected by proximal hamstring tendinopathy. The Authors found

Table I. Design, follow-up, results and measurements of outcomes of selected studies.

Author	Title	Type of study	Number of cases	Follow-up	Outcomes	Results
Dallaudière et al.[23].	Intratendinous injection of platelet-rich plasma under US guidance to treat tendinopathy: a long-term pilot study.	Pilot Study.	408, of whose hamstring and adductor longus tendons, n = 40 [25.3%].	D0, W6, and long-term follow-up, US size of lesions.	QuickDASH, WOMAC, and VAS.	*Quick*DASH score, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score, and residual US size of lesions were significantly lower after intratendinous injection of PRP under US guidance at 6 weeks and during long-term follow-up compared with baseline ($P < .001$ in upper and lower limb) independent of age, gender, and type of tendinopathy ($P > .29$). No clinical complication was reported during follow-up.
Davenport KL et al.[24].	Ultrasound-Guided Intratendinous Injections With Platelet-Rich Plasma or Autologous Whole Blood for Treatment of Proximal Hamstring Tendinopathy.	A Double-Blind Randomized Controlled Trial.	15 patients were included in the analysis, for a total of 17 hips. 11 hips in the PRP group and 6 hips in the WB group.	2, 6, and 12 weeks and 6 months after injection.	The Modified Harris Hip Score (MHHS), Hip Outcome Scores for activities of daily living (ADL) and sport-specific function, and International Hip Outcome Tool 33 (IHOT-33).	Both PRP and WB groups showed improvements in all outcome measures at 6 months. The PRP group showed significant improvements in 6-month ADL and IHOT-33 scores. The WB group reached significance in 15-minute sitting pain. No significant between-group differences were observed at any time point.
Zissen MH et al.[25].	High hamstring tendinopathy: MRI and ultrasound imaging and therapeutic efficacy of percutaneous corticosteroid injection.	Retrospective study.	65 patients.	A mean time to follow-up of 4 years (range, 6 months to 8 years).	Telephone Questionaire.	38 of the original 65 patients responded. The duration of symptom resolution was longer than 6 months for nine (23.7%) of the 38 patients, 1–6 months for 10 patients (26.3%), 1 week to 1 month for 9 patients (23.7%), and less than 1 week for one patient (2.6%). The same nine patients who did not experience any pain relief immediately after the injection also felt no later benefit of the injection. At the ultimate outcome, 27 (71.0%) of 38 patients reported returning to their presymptom level of activity after the injection.

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Cacchio A et al.[26].	Shockwave therapy for the treatment of chronic proximal hamstring tendinopathy in professional athletes.	Randomized controlled clinical study.	40 professional athletes, subdivided in two groups; one group received shockwave therapy (n=20), second group received traditional conservative treatment consisting of nonsteroidal anti-inflammatory drugs, physiotherapy, and an exercise program for hamstring muscles (n = 20).	The visual analog scale (VAS) score for pain and Nirschl phase rating scale (NPRS) were used as primary outcome measures.	1 week and 3, 6, and 12 months after the end of treatment.	The results of the current study show that the SWT treatment yielded better results than TCT and comparable results to surgery in the management of patients with chronic PHT.
Holmich et al.[27].	Continued Significant Effect of Physical Training as Treatment for Overuse Injury 8- to 12-Year Outcome of a Randomized Clinical Trial.	Randomized Controlled Trial.	47 patients.	Standardized and reproducible clinical examination and personal interview.	8-12 years	A significant effect of the active training treatment still existed for the whole group (P = .047) and even more for the subgroup of 39 (83%) soccer players (P = .012). No significant differences were found regarding age, present sports activity, reasons for activity reduction, or time to follow-up.
Weir et al.[28].	Manual or exercise therapy for long-standing adductor-related groin pain: A randomised controlled clinical trial.	Single Blinded, Prospective, Randomised Controlled Trial.	54 patients.	Primary outcome: time to return to full sports participation. Secondary outcome measures: objective outcome score and the visual analogue pain score during sports activities (o-100).	0, 6, 16 and 24 weeks.	Athletes who received MMT returned to sports quicker (12.8 weeks, SD 6.0) than athletes in the ET group (17.3 weeks, SD 4.4. p ¼ 0.043). Only 50e55% of athletes in both groups made a full return to sports. There was no difference between the groups in objective outcome (p ¼ 0.72) or VAS during sports (p ¼ 0.12).

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Philippon MJ et al.[29].	Rehabilitation exercise progression for the gluteus medius muscle with consideration for iliopsoas tendinitis: an in vivo electromyography study.	Descriptive laboratory study.	10 healthy participants.			A continuum of hip rehabilitation exercises was identified. Resisted terminal knee extension, resisted knee flexion, and double-leg bridges were identified as appropriate for phase I and resisted hip extension, stool hip rotations, and side-lying hip abduction with wall-sliding for phase II. Hip clam exercises with neutral hips may be used with caution in patients with hip flexor tendinitis. Prone heel squeezes, side-lying hip abduction with internal hip rotation, and single-leg bridges were identified for phase III.
Kanai Garala, Vishnu Prasad[30].	Medium-Term and Long-TermOutcomes of Interventions for primary Psoas Tendinopathy.	Retrospective case-control study.	23 patients.	Follow-up over a time of 49 months for surgery, 77 months for injection.	NAHS score.	Local steroid injections can provide long-term relief for patients presenting with psoas tendinopathy. For patients with only temporary relief from injection, psoas tenotomy can provide good long-term pain relief.
Ryan M et al.[31].	Iliopsoas Bursa Injections Can be Beneficial for Pain after Total Hip Arthroplasty.	Retrospective Study.	27 patients.		Pre and immediately postinjection, questionnaires and telephone followup questionnaires.	The average modified Harris hip score in the 19 patients improved from 61 preinjection to 82 postinjection and the average pain improved from 6.4 preinjection to 2.9 postinjection, but eight patients (30%) required a second injection at an average of 8.2 months after the first injection. Six patients (22%) had an additional surgical procedure to address the underlying cause of the iliopsoas irritation.
Park SM et al.[32].	Management of acute calcific tendinitis around the hip joint.	Case series.	Thirty hips (29 patients) with acute calcific tendinitis.	Follow-up period of 12 to 32 months.	Level of subjective hip pain using the Visual Analog Scale Pain Score.	The most common site of calcium deposition was the tendon of the gluteus medius. During follow-up, calcium deposition completely resolved in 5 of 20 hips. Symptoms in 23 patients (24 hips) responded to nonoperative treatment. Two patients (2 hips) were treated with ultrasound-guided local anesthetic and steroid injection. Four patients (4 hips) with long duration (>3 months) of severe pain, solid type, and large size (range, 96-416 mm) were treated with arthroscopic excision.

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McEvoy JR et al.[33].	Ultrasound-guided corticosteroid injections for treatment of greater trochanteric pain syndrome: greater trochanter bursa versus subgluteus medius bursa.	Retrospective Trial.	183 injections; 41injections were into the greater trochanteric bursa and 24 into the subgluteus medius bursa.	At baseline, 14 days after the procedure.	A 10-cm visual analog scale.	There was a statistically significant difference in pain reduction between greater trochanteric bursa and subgluteus medius bursa injections with a median pain reduction of 3 as opposed to 0 ($p < 0.01$).
Cohen S et al.[34].	Comparison of fluoroscopically guided and blind corticosteroid injections for greater trochanteric pain syndrome.	Multicentre double blind randomised controlled study.	65 patients with a clinical diagnosis of greater trochanteric pain syndrome were injected with corticosteroid and local anaesthetic; n=32 patients were injected using fluoroscopy, n=33 patients using landmarkers for guidance.	1,3 months.	0-10 numerical rating scale pain scores; Oswestry disability scores, SF-36 scores, reduction in drug use, and patients' satisfaction.	No differences in outcomes occurred favouring either the fluoroscopy or blind treatment groups. One month after injection the average pain scores were 2.7 at rest and 5.0 with activity in the fluoroscopy group compared with 2.2 and 4.0 in the blind injection group. Three months after the injection, 15 (47%) patients in the blind group and 13 (41%) in the fluoroscopy group continued to have a positive outcome.
Furia JP et al.[35].	Low-energy extracorporeal shock wave therapy as a treatment for greater trochanteric pain syndrome.	Case Control Study.	66 patients with chronic greater trochanteric pain syndrome were subdivided in two groups: n=33 patients received low-energy shock wave therapy; n=33 only received additional forms of nonoperative therapy (control).	1, 3, 12 months after treatment.	VAS Scale, Harris Hip Score (HHS) and Maudsley e Roles Scale (MR).	The mean visual analog score for the control and shock wave therapy groups were 7.6 and 5.1 ($P < .001$), 7 and 3.7 ($P < .001$), and 6.3 and 2.7 ($P < .001$), respectively. One, 3, and 12 months after treatment, mean Harris hip scores for the control and shock wave therapy groups were 54.4 and 69.8 ($P < .001$), 56.9 and 74.8 ($P < .001$), and 57.6 and 79.9 ($P < .001$), respectively. At final follow-up, the number of excellent, good, fair, and poor results for the shock wave therapy and control groups were 10 and 0 ($P < .001$), 16 and 12 ($P < .001$), 4 and 13 ($P < .001$), and 3 and 8 ($P < .001$), respectively. Chi-square analysis showed the percentage of patients with excellent (1) or good (2) Roles and Maudsley scores

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						(ie, successful results) 12 months after treatment was statistically greater in the shock wave therapy than in the control group ($P < .001$).
Jan D. Rompe et al.[36]	Home Training, Local Corticosteroid Injection, or Radial Shock Wave Therapy for Greater Trochanter Pain Syndrome.	Randomized Controlled Trial.	229 patients with refractory unilateral greater trochanter pain syndrome were assigned sequentially to a home training program (n=76), a single local corticosteroid injection (25 mg prednisolone) (n=75), or a repetitive low-energy radial shock wave treatment (n=78).	At baseline and at 1, 4, and 15 months.	6-Point Likert scale and severity of pain over the past week.	One month from baseline, results after corticosteroid injection were significantly better than those after home training or shock wave therapy. Regarding treatment success at 4 months, radial shock wave therapy led to significantly better results than did home training and corticosteroid injection. Fifteen months from baseline, radial shock wave therapy and home training were significantly more successful than corticosteroid injection.
Brinks A. et al.[37].	Corticosteroid Injections for Greater Trochanteric Pain Syndrome: A Randomized Controlled Trial in Primary Care.	Randomized Controlled Trial.	120 patients (aged 18 to 80 years) with GTPS were randomly allocated to receive or local corticosteroid injections (n = 60) or usual care (n= 60).	3-month and 12-month follow-up visits.	Numerical rating scale 0 to 10) and recovery (yes or no total or major recovery).	At the 3-month follow-up visit, 34% of the patients in the usual care group had recovered compared with 55% in the injection group. Pain severity at rest and on activity decreased in both groups, but the decrease was greater in the injection group. The 12-month follow-up showed no significant differences.
Labrosse et al.[38].	Effectiveness of ultrasound-guided corticosteroid injection for the treatment of gluteus medius tendinopathy.	Prospective study not randomized.	54 patients.	Baseline, 1 month.	a 10-cm visual analog scale (VAS).	There was a 55% average reduction of pain level before versus after treatment. One month after treatment, 72% of the patients showed a clinically significant improvement in pain level, with a reduction in the VAS pain score of ≥ 30%.

a statistically significant clinical and US improvement at 6 weeks of follow-up that was not dependent by age, gender and type of tendinopathy. No clinical complications were reported during follow-up.
In a double blind RCT, PRP injections result equally effective to whole blood cell injections until 6 months of follow-up, without any statistically significance difference[24].
Zissen MH et al.[25] in a retrospective study enrolled 65 patients who received ultrasound-guided corticosteroid injections between January 2002 and December 2008. There were 28 men (43.1%) and 37 women (56.9%). A total of 65 injections were performed, with a mean time to follow-up of 4 years (range, 6 months to 8 years). Patients were followed through telephone questionnaires. A total of 38 of the original 65 patients responded to survey. Nine of the patients in their study reported sudden improvement after injection of the local anesthetic, confirming that the hamstring tendon was indeed the cause of their discomfort. No significant side effects or complications were reported by any of the patients undergoing injection. Furthermore, there was an excellent clinical response to corticosteroid injection, with 50% of patients reporting moderate-to-complete resolution of their symptoms for at least 1 month after the injection and 28.9% reporting complete and sustained resolution of symptoms post injection.
In a RCT, Cacchio et al.[26] compared the efficacy of ESWT alone to a general conservative treatment protocol in 40 professional athletes divided into two groups of 20 subjects each. The general conservative treatment protocol consisted in the administration of NSAIDs (Ibuprofen 600mg twice daily) for the first week, physiotherapy and an exercise program for the hamstrings. The exercise program included hamstring stretching and eccentric and concentric strengthening exercises for hamstring muscles, performed 3 days a week for 3 weeks. The patients were evaluated at 1 week and at 3, 6 and 12 months after treatment. The primary outcome measures used were the VAS, the phase Nirschl rating scale (NPRS). Significant differences were found between the two groups in favor of the group treated with ESWT in all scores. In addition, 16 patients in the ESWT group came back to sport at the same preinjury level. By contrast, none of the patients in the control group were able to return to preinjury level at follow-up evaluations.

Adductor tendinopathy

Two studies were reported about the conservative treatment of adductor tendinopathy; 1 RCT and 1 single blinded, prospective, randomized controlled trial.
Holmich et al.[27] evaluated the long-term effect of an exercise protocol, validated in a previous RCT conducted by the same Authors, in which was compared the effectiveness of supervised active training program (AT) to a general program without active training (PT) in the treatment of adductor-related groin pain in 69 athletes of whom 59 completed the study. The AT consisted in exercises focused in muscular strengthening, mainly eccentric, with special emphasis on the adductor muscles, as well as training muscular coordination to improve the postural stability of the pelvis, while PT in manual techniques (transverse friction massage), electrotherapy (laser and transcutaneous electrical nerve stimulation), and exercise therapy (stretching). Forty-seven athletes (80%) participated in the follow-up evaluation, in which the distribution of outcomes showed a significant difference in favor of the AT treatment, in terms of pain reduction and return to sport participation at preinjury level.
Weir et al.[28] in a single-blind, prospective, RCT compared two groups of 54 patients with diagnosis of adductor tendinopathy; one group was treated with the same exercise protocol of Hölmich et al. [27] (ET, n=22), while the other group with a multi modal treatment (MMT, n=26). Multi-modal treatment program (MMT) consisted in using heat, Van Den Akker manual therapy method, stretching and returning to running program. Primary outcome was time to return to full sports participation. Secondary outcome measures were objective outcome score and the VAS score during sports activities. The athletes were assessed by a single experienced blinded physician at baseline, 6, 16 and 24 weeks after the start of treatment. There was no significant difference in the number of athletes able to return to sporting activities between the two treatment groups. The objective treatment outcome and pain scores during sporting activities did not differ between the two treatment groups. The athletes in the MMT group significantly return more quickly to sports than athletes in ET. This clinical trial showed that the MMT was safe and equally effective treatment for athletes as an ET program. However, the Authors argue that the efficacy is lower than the results obtained in other studies in which were proposed.

Iliopsoas tendinopathy

Three studies on the conservative treatment of iliopsoas tendinopathy have been included.
Philippon et al.[29] proposed a rehabilitative protocol based on gluteus medius strengthening, observing that a concomitant weakness of the gluteus medius in many cases of iliopsoas tendon pathology is often present. EMG signals of the gluteus medius and iliopsoas muscles were recorded from 10 healthy participants. Exercises were placed into respective time phases based on average gluteus medius EMG amplitude, exercises involving hip rotation were avoided in phase I (phase I, initial 4 or 8 weeks; phase II, subsequent 4 weeks; Phase III, final 4 weeks). It was identified a continuum of gluteus medius muscle activation for 13 common hip rehabilitation exercises and evaluated concurrent iliopsoas activation. Based on these data a continuum of hip rehabilitation exercises was identified. Resisted knee extension terminal, resisted knee flexion, and double-leg bridges were identified as appropriate for phase I and resisted hip extension, hip

rotations stool, and side-lying hip abduction with wall-sliding for phase II. Hip clam exercises with neutral hips may be used with caution in patients with hip flexor tendinopathies. Heel squeezes prone, side-lying hip abduction with internal hip rotation, and single-leg bridges were identified for phase III.

Garala and Prasad[30] in a retrospective case-control study evaluated the efficacy of psoas tenotomy and image-guided steroid injections. Twenty-three patients were evaluated over a time of 49 months for surgery and 77 months for injection. Eight patients had a lasting response to injection and not required more interventions. Fifteen patients submitted to psoas tenotomy, using Ludloff approach, of which 10 patients reported pain relief after tenotomy, while 5 patients reported no change in pain. The average NAHS after surgery was 66.15% and 76.08% after injection. The Authors conclude that local corticosteroid injection can provide long-term relief. For patients with only temporary relief from injection, psoas tenotomy could represent a valid treatment with long-term efficacy. Furthermore, the Authors sustained that patients who had no pain relief after injection, did not receive any benefit from the surgery.

Ryan et al.[31] retrospectively reviewed 27 patients with presumed iliopsoas tendinopathy treated by a single fluoroscopically-guided injection of a combination of 1 mL depo steroid (Kenalog-40) (40 mg/mL) z 1 mL of bupivacaine 0.25%, and 1 mL of a 2:1 mixture of Conray-43 and 0.25% bupivacaine or 1% lidocaine. The treatment was promptly effective in 19 patients, while 8 patients (30%) required a second injection at an average of 8.2 months after the first injection. One patient had a third injection 3 months after second injection. Six patients had an additional surgical procedure to address the underlying cause of the iliopsoas irritation. The Authors concluded that selective steroid and anesthetic injections of the iliopsoas bursa represent a safe and effective treatment.

Calcific tendinopathies around hip

A retrospective study[32], involved 39 patients affected by calcific tendinopathies around the hip. Subjective hip pain at the first visit was measured with VAS. During the follow-up, the VAS pain score and duration of symptoms were recorded. Standardized pelvic anteroposterior and lateral radiographs were taken to determine the size, location, and shape of calcific deposits. Of 29 patients (30 hips), 23 (24 hips) were managed with non-operative treatment. Among 30 hips, calcium phosphate crystals were located within the tendon of the gluteus medius muscle in 15 patients, the reflected head of the rectus femoris muscle in 9 hips, the capsule in 3 hips, and the piriformis, iliopsoas, and direct head of the rectus femoris muscle in 1 hip. The VAS score decreased from a mean of 7.1 (range, 5-10) at the first visit to 0.8 (range, 0-4) at the final follow-up visit. Of 6 patients (6 hips) who were treated with interventions, 2 patients with severe pain (VAS score 9 or 10) underwent ultrasound-guided local anesthetic and steroid injection. Both patients reported complete symptom subsidence at 4 weeks after injection. Radiographic evaluation showed complete disappearance of the calcifications with no recurrence at the final follow-up. The remaining 4 patients who reported pain after 3 months of non-operative treatment were treated using arthroscopic surgery.

Greater trochanteric syndrome

Six studies were included: 1 open-label randomized trial, 2 RCTs, 1 case-control study, 1 retrospective study and 1 multicentric double-blind RCT. Four of these studies evaluate the efficacy of local corticosteroid injections, two the efficacy of ESWT, one study compares home training with local injections of corticosteroids and with ESWT.

Brinks et al.[33] in an open label randomized trial compared the effectiveness of corticosteroid injections to usual care treatment, consisting in analgesics as needed. The injection according to a standard procedure: i.e. to use 40 mg triamcinolone acetate combined with lidocaine 1 or 2% in a 5 ml syringe. A clinically relevant effect of corticosteroids has been shown in the assessment after six weeks; at 3 months follow-up, the effect was decreased; after 12 months no differences were evident between the groups. The same Authors had compared the efficacy of corticosteroids to analgesics as needed in a previous study (RCT), in which corticosteroids were more efficient to reduce pain at three and six months, while results were not statistical different at 1 year follow-up.

McEvoy et al.[34] compared the effects of corticosteroid injections in the trochanteric bursa to injections in the subgluteus medius bursa, showing that injections directed into the greater trochanteric bursa result in greater pain reduction than subgluteus medius bursa injections in the short-term treatment of patients with GTPS. Furthermore, there was no association between pain reduction and the ultrasound findings of tendinopathy, bursitis, or enthesopathy, suggesting that sonographic findings may not be predictive of response to treatment with corticosteroid injections.

Nevertheless, Cohen et al.[35] found no differences in injecting within the trochanteric bursa, using fluoroscopic guidance or through simple anatomical landmarks. This could be due in part that patients with GTPS often have no signs of inflammation at the trochanteric bursa, and pain may result from problems in the surrounding structures.

Furia et al.[36] have shown that ESWT determined greater clinical effects, considering the changes in the VAS score, Harris Hip Score (HHS) and the Maudsley scale, than other forms of conservative therapies in patient affected by chronic forms of GTPS, until 12 months of follow-up ($p<0.0001$).

Recently, the same Authors[37] enrolled 229 patients with refractory unilateral GTPS that were assigned sequentially to a home training program (n=76), a single local corticosteroid injection (25 mg predni-

solone) (n=75), or a repetitive low-energy radial shock wave treatment (n=78). While in the first month of follow-up corticosteroids were more effective than other treatment modalities, ESWT and exercise home based therapy were revealed both more effective at 15 months follow-up.

Gluteal tendinopathy

Labrosse et al.[38], in a prospective study, evaluated 54 patients with clinical and US diagnosis of gluteus medius tendinopathy. All patients were administered a ultrasound-guided injection of 30 mg of triamcinolone combined with 3 mL of 0.5% bupivacaine using an anterior oblique coronal plane. One month after treatment, 72% of the patients showed a clinically significant improvement in pain level, which was defined as a reduction in the VAS pain score of ≥30%. Seventy percent of patients was satisfied with the results of the intervention.

Discussion

The management of tendinopathies is changing with the progression of the research and the growing evidences on this argument[39]. Currently, the treatment should include early functional treatments, rather than rest and immobilization[21]. Several therapeutic options are allowed: eccentric and concentric exercise, ESWT, therapeutic ultrasound, low level laser therapy (LLLT), hyperthermia, splinting-bracing and orthoses, deep transverse friction and topical glycerine[40,41].

Although hip tendinopathies are recognized as common causes of pain and functional impairment in athletes and in general population, actually the evidences are still lacking, compared to other tendinopathies. In our knowledge, most of studies aimed to determine short-term pain relief, while the long-term management is often not investigated.

Particularly, corticosteroid injection seems to represent the most used therapy, whereas the mechanisms of efficacy and safety, especially in repeated use, remain unclear. The use of corticosteroid injection is well-described but the clinical application may be limited by short-term efficacy. Corticosteroid injection has been suggested to provide an analgesic effect related to its interaction with local neuropeptides and neurotransmitters[42]. Repeated use is associated with tendon rupture whether the event is not common[43]. Recurrence of pain following corticosteroid injection may reflect the failure of the intervention to address the underlying pathology and the associated central mechanisms, thought to be important co-drivers of longer-term tendon pain[44]. Furthermore, corticosteroids may cause down-regulation of fibroblastic production of collagen, hiding tendon capacity to respond appropriately to loading[44].

In the last years, an increased number of studies has been accomplished on the role of PRP or hyaluronic acid in tendinopathies, due in part to the superiority to corticosteroid in the long-term management of different tendinopathies. Furthermore, the use of PRP may avoid tendon rupture risk, related to corticosteroid injection. PRP could provide several molecules capable of boosting healing mechanisms and counteracting degenerative processes in tendinopathic tendon, restoring tissue architecture and enhancing tenocyte viability. In the present review, initial evidences in favor of PRP injections have been found only in the management of hamstring tendinopathy[23,24], while the efficacy of this treatment in the other hip tendinopathies is not investigated yet. However, the encouraging results obtained, may allow to an ulterior option prior to surgical intervention.

ESWT has been shown to be effective for different tendinopathies, even for proximal hamstring tendinopathy and GTPS in long-term follow-up[45,46]. ESWT has proven to have direct benefits on tendon healing process, promoting neoangiogenesis, especially on tendon-bone junction, and inducing the up-regulation of nitric oxide and several growth factors: Insulin-like Growth Factor 1 (IGF-I), Platelet-Derived Growth Factor (PDGF), Vascular Endothelial Growth Factor (VEGF), basic Fibroblast Growth Factor (b-FGF), and Transforming Growth Factor beta (TGF-beta)[47].

Treatment regimens for ESWT vary dependent upon energy density, frequency of shockwaves and number of sessions. The studies evaluating effectiveness of ESWT present many variables including wave type (focal or radial), intensity per shock wave, frequency of the shock waves, type of SW generator and the overall treatment protocol. However, in our review, all the studies included opted for radial ESWT, whether no comparison study was already been performed between wave types.

Eccentric exercises (EE) applied as a regular training program over months are generally considered the gold standard for managing tendinopathies, especially patellar and Achilles tendinopathies[48]. EE has been demonstrated to improve tendon structure and muscle strength[49]. Although the lack of a general consensus, it has been noted that EE reduces the tendency of tendon to degenerate by increasing collagen content and reducing neovascularization[50]. Whether EE has been showed to be effective, programs are not well established yet, neither for dose, velocity and number of contractions or for period of treatment[51]. Nevertheless, in our review the use of EE is restricted to studies on hamstring tendinopathies, while there are no evidences in other sites hip tendinopathies. However, in adductor tendinopathies a combined approach of concentric and eccentric strengthening, endurance and neuromuscular training may be efficient in athletes to resume sports at their preinjury level and that exercise therapy may represent the therapy with the highest level of evidence for the treatment of adductor-related groin pain.

Indeed, it could be argued that each tendinopathy requires an appropriate and specific management. This is currently not practicable and it is therefore neces-

sary that future studies should be conducted targeted for each specific tendinopathy around the hip.

Iliopsoas tendon pathology may be associated with chronic pain following hip surgery and even if is uncommon after THA, it should be considered in the differential diagnosis of all patients who present with groin pain after THA[31]. However, studies performed are largely focused on the surgical treatment omitting the conservative aspects. Actually, evidences about conservative approach are limited to corticosteroid injections that are often effective and determine lasting in pain relief. Selective steroid and anesthetic injections of the iliopsoas bursa give adequate pain relief in the majority of patients and should be considered part of the nonoperative management before surgical release of the iliopsoas tendon or component revision[31]. The lack of response to treatment with corticosteroids may be predictive of a poor response to surgery[31].

For proximal hamstring tendinopathy injections with PRP may have interesting implications[23,24]. In our review, it emerges that the shock waves[26] and injection with corticosteroids[25] are efficient, but new types of training and exercises should still be considered.

Gluteal tendinopathy is the most frequent cause of pain in the greater trochanter region[13]. In the literature the treatment with corticosteroids injections has been shown to be effective[38], whether studies with a long follow-up are still missing.

Studies about GTPS were included, because in most cases this pathological condition is related to medius and minimus gluteus tendinopathies[14]. Conservative treatment is the gold standard for GTPS with over 90% success rate, whereas there is currently no evidence-based protocol for the management of GTPS[21].

Corticosteroids are useful to relieve pain and reduce inflammation[52], especially in the short term (within three months after the administration)[44]. Several studies have shown that in the long term other conservative treatments are much more effective, as ESWT is the one with greater effectiveness especially in the long period for GTPS[53].

Conclusion

Conservative treatment is effective in the management of hip tendinopathies and may be considered the first-line approach for patients affected. However, there is lack of evidences about which therapy should be indicated on patients affected by hip tendinopathies for two main reasons. First, only in the last years the pathologies of soft tissue around the hip were accurately categorized. Secondly, the literature available is low-quality and exiguous in volume. Most of studies performed are limited to corticosteroid injections, which represent a valid treatment in short-term pain relief, while the long-term use may impair tendon architecture, until tendon rupture. Therefore, further studies about different local approaches, as PRP or hyaluronic acid injections, may be encouraged. Long-term relief may be achieved with exercise therapy, whereas the literature is still lacking about the correct type, dose, posology, intensity of exercise prescribed.

References

1. Wilson JJ, Furukawa M. Evaluation of the patient with hip pain. Am Fam Physician. 2014;1;89(1):27-34.
2. Williams RL, Warwick R. Gray's Anatomy. 36th ed. Philadelphia, PA: Saunders. 1980.
3. Williams BS, Cohen SP. Greater trochanteric pain syndrome: A review of anatomy, diagnosis and treatment. AnesthAnalg. 2009;108(5):1662-1670.
4. Dunn T, Heller CA, McCarthy SW, Dos Remedios C. Anatomical study of the trochanteric bursa. Clin Anat. 2003;16:233-240.
5. Bunker TD, Esler CN, Leach WJ. Rotator cuff tear of the hip. J Bone Joint Surg Br. 1997;79(4):618-620.
6. Schilders E, Dimitrakopoulou A, Cooke M, Bismil Q, Cooke C. Effectiveness of a selective partial adductor release for chronic adductor-related groin pain in professional athletes. Am J of Sports Med. 2013;41(3):603-607.
7. Heiderscheit B, McClinton S. Evaluation and Management of Hip and Pelvis Injuries. Phys Med Rehabil Clin N Am. 2016; 27(1):1-29.
8. Minnich JM, Hanks JB, Muschaweck U, Brunt LM, Diduch DR. Sports hernia: diagnosis and treatment highlighting a minimal repair surgical.
9. Bird PA, Oakley SP, Shnier R, Kirkham BW. Prospective evaluation of magnetic resonance imaging and physical examination findings in patients with greater trochanteric pain syndrome. Arthritis Rheum. 2001;44:2138-45.
10. Kingzett-Taylor A, Tirman PF, Feller J, et al. Tendinosis and tears of the gluteus medius and minimus muscles as a cause of hip pain. MR imaging findings. Am J Roentgenol. 1999;173: 1123-6.
11. 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;23:2104-2106.
12. 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):1083-1086.
13. Strauss EJ, Nho SJ, Kelly BT: Greater trochanteric pain syndrome. Sports Med Arthrosc. 2010;18(2):113-119.
14. Connell DA, Bass C, Sykes CA, Young D, Edwards E. Sonographic evaluation of gluteus medius and minimus tendinopathy. Eur Radiol. 2003;13(6):1339-1347
15. Genth B, Von During M, Von Engelhardt LV, Ludwig J, Teske W, Von Schulze-Pellengahr C. Analysis of the sensory innervations of the greater trochanter for improving the treatment of greater trochanteric pain syndrome. Clin Anat. 2012; 25:1080-1086.
16. Cushman D, Rho ME. Conservative Treatment of Subacute Proximal Hamstring Tendinopathy Using Eccentric Exercises Performed With a Treadmill: A Case Report. J Orthop Sports Phys Ther. 2015;45(7):557-62.
17. Jayaseelan DJ1, Moats N, Ricardo CR. Rehabilitation of proximal hamstring tendinopathy utilizing eccentric training, lumbopelvic stabilization, and trigger point dry needling: 2 case reports. J Orthop Sports Phys Ther. 2014;44(3):198-205.
18. Valent A, Frizziero A, Bressan S, Zanella E, Giannotti E, Masiero S. Insertional tendinopathy of the adductors and rectus abdominis in athletes: a review. Muscles Ligaments Tendons J. 2012;10;2(2):142-8.

19. Tyler TF, Fukunaga T, Gellert J. Rehabilitation of soft tissue injuries of the hip and pelvis. Int J Sports Phys Ther. 2014;9 (6):785-97.
20. Bui KL, Ilaslan H, Recht M, Sundaram M. Iliopsoas injury: an MRI study of patterns and prevalence correlated with clinical findings. Skeletal Radiol. 2008;37(3):245-9.
21. Lustenberger DP, Ng VY, Best TM, Ellis TJ: Efficacy of treatment of trochanteric bursitis: A systematic review. Clin J Sport Med. 2011;21(5):447-453.
22. Padulo J, Oliva F, Frizziero A, Maffulli N. Muscles, Ligaments and Tendons Journal. Basic principles and recommendations in clinical and field Science Research: 2016 Update. MLTJ. 2016;6(1):1-5.
23. Dallaudière B, Pesquer L, Meyer P, Silvestre A, Perozziello A, Peuchant A. et Al. Intratendinous injection of platelet-rich plasma under US guidance to treat tendinopathy: a long-term pilot study. J Vasc Interv Radiol. 2014;25(5):717-23.
24. Davenport KL, Campos JS, Nguyen J, Saboeiro G, Adler RS, Moley PJ. Ultrasound-Guided Intratendinous Injections With Platelet-Rich Plasma or Autologous Whole Blood for Treatment of Proximal Hamstring Tendinopathy. J Ultrasound Med. 2015;34(8):1455-63.
25. Zissen MH, Wallace G, Stevens KJ, Fredericson M, Beaulieu CF. High Hamstring Tendinopathy: MRI and Ultrasound Imaging and Therapeutic Efficacy of Percutaneous Corticosteroid Injection. AJR 2010;195:993-998.
26. Cacchio A, Rompe JD, Furia JP, Susi P, Santilli V, De Paulis F. Shockwave therapy for the treatment of chronic proximal hamstring tendinopathy in professional athletes. Am J Sports Med. 2011;39(1):146-53.
27. Hölmich P, Nyvold P, Larsen K. Continued Significant Effect of Physical Training as Treatment for Overuse Injury 8- to 12-Year Outcome of a Randomized Clinical Trial. Am J Sports Med. 2011;39:2447.
28. Weir A, Jansen JACG, van de Port IGL, Van de Sande HBA, Tol JL, Backx FJG. Manual or exercise therapy for long-standing adductor-related groin pain: A randomised controlled clinical trial. Man Ther. 2011 Apr;16(2):148-54.
29. Philippon MJ, Decker MJ, Giphart JE, Torry MR, Wahoff MS, LaPrade RF. Rehabilitation exercise progression for the gluteus medius muscle with consideration for iliopsoas tendinitis: an in vivo electromyography study. Am J Sports Med. 2011;39(8):1777-85.
30. Garala K, Prasad V. Medium-Term and Long-TermOutcomes of Interventions for primary Psoas Tendinopathy. Clin J Sport Med. 2014;24(3):205-10.
31. Ryan M. Nunley MD, Joyce M. Wilson MD, Louis Gilula MD et Al. Iliopsoas Bursa Injections Can be Beneficial for Pain after Total Hip Arthroplasty. Clin Orthop Relat Res. 2010;468:519-526.
32. Park SM, Baek JH, Ko YB, Lee HJ, Park KJ, Ha YC. Management of acute calcific tendinitis around the hip joint. Am J Sports Med. 2014;42(11):2659-65.
33. 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.
34. Cohen SP, Strassels SA, Foster L, et al. Comparison of fluoroscopically guided and blind corticosteroid injections for greater trochanteric pain syndrome: multicentre randomised controlled trial. BMJ. 2009;338:b1088.
35. Furia J, Rompe J, Maffulli N. Low-energy extracorporeal shock wave therapy as a treatment for greater trochanteric pain syndrome. Am J Sports Med. 2009;37:1806-1813.
36. Rompe J, Segal N, Cacchio A, et al. Home training, local corticosteroid injection, or radial shock wave therapy for greater trochanteric pain syndrome. Am J Sports Med. 2009;37:1981-1990.
37. Brinks A, van Rijn RM, Willemsen SP, et al. Corticosteroid injections for greater trochanteric pain syndrome: a randomized controlled trial in primary care. Ann Fam Med. 2011;9(3):226-34.
38. Labrosse JM, Cardinal E, Leduc BE, Duranceau J, Rémillard J, Bureau NJ et Al. Effectiveness of ultrasound-guided corticosteroid injection for the treatment of gluteus medius tendinopathy. AJR 2010;194:202-206.
39. Grimaldi A, Mellor R., Paul Hodges. Gluteal Tendinopathy: A Review of Mechanisms, Assessment and Management. Sports Med. 2015;45:1107-1119.
40. Kaux JF, Forthomme B, Le Goff C, Crielaard JM, Croisier JL. Current opinions on tendinopathy. J Sports Sci Med. 2011;10: 238-253.
41. Paavola M, Kannus P, Jarvinen TA, et al. Treatment of tendon disorders: is there a role for corticosteroid injection? Foot Ankle Clin. 2002;7(3):501-13.
42. 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;376:1751-1767.
43. Rio E, Moseley L, Purdam C, et al. The pain of tendinopathy: physiological or pathophysiological? Sports Med. 2014;44 (1):9-23.
44. Coombes BK, Bisset L, Brooks P, et al. Effect of corticosteroid injection, physiotherapy, or both on clinical outcomes in patients with unilateral lateral epicondylalgia: a randomized controlled trial. JAMA. 2013;309(5):461-9.
45. Peed C. A systematic review of shockwave therapies in soft tissue conditions: focusing on the evidence. Br J Sports Med. 2014;48:1538-42.
46. Notarnicola A, Moretti B. The biological effects of extracorporeal shock wave therapy (eswt) on tendon tissue. Muscles Ligaments Tendons J. 2012;17;2(1):33-7.
47. Wang CJ, Huang KE, Sun YC, Yang YJ, Ko JY, Weng LH, Wang FS. "VEGF Modulates Angiogenesis and Osteogenesis in Shockwave-Promoted Fracture Healing in Rabbits". J Surg Res. 2011;171(1):114-9.
48. Alfredson H, Pietilä T, Jonsson P, Lorentzon R. Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. Am J Sports Med. 1998;26:360-366 [PMID: 9617396].
49. Mafi N, Lorentzon R, Alfredson H. Superior short-term results with eccentric calf muscle training compared to concentric training in a randomized prospective multicenter study on patients with chronic Achilles tendinosis. Knee Surg Sports Traumatol Arthrosc. 2001;9:42-47 [PMID: 11269583].
50. Silbernagel KG, Thomeé R, Thomeé P, Karlsson J. Eccentric overload training for patients with chronic Achilles tendon pain: arandomised controlled study with reliability testing of the evaluation methods. Scand J Med Sci Sports. 2001;11:197-206 [PMID:11476424].
51. Brosseau L, Casimiro L, Milne S, Robinson V, Shea B, Tugwell P, Wells G. Deep transverse friction massage for treating tendonitis (Cochrane review). In the Cochrane Library. 2003;4:CD003528.
52. Stephens MB, Beutler AI, O'Connor FG. Musculoskeletal injections: a review of the evidence. Am Fam Physician. 2008;15;78(8):971-6.
53. Sethu Mani-Babu, Dylan Morrissey, Charlotte Waugh, Hazel Screen, and Christian Barton. The Effectiveness of Extracorporeal Shock Wave Therapy in Lower Limb Tendinopathy. Am J Sports Med. 2015;43:752.