Systematic Review

Painful Total Hip Arthroplasty: A Systematic Review and Proposal for an Algorithmic Management Approach

Daniela Yucuma, MD, Irene Riquelme, MD, and Martín Avellanal, MD, PhD

From: Pain Clinic, University Hospital Sanitas La Moraleja, Madrid, Spain

Address Correspondence:
Martín Avellanal, MD, PhD
Pain Clinic, University Hospital Sanitas La Moraleja
c/ Sagasta, 16
28004 Madrid, Spain
E-mail: mavellanal@telefonica.net

Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 05-14-2020
Revised manuscript received: 09-28-2020
Accepted for publication: 10-29-2020

Free full manuscript: www.painphysicianjournal.com

Background: The etiological diagnosis of painful primary total hip arthroplasty and its management is a complex clinical challenge for pain physicians. Extrinsic sources of pain in the hip joint might be efficiently treated by clinical pain units, although the topic remains controversial.

Objectives: To conduct a literature review and suggest an evidence-based algorithmic approach to managing painful hip arthroplasty.

Study Design: Systematic literature review with qualitative data synthesis.

Methods: We conducted an online search of Medline/Pubmed, Embase, Clinical Trials, and Cochrane database using the Medical Subject Heading (MeSH) and free terms on all biomedical literature published up to August 2019. Articles that described either the etiologies and management of painful primary total hip arthroplasty or the imaging techniques to specifically assess any of its causes were included. We collected the demographic data (gender, age, body mass index), main etiologies, diagnostic tests, and specific treatments applied in each study. Based on the reviewed evidence, we propose an algorithmic approach, with a special emphasis on etiologies that should be referred to pain clinics.

Results: Twenty-four studies were included for the synthesis, 16 of which were observational studies and 8 of which were non-systematic literature reviews that described a wide range of etiologies of painful primary total hip arthroplasty. The results showed that 2/3 of the causes of pain were intrinsic and need to be managed by orthopedic surgeons. One third of the etiologies were extrinsic and should be referred to pain clinics once intrinsic causes have been ruled out. Among extrinsic sources of pain, the most frequent was myofascial etiology.

Limitations: A publication bias might have been present due to the inclusion of studies published only in English, Spanish, and German. The included studies also had heterogeneous methodologies.

Conclusions: The current review suggests that painful hip arthroplasty is not a rare condition in clinical practice. We systematically reviewed etiologies and various treatments published in the literature and we suggest an algorithmic approach to management based on the available evidence. This approach incorporates the evidence regarding our knowledge of the etiologies, diagnosis, and management of chronic pain after total hip arthroplasty.

Systematic review registration: The protocol was registered in PROSPERO the international prospective register of systematic reviews, ID CRD42020185663.

Key words: Chronic pain, review, pain management, arthroplasty, hip replacement

Pain Physician 2021: 24:193-201

Over the past half century, total hip arthroplasty (THA) has become a commonplace surgical procedure worldwide. Severe preoperative pain is the primary indication for THA, and its utility in relieving pain and increasing the level of function is widely accepted (1,2). However, a significant number of patients develop chronic pain after the procedure, despite well-fixed and well-positioned components.

Recent studies have reported that 7% – 28.1% of patients who underwent THA had persistent hip pain 12 – 18 months after the operation (3,4). This persistent pain is also known as painful THA and occurs when pain persists, for various reasons, beyond the normal time for tissue to heal (usually longer than 3 – 6 months) (5). Persistent pain after hip arthroplasty can be problematic for the patient and usually presents a diagnostic and therapeutic challenge (5).

Painful THA is not a rare clinical condition, due to the high and increasing number of patients undergoing hip arthroplasties each year (3,4,6,7). Although, actual frequency of etiological sources of pain have not been well established. Fundamental for successful treatment is the ability to establish the specific source of pain. Thus, therapy can be targeted to the direct etiology. In addition, successful diagnosis and management processes may require multidisciplinary approaches, which necessarily involves pain management.

Study Rationale

Results of the existing evidence leave the question regarding how frequently the source of pain can be identified in patients with a painful THA, how successful is its management and the role of pain specialist within the management of these patients.

Study Objectives

Consequently, there is a need to conduct a new, comprehensive review that can present all the available information of the studies addressing painful total hip arthroplasties, which will summarize available evidence in order to update the knowledge of clinicians and researchers. We aim to systematically review the available literature on chronic pain associated with THA or painful THA. We describe the possible etiologies, their treatment, and the utility of imaging tests for assessing the causes of chronic hip pain after THA. Lastly, we propose an evidence-based management algorithm, which we have implemented at our pain clinic for patients with painful THA.

Methods

Information Sources and Protocol Registration

This study was conducted according to the PRISMA statement (8). We systematically searched Medline/Pubmed, Embase, Clinical Trials, and Cochrane database (last search date August 2, 2019). The protocol was registered in PROSPERO the international prospective register of systematic reviews, ID CRD42020185663.

Search Strategy

We used the following terms: ((“hip arthroplasty” OR “THA” OR “total hip arthroplasty”) AND (“chronic pain”)) OR (“painful hip arthroplasty”) OR (“painful total hip arthroplasty”)) with no publication year or language limits (last search date August 2, 2019).

Eligibility Criteria and Study Selection

Articles describing either the etiologies and management of painful THA or the imaging techniques to specifically assess any of its causes were included. We performed an initial selection of relevant articles based on title and abstract and obtained full-text versions for the data extraction. The selected studies were narrative reviews and observational studies (prospective and retrospective) and case reports.

Data Collection Process, Data Items and Quality Assessment

We collected demographic data (gender, age, body mass index [BMI]), main etiologies, diagnostic tests, and the specific treatments applied. The data are expressed as mean, median, frequencies, and relative frequencies, as appropriate. For dispersion, we collected standard deviation and range when appropriate. Due to the heterogeneity in the included articles, we did not rate the quality of evidence with a standardized method.

Risk of Limitations Across Studies

A publication bias might have been present due to the inclusion of studies published only in English, Spanish, and German. Furthermore, including only studies that were published in the medical literature and exclusion of grey literature may have caused publication limitation.

Results

Using the previously described search strategy, we initially found 258 articles. Figure 1 shows the flowchart for the article selection. We excluded from the analysis those studies that focused on acute or postoperative pain and those that reported arthroscopic surgery techniques. In the end, we included 24 articles, which covered 8 reviews, 7 retrospective studies (466 patients), 2 prospective studies (61 patients), 3 case series (11 patients), and 4 case reports that described a wide range of etiologies for painful THA (Table 1 [5,9-31]). Most

of the patients (n = 542) included in studies that recorded an etiology were women. The included studies described either the etiologies and management of painful THA or the imaging techniques to specifically assess any of its causes.

The etiologies of painful THA ranged from intrinsic to extrinsic, and a small patient group had persistent painful THA of unexplained origin. Some 65.3% of the patients had intrinsic etiologies for the pain, which included 1) joint infection or loosening (182 patients), 2) impingement (80 patients), 3) wear (41 patients), 4) material problems (32 patients), and 5) misplacement or fracture (7 patients). Some 38.6% of patients had extrinsic etiologies for the pain, which included 1) myofascial/soft tissue pain (67.4%), 2) projected pain (26%), and 3) peripheral neuropathic pain (6.6%). The etiological diagnosis was not established in 8 cases (Table 2).

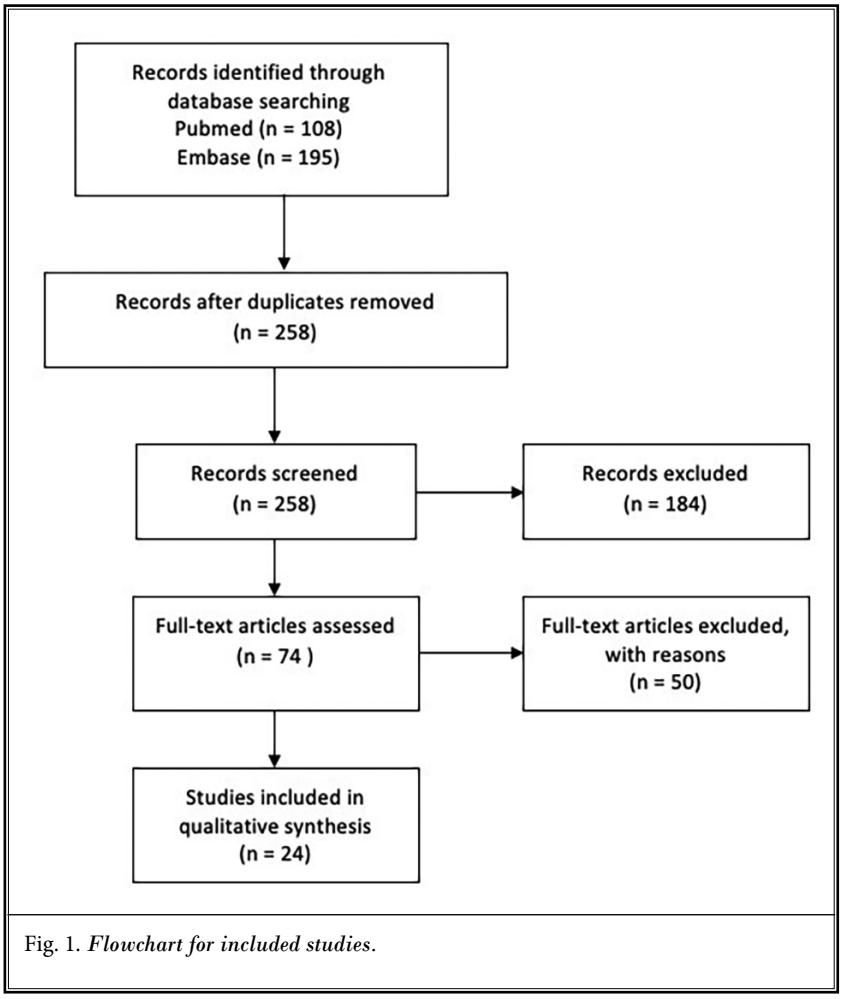

Fig. 1. *Flowchart for included studies.*

Discussion

The management of patients with persistent pain after THA remains controversial. There are numerous possible etiologies that, according to the reviewed literature, can be classified as extrinsic or intrinsic to the hip joint (11,18,23,27).

First, intrinsic causes for the pain should be considered, which include loosening, infection, wear, material problems, misplacement, and fracture, all of which are important etiologies that usually require surgical management. These causes should therefore be ruled out by orthopedic surgeons before considering other less common causes.

Patients with suspected extra-articular etiologies for the persistent pain should be referred to pain clinics for study and treatment. In a number of the published cases and in our own experience, certain patients might have more than one concomitant etiology, especially when an extrinsic etiology is reported.

The patients included in this review were mostly women; however, one of the included studies did not report this information. Additionally, not all of the included articles reported other characteristics such as age, follow-up time, and BMI. Even with these limitations, it is interesting to note the presence of a significant number of female patients among the reported patients, given that gender has been previously reported as a risk factor for chronic pain after THA (5). Additional characteristics reported as risk factors include high BMI, high preoperative pain levels, age, and depression (5).

Regarding the etiologies, these reports might have an inherent reporting bias because those cases without an established etiology, especially if treatment is ineffective, are less likely to be reported in the literature.

Diagnosis of Painful Total Hip Arthroplasty

A comprehensive medical history review and physical examination constitute the basis for establishing the diagnosis and thereby provide appropriate and

Table 1. *Characteristics of included studies.*

First author	Year	Article	Reported etiology
Berquist et al (9)	1987	Retrospective study (n: 175 patients with painful hip arthroplasty taken to subtraction arthrograms)	Bursae and/or communicating cavities (n: 75) Loosening or infection (n: 97)
Biant et al (10)	2010	Case report (n: 1)	Hypersensitivity reaction to the metal-on-metal prosthesis of the hip articulation
Bozic and Rubash (11)	2004	Review	(i) Intrinsic causes: infection, mechanical loosening, tip of stem pain (modulus mismatch), stress fracture, periprosthetic fracture, non-union, osteolysis, occult instability, inflammatory bursitis, tendonitis. (ii) Extrinsic causes: lumbar spine disease, peripheral vascular disease, nerve injury or irritation, causalgia or complex regional pain syndrome, metabolic disease, malignancy or metastases, hernia, referred pain
Browne et al (12)	2011	case series (n: 3)	Anterior iliopsoas impingement
Chalmers et al (13)	2017	Retrospective study (n: 49)	Psoas impingement
He (14)	2014	Prospective study (n: 56)	Material problems (n: 2) Aseptic loosening (n: 30) Periprosthetic infection (n: 17) Periprosthetic fractures (n: 2) Trochanteric bursitis (n: 5)
Classen et al (5)	2013	Review	(i) Soft tissue damage or irritation: bursitis, tendinopathy of the gluteus medius and minimus tendon, rupture of the gluteal muscles or tendons, snapping hip syndrome, impingement of the iliopsoas. (ii) Bony aspects: bone-to-bone impingement, component-to component impingement and component-to-bone impingement, heterotopic ossifications, stress shielding, fatigue fractures. (iii) Neurological or vascular causes
Dahm et al (15)	1998	Case report (n: 1)	Intrapelvic extrusion of bone cement
Erivan et al (16)	2019	Retrospective study (n: 194)	(i) Periarticular pain (53 cases) (ii) Projected pain (49 cases) (iii) Wear (40 cases) (iv) Loosening (20 cases) (v) Material problems (17 cases) (vi) No diagnosis (7 cases) (vii) Chronic infection (6 cases) (viii) Misplacement (3 cases) (ix) Fracture (2 cases) (x) Complex regional pain syndrome (1 case)
Ferrata et al (17)	2011	Review	(i) Positive x-rays: aseptic loosening, septic loosening, osteolysis, micromotion, heterotopic ossification, stress shielding. (ii) Negative x-rays: reactive synovitis, aseptic lymphocytic vasculitis associated lesion (ALVAL), iliopsoas tendinitis, abductor muscle damage, trochanteric bursitis, lumbar spine disease, nerve injuries, Hernia femoral or inguinal, and referred pain
Forster-Horvath et al (18)	2014	Review	(i) Intrinsic causes: aseptic loosening, prosthetic joint infection, instability, and impingement, thigh pain (micromotion, modulus mismatch, unnoticed periprosthetic fractures), iliopsoas impingement or hypersensitivity to metal debris. (ii) Extrinsic causes: trochanteric pain syndrome, heterotopic ossification, insufficiency fractures, spinal pathology, postsurgical pain syndrome and causes unrelated to the musculoskeletal system radiating to this area
Hargunani et al (19)	2016	Review	(i) Aseptic loosening (ii) Instability and dislocation (iii) Infection (iv) Particle disease and osteolysis (v) Adverse reactions to metal debris (vi) Fracture (v) Soft tissue abnormalities: abductor tendon defects, iliopsoas impingement (vi) Heterotopic ossifications (vii) Neurovascular damage

Table 1. *Characteristics of included studies (continued).*

First author	Year	Article	Reported etiology
Kim et al (20)	2017	Case report (n: 1)	Chronic post-arthroplasty hip pain, no specific diagnosis
Kisielinski et al (21)	2003	Case report (n: 1)	Inflammatory reaction caused by polyethylene wear in total hip arthroplasty
Lahner et al (22)	2013	Prospective study (n: 5)	Prosthetic joint infection (n: 2) Psoas impingement (n: 2) Adhesions of the periprosthetic tissue (n: 1)
Lanting and MacDonald (23)	2013	Review	(i) Intracapsular causes: aseptic loosening, infection, prosthetic failure, osteolysis, stem tip pain, pending stress fracture, instability, peri-prosthetic fracture, non-union, and impingement. (ii) Extracapsular causes: iliopsoas tendonitis, heterotopic ossification, or trochanteric bursitis (iii) Extrinsic causes: spine disease, neuropathy, inguinal or muscular hernias, abductor tendinopathy or tears, metabolic bone disease, malignancy, vascular disease, complex regional pain syndrome
Lombardi (24)	2014	Case series (n: 6)	Femoral loosening (n: 1) and material problems (n: 5)
McCarthy et al (25)	2009	Retrospective study (n: 14)	Infection (n: 2) Material related problems (n: 3) Loose of acetabular component (n: 1) Corrosion at the head-neck junction of a metal-on-metal articulation (n: 1) Soft tissue-scar impingement at the head/cup interface (n: 4) Capsular scarring with adhesions (n: 1) Synovitis (n: 4)
Nazal et al (26)	2019	Retrospective study (n: 10)	Iliopsoas impingement (n: 10) Capsular fibrosis (n:1 0) Loose bodies (n: 6)
Pietrzak et al (27)	2018	Review	(i) Intrinsic causes: infection, aseptic loosening, instability, modulus mismatch synovitis. (ii) Extrinsic causes: impingement, bursitis, tendonitis, heterotopic ossification, stress fracture, spine pathology, neuropathy or nerve entrapment, vascular claudication, hernia, tumor
Potter et al (28)	2005	Review	(i) Infection (ii) Dislocation (iii) Periprosthetic osteolysis (iv) Neuropathy (v) Heterotopic ossification (vi) Pain of indeterminate origin
Schoof et al (29)	2017	Retrospective study (n: 12)	Anterior iliopsoas impingement due to a mispositioned acetabular component
Shahrdar et al (30)	2006	Case series (n: 2)	Stenosis of the lumbar spine and contralateral arthritic knee due to an overload of that leg
Yakovlev and resch (31)	2011	Retrospective study (n: 12)	Intractable neuropathic pain after THA

efficient treatment. The temporal onset, duration, and presence of signs or symptoms of neuropathic versus nociceptive pain (or both), and the location of the pain are crucial in determining the etiology of painful THA. Locating the pain is essential and could suggest the underlying etiology. For example, groin pain might suggest an inguinal hernia, referred pain, quadratus femoris or ischiofemoral impingement, enthesitis of the direct tendon of the rectus femoris, adductor enthesopathy, or, more commonly, iliopsoas syndrome. Pain in the anterior thigh might suggest iliopsoas syndrome, femoral nerve neuropathy, and/or lumbar (L2-L3) projected pain. Lateral thigh pain suggests tendinopathy of the gluteus medius tendon, or lumbar (L4-L5) projected pain. Posterior thigh pain might suggest pyramidal, projected pain (L5-S1), sacroiliitis, facet joint pain (L4-S1), or quadratus femoris or ischiofemoral impingement.

Table 2. *Specific etiologies associated with THA. Calculated over n: 542 patients included in studies that registered any etiology (some cases reported more than one etiology for the same patient).*

Source of pain	Specific etiology	Incidence	Treatment
Intrinsic causes	Loosening or infection	182 (33.6%)	Surgery
	Iliopsoas Impingement or impingement at the head/cup interface due to soft tissue-scar	80 (14.8%)	44 patients underwent surgery, and 20 had nonoperative management
	Wear	41 (7.6%)	Surgery
	Material related problems	32 (5.9%)	Surgery and one patient received intrathecal infusion of opioid/bupivacaine after further surgery was declined
	Adhesions of the periprosthetic tissue, capsular fibrosis, or capsular scarring	12 (2.2%)	Surgery
	Misplacement or fracture	7 (1.3%)	Surgery
Extrinsic causes	Bursae and/or communicating cavities	75 (13.8%)	Local injection of anesthetic into the bursa
	Projected pain: back pain with or without neuropathy (45), knee osteoarthritis (3), metabolic neuropathy (1), stenosis of the lumbar spine (2)	51 (9.4%)	Management of underlying etiology
	Trochanteric bursitis	45 (8.3%)	Medical treatment and physiotherapy
	Intractable neuropathic pain after THA	12 (2.2%)	Peripheral nerve field stimulation (PNFS) with percutaneous placement of 2 temporary 8-electrode leads in subcutaneous tissue in the area of greatest pain
	Iliopsoas tendinitis	5 (0.9%)	Medical treatment and physiotherapy
	Abductor deficiency	5 (0.9%)	
	Heterotopic ossification	2 (0.4%)	
	Ischial tuberosity tendinitis	1 (0.2%)	
	Synovitis	4 (0.7%)	No report
	Complex regional pain syndrome	1 (0.2%)	
No established caused	Chronic post-arthroplasty hip pain, no specific diagnosis	8 (1.5%)	One patient underwent cooled (60°C) radiofrequency lesioning of the articular branches of the femoral nerve (ABFN)

Complementary diagnostic tests should be performed based on the patient's medical history, physical examination findings, and suspected etiology. According to the main clinical suspicion, various tests should be considered:

- Infection: complete blood count, erythrocyte sedimentation rate, C-reactive protein, gallium scan or labelled white blood cell scintigraphy (10,32), culture test, or orthopedic consultation.
- Loosening: x-rays, computed tomography (CT), orthopedic consultation, and nuclear medicine. Technetium-99 methylene diphosphonate bone scintigraphy is a highly sensitive technique but has a very low specificity (11). Increased uptake can be seen in loosening (and in other conditions) and can occur for up to 2 years after uncomplicated cemented and cementless THA (11). This test is therefore considered to have better diagnostic performance one year after surgery for cemented THA and 2 years for cementless THA.
- Iliopsoas impingement: x-ray analysis (including direct lateral radiography) and ultrasonography (10). Ultrasonography might confirm the diagnosis as well as CT. Furthermore, it has been suggested to use a test injection (with corticosteroid and/or local anesthetic) into the deep aspect of the tendon under ultrasound guidance to assist the diagnosis. Nevertheless, this procedure is controversial, as false-positive results rate might be high due to frequent communications between the ilio-psoas bursa and the joint cavity (33).
- Other periprosthetic soft tissue etiologies: ultrasonography (5), optimized magnetic resonance imaging (MRI) (with metal artifact reduction, turbo spin echo sequences), and diagnostic nerve blocks (14,28).

- Referred pain: sacroiliac joint and lumbar spine MRI, knee pain assessment, and electromyography.

For patients with painful THA referred to our pain clinic, the myofascial etiology was by far the most common (mainly iliopsoas bursitis or impingement), followed by referred radicular pain and peripheral neuropathic pain (usually femoral nerve neuropathy). Uncommon causes included inguinal hernia and stress fractures of the iliopubic ramus. Very frequently, x-ray analysis, complete blood count, and scintigraphy are needed in order to rule out the most common causes of intrinsic pain (such as infection, fractures, loosening, or iliopsoas impingement) and then proceed to study extrinsic etiologies that might explain the pain.

Figure 2 shows a suggested algorithmic approach for the diagnosis and management of painful THA. We have highlighted the tests required to rule out the most frequently reported extrinsic and intrinsic etiologies of painful THA.

Treatment of Painful Total Hip Arthroplasty

The diagnosis and source of pain can be determined in most cases. Based on our results, the diagnosis was not established in only 1.5% of cases. Intrinsic etiologies of pain usually require orthopedic management, while extrinsic causes of persistent pain warrant a pain clinic consultation. Once the underlying etiology has been determined, it should be specifically addressed. Typical approaches for addressing the etiology in the pain clinic setting include the following:

Periprosthetic myofascial etiology: Its treatment includes injection of local anesthetics and corticosteroids under ultrasound guidance or under x-rays with contrast dye (Fig. 3), as well as physical therapy, botulinum toxin injection, and multimodal analgesia. Follow-up

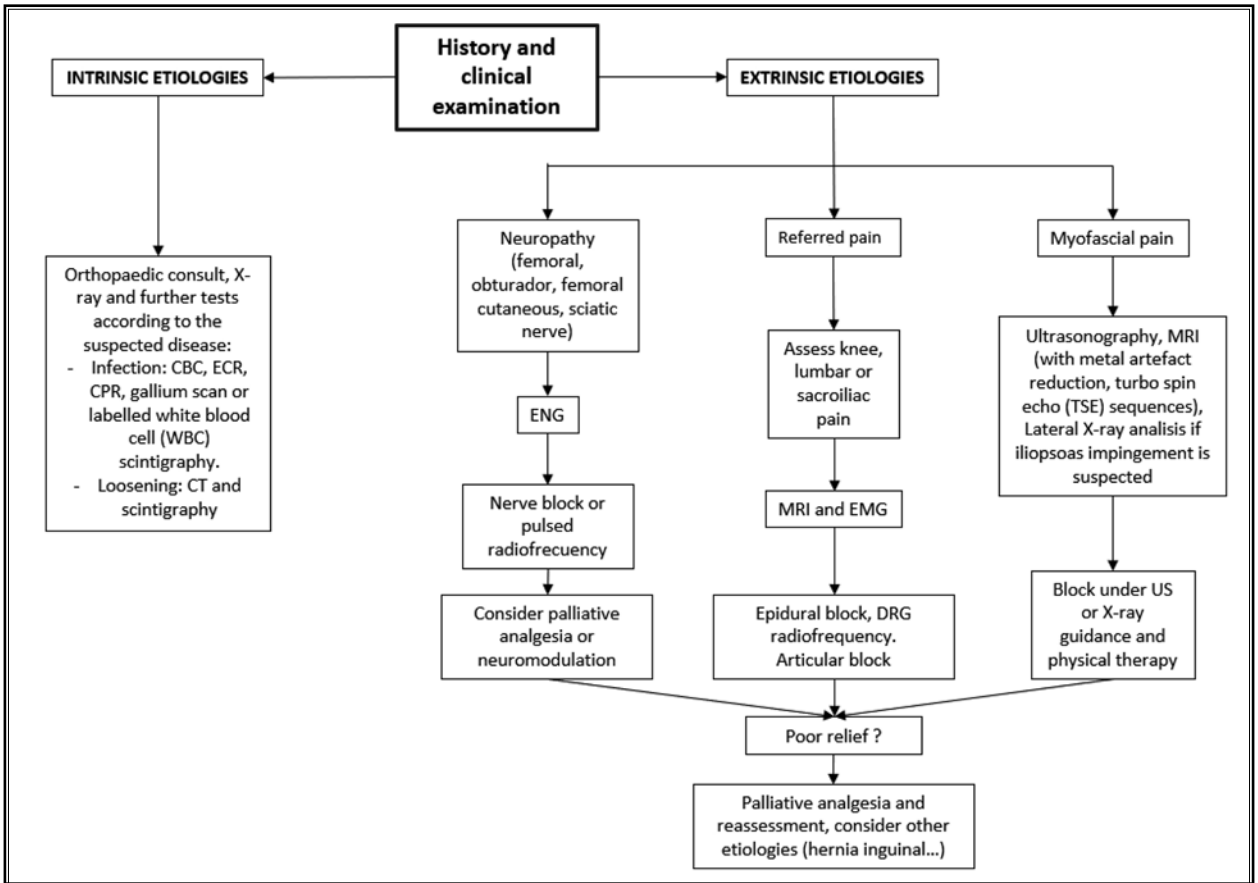

Fig. 2. *Suggested algorithm for painful THA. (CBC: complete blood count, ECR: erythrocyte sedimentation rate, CRP: C-reactive protein, ENG: electroneurography, EMG: Electromyography, MRI: magnetic resonance imaging, CT: computed tomography, DRG: dorsal root ganglion, US: ultrasound).*

Fig. 3. *Injection of local anesthetics and corticosteroids under X-rays with contrast dye in a patient with painful THA due to periprosthetic myofascial etiology. (1: iliopsoas muscle, 2: rectus femoralis and, 3: quadratus femoris muscle).*

and reassessment of the etiology should be considered in those cases with poor pain relief. This etiology was by far the most frequent etiology for presenting extrinsic pain, accounting for 67.4% of the cases with an extrinsic source of pain (Table 2). Periprosthetic myofascial etiology groups specific diagnosis such as iliopsoas tendinitis/tendinopathy due to tendon impingement, ischial tuberosity tendinitis, and bursitis. Similarly, to Erivan et al (16), our results showed that periarticular pain is poorly described in literature and the best described myofascial etiology is iliopsoas impingement, probably due to its potential surgical treatment.

Iliopsoas impingement: Specific initial treatment for this etiology includes a non-operative approach combining physical therapy and local corticosteroid injections. Available evidence also reports injection of botulinum toxin into the iliopsoas muscle as an alternative to provide significant pain relief and functional improvement (34). If these measures fail, endoscopic, arthroscopic, or even open revision surgery may provide good outcomes in terms of pain alleviation. Unfortunately, risks inherent to these procedures are associated with higher morbidity rates as compared to a non-operative management (33, 35,36).

Referred pain: One of the main sources of referred pain is spinal. In those cases, epidural block (a transforaminal approach is suggested) or pulsed radiofrequency of the dorsal root ganglion should be considered for managing the pain, according to the specific etiology.

Peripheral neuropathic pain: Although this type of pain is typically due to femoral nerve neuropathy, other conditions such as sciatic nerve, femoral cutaneous nerve, or obturator nerve neuropathy should be considered. For these conditions, nerve block or pulsed radiofrequency under ultrasound guidance could result in pain relief. However, multimodal analgesia and interventions such as spinal cord stimulation, dorsal root ganglion stimulation, and peripheral nerve stimulation might be considered if adequate relief from the neuropathic pain is not achieved after the first attempt.

Inguinal hernia: Referral to general surgery. We previously proposed a decision tree algorithm for diagnosing and managing patients with painful THA within the context and approach of a pain clinic consultation (Fig. 2).

Conclusions

Painful THA is not a rare clinical condition, although, actual frequency of etiological sources of pain have not been well established. We have systematically reviewed the etiologies and various treatments published in the literature, the results of which showed that 2/3 of the causes of pain are intrinsic and need to be managed by orthopedic surgeons. A third of the etiologies are extrinsic and should be referred to pain clinics once the intrinsic causes have been ruled out. We have proposed an evidence-based algorithmic approach for managing THA pain.

References

1. Ethgen O, Bruyerè O, Richy F, Dardennes C, Reginster JY. Health-related quality of life in total hip and total knee arthroplasty: A qualitative and systematic review of the literature. *Journal of Bone and Joint Surgery* 2004; 86:963-974.
2. Mariconda M, Galasso O, Costa GG, Recano P, Cerbasi S. Quality of life and functionality after total hip arthroplasty: A long-term follow-up study. *BMC Musculoskelet Disord* 2011; 12:222.
3. Wylde V, Hewlett S, Learmonth ID, Dieppe P. Persistent pain after joint replacement: Prevalence, sensory qualities, and postoperative determinants. *Pain* 2011; 152:566-572.
4. Nikolajsen L, Brandsborg B, Lucht U, Jensen TS, Kehlet H. Chronic pain following total hip arthroplasty: A nationwide questionnaire study. *Acta*

Anaesthesiol Scand 2006; 50:495-500.

5. Classen T, Zaps D, Landgraeber S, Li X, Jäger M. Assessment and management of chronic pain in patients with stable total hip arthroplasty. *International Orthopaedics* 2013; 37: 1-7.
6. Kurtz SM, Lau E, Ong K, Zhao K, Kelly M, Bozic KJ. Future young patient demand for primary and revision joint replacement: National projections from 2010 to 2030. *Clin Orthop Relat Res* 2009; 467:2606-2612.
7. Mei XY, Gong YJ, Safir O, Gross A, Kuzyk P. Long-term outcomes of total hip arthroplasty in patients younger than 55 years: A systematic review of the contemporary literature. *Can J Surg* 2019; 62:249-258.
8. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Ann Intern Med* 2009; 151:264-269.
9. Berquist TH, Bender CE, Maus TP, Ward EM, Rand JA. Pseudobursae: A useful finding in patients with painful hip arthroplasty. *Am J Roentgenol* 1987; 148:103-106.
10. Biant LC, Bruce WJM, van der Wall H, Walsh WR. Infection or allergy in the painful metal-on-metal total hip arthroplasty? *J Arthroplasty* 2010; 25:334. e11-334.e16.
11. Bozic KJ, Rubash HE. The painful total hip replacement. *Clinical Orthopaedics and Related Research* 2004:18-25.
12. Browne JA, Polga DJ, Sierra RJ, Trousdale RT, Cabanela ME. Failure of larger-diameter metal-on-metal total hip arthroplasty resulting from anterior iliopsoas impingement. *J Arthroplasty* 2011; 26:978.e5-978.e8.
13. Chalmers BP, Sculco PK, Sierra RJ, Trousdale RT, Berry DJ. Iliopsoas impingement after primary total hip arthroplasty: Operative and nonoperative treatment outcomes. *J Bone Jt Surg* 2017; 99:557-564.
14. He C, Lu Y, Jiang MH, Feng JM, Wang Y, Liu ZH. Clinical value of optimized magnetic resonance imaging for evaluation of patients with painful hip arthroplasty. *Chin Med J* 2014; 127:3876-3880.
15. Dahm PO, Nitescu P V., Appelgren LK, Curelaru ID. Six years of continuous intrathecal infusion of opioid and bupivacaine in the treatment of refractory pain due to intrapelvic extrusion of bone cement after total hip arthroplasty. *Reg Anesth Pain Med* 1998; 23:315-319.
16. Erivan R, Villatte G, Ollivier M, Paprosky WG. Painful Hip Arthroplasty: What should we find? Diagnostic approach and results. *J Arthroplasty* 2019; 34:1802-1807.
17. Ferrata P, Carta S, Fortina M, Scipio D, Riva A, Di Giacinto S. Painful hip arthroplasty: Definition. *Clinical Cases in Mineral and Bone Metabolism* 2011; 8:19-22.
18. Forster-Horvath C, Egloff C, Valderrabano V, Nowakowski AM. The painful primary hip replacement - Review of the literature. *Swiss Medical Weekly* 2014; 144:w13974.
19. Hargunani R, Madani H, Khoo M, et al. Imaging of the painful hip arthroplasty. *Canadian Association of Radiologists Journal* 2016; 67:345-355.
20. Kim DJ, Shen S, Hanna GM. Ultrasound-guided radiofrequency lesioning of the articular branches of the femoral nerve for the treatment of chronic post-arthroplasty hip pain. *Pain Physician* 2017; 20:E323-E327.
21. Kisielinski K, Cremerius U, Reinartz P, Niethard FU. Fluordeoxyglucose positron emission tomography detection of inflammatory reactions due to polyethylene wear in total hip arthroplasty. *J Arthroplasty* 2003; 18:528-532.
22. Lahner M, Von Schulze Pellengahr C, et al. The role of arthroscopy in patients with persistent hip pain after total hip arthroplasty. Technol Heal Care 2013; 21:599-606.
23. Lanting BA, MacDonald SJ. The painful total hip replacement: Diagnosis and deliverance. *The Bone & Joint Journal* 2013; 95-B:70-73.
24. Lombardi A V. Case studies in management of THA failure secondary to taper corrosion, modular junctions and metal-on-metal bearings. *J Arthroplasty* 2014; 29:663-667.
25. McCarthy JC, Jibodh SR, Lee JA. The role of arthroscopy in evaluation of painful hip arthroplasty. *Clinical Orthopaedics and Related Research* 2009; 174-180. {Need issue.}
26. Nazal MR, Parsa A, Martin SD. Arthroscopic diagnosis and treatment of chronic hip pain after total hip arthroplasty and the role of anterior capsule disruption in iliopsoas tendinopathy. *Orthop J Sports Med* 2019; 7:2325967119854362.
27. Pietrzak JR, Donaldson MJ, Kayani B, Haddad FS. Painful total hip arthroplasty. *Orthop Trauma* 2018; 32:38-44.
28. Potter HG, Foo LF, Nestor BJ. What is the role of magnetic resonance imaging in the evaluation of total hip arthroplasty? *HSS J* 2005; 1:89-93.
29. Schoof B, Jakobs O, Schmidl S, et al. Anterior iliopsoas impingement due to a malpositioned acetabular component - effective relief by surgical cup reorientation. *HIP Int* 2017; 27:128-133.
30. Shahrdar C, Campbell P, Mirra J, Dorr LD. Painful metal-on-metal total hip arthroplasty. *J Arthroplasty* 2006; 21:289-293.
31. Yakovlev AE, Resch BE. Treatment of chronic intractable hip pain after iliac crest bone graft harvest using peripheral nerve field stimulation. *Neuromodulation* 2011; 14:156-159.
32. Simonsen L, Buhl A, Oersnes T, Duus B. White blood cell scintigraphy for differentiation of infection and aseptic loosening: A retrospective study of 76 painful hip prostheses. *Acta Orthop* 2007; 78:640-647.
33. May O. Arthroscopic techniques for treating ilio-psoas tendinopathy after hip arthroplasty. *Orthop Traumatol Surg Res* 2019; 105:S177-S185.
34. Fish DE, Chang WS. Treatment of iliopsoas tendinitis after a left total hip arthroplasty with botulinum toxin type A. *Pain Physician* 2007; 10:565-571.
35. Batailler C, Bonin N, Wettstein M, et al. Outcomes of cup revision for ilio-psoas impingement after total hip arthroplasty: Retrospective study of 46 patients. *Orthop Traumatol Surg Res* 2017; 103:1147-1153.
36. Guicherd W, Bonin N, Gicquel T, et al. Endoscopic or arthroscopic iliopsoas tenotomy for iliopsoas impingement following total hip replacement. A prospective multicenter 64-case series. *Orthop Traumatol Surg Res* 2017; 103:S207-S214.