Painful hip arthroplasty: definition

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Summary

Total hip arthroplasty (THA) has been indicated as the surgical intervention with greatest improvement in pain and physical function. However some patients continue to experience hip pain after elective surgery. We investigate prognostic factors that negatively affect treatment effectiveness and the patient outcome. The "hip region" constitutes the groin, buttock, upper lateral thigh, greater trochanteric area, and the iliac crest. Pain originating from various sources and not directly linked to prosthesis may be perceived here and includes the lumbosacral spine, referred pain from abdominal organs and soft tissue sources such as trochanteric bursitis, tendinitis, hip abductor dysfunction, and inguinal hernia. An accurate assessment of the pain cause is extremely difficult to construct and a complete differential diagnosis is fundamental. We assess all the possible causes of hip pain after THA and we divide them depending on the presence or absence of radiographic signs.

KEY WORDS: total hip arthroplasty; pain; epidemiology; complication; revision.

Introduction

Total hip arthroplasty (THA) is one of the most clinically successful and cost-effective interventions in health care, with excellent long-term results in terms of reducing pain and improving function and quality of life in patients with debilitating hip disease (1-3).
Self reported patient satisfaction has been reported to be closer to 90% (4). Many authors reported on successfully relieved pain after THA also in cases where patients' preoperative functional status was poor (5,6). Physical function improvement is long lasting over 25 years (7) and is not affected by mild pain (8).
However, despite remarkable developments in surgical technique and implant design, some patients continue to experience distressing pain after elective surgery. Results from a Danish nationwide study found that 12.1% of patients 12-18 months after hip arthroplasty were significantly impaired in their daily activities by chronic pain (9).
The occurrence of pain following a technically satisfactory arthroplasty is of concern for both the orthopaedic surgeon and the patient. It's one of the most difficult challenges for the surgeon to evaluate and to treat. The difficulties in managing painful THA is due to the heterogeneous nature of the disease. Pain related to the surgery itself can be associated with the implant, bone alterations and soft tissue or nerve injuries. The situation complicates when history, clinical examination, and plain radiography fail to locate the exact origin of hip pain. In few cases patients were revised without having found the cause of pain. In the total 299,368 primary THAs reported in the Swedish Hip Register that were performed from 1979 to 2008, the 0,03% was revised for pain as a single cause representing the 0,4% of all the reasons for revision in the 24,199 first revision THAs (10).
In order that the source of the pain be accurately located, a systematic approach is required. Surgeons and physicians must contend with numerous factors that can affect the patient outcomes.
We have analyzed the predisposing factors that could lead to a painful hip arthroplasty and we have investigated the possible causes of this pain.

Painful HIP predisposing factors

Prognostic factors influence the probability of response, remission, recurrence and duration of pain after the operation. Determining prognostic factors that affect treatment effectiveness is essential to clinicians and important to patients in their decision-making.
Many factors can affect the patient outcome, like patients' preoperative status and characteristics, timing of operation, type of operation, type of prosthesis and length of hospital stay but only few of these seems to have a correlation with pain (11,12).
Age and pain. Some studies that examined age as potential predictors of pain reported more pain in younger patients (13). Better pain outcomes in the more elderly compared to younger patients may be due to higher pain tolerance, lower physical demands for sports-related activities and lower prevalence of subclinical anxiety and depression. When results were adjusted for covariates of interest and potential confounders, including gender, BMI, comorbidity, ASA class, operative diagnosis, depression, and anxiety, age of the patient seems to be more important for the improvement in physical function than for the improvement in the pain score (11). Clarke et al. confirmed in a prospective double blind randomized study that age do not influence the outcome of pain (14). McGuigan et al. (15) and Nilsdotter et al. (16) found that older patients had a degree of pain improvement similar to that experienced by those younger. The postoperative functional limitation in more elderly is likely related to greater severity of other comorbidity (back problems, vision, and balance problems) and higher risk of arthritis in other lower extremity joints. The preoperative subjective status is the only significant predictor of the six months self-perceived functional status. In other words, the worst pre-operative self-perceived status was also the worst post-operative self-perceived status will be (17).
Gender and pain. The relationship between gender and pain is not clear. Some studies reported that women experienced less postoperative pain than men (18). Bogoch et al. (19) found that women had more pain than men, both preoperatively and postoperative-

ly. However, equal proportions of women and men improved to good or excellent outcomes, such that women benefited from surgery slightly more than men did. McGuigan et al. (15) and Halket et al. (16) noted that male gender was associated with a greater improvement after surgery with respect to pain scores than was female gender. Singh et al. reported that at 2 and 5-years post-primary THA gender and age were not significantly associated with hip pain (17), but female gender was associated with higher odds of NSAID and opioid medication use.

Commonly used outcome measures like VAS pain, SF-36 and WOMAC pain, stiffness, and function scores, can be flawed due to floor and ceiling effects. These effects are minimized in large cohort as in the one reported in the Swedish Hip Register (10) with 21,804 operations performed in 2004-2008. Women reported a greater pain relief than men, measured on a VAS scale. However, women experienced somewhat poorer satisfaction with the operation after one year. Women reported a better effect of the intervention regarding health-related quality of life and pain but are not as satisfied as men.

Obesity and pain. Body mass index (BMI) is regarded as one of the most useful measures of obesity and has been shown to have a direct relationship with morbidity and mortality (22). Ibrahim et al. compared 179 hip arthroplasties in 162 patients with an average BMI of 22.5 (18.6-24.9) with 164 hip arthroplasties in 151 age-matched patients with an average BMI of 33.3 (30-39.6). Six out of 138 (4.3%) and five out of 157 (3.2%) patients recorded bad pain following their total hip replacement in groups 1 and 2 respectively. The difference in proportion was not significant (23). Kessler et al. found that no significant differences in postoperative functional status, stiffness, and pain were found among patients with normal-weight (BMI 25 kg/m2, n 11), overweight (BMI 25 to 29.9 kg/m2, n 36), and obese (BMI 30 kg/m2, n 20), either 10 days or 3 months postoperatively (24). Similarly Bolland et al., in 28,068 THAs found that at 1 and 2 years there was a fall in anti-inflammatory use, studied as a marker of effective pain relief, with similar magnitude across all BMI groups (25). Conversely Singh et al. (17) reported that higher body mass index (BMI: 35-40) was associated with significantly higher odds of moderate-severe hip pain and use of NSAID medications at 5-years.

Pre-operative scores and pain. If patients' preoperative functional status was poor, they were more likely to have pain and need assistance with walking postoperatively at one year compared with patients with better baseline status. Patients with low preoperative SF-36 pain and physical functioning scores were found to have lower scores postoperatively in comparison with patients with high preoperative scores ($p < 0.01$) (26). The baseline score, either SF-36 or WOMAC pain, was always the most important predictor not only of the six-month score (11, 27) but also at 7 years follow-up (28).

Level of education. Patients with a higher level of education reported greater improvement in pain (28). MacWilliam et al. (26) found that a low level of education, and each additional comorbidity were associated with a decrease in the change in the pain score ($p < 0.01$) and the change in the physical function score ($p < 0.01$).

Patients' expectation. Mahomed et al. (30) explored the role of patient expectation on postoperative outcome and showed that the expectation of complete pain relief was an independent predictor of greater improvement in the pain score (WOMAC) and physical functioning score (SF-36 and WOMAC) ($p < 0.05$). On the other hand, patients that hope for return or increase in nonessential activity were less satisfied (31).

Waiting Time for Surgery. Several studies concurred that there was no association between the time that the patients waited for surgery and postoperative pain (18, 32, 33).

Mental Status. In a large retrospective study with 5,707 THAs at 2-years and 3,289 THAs at 5-years associations of moderate-severe pain with depression were significant at 2-years, but not at 5-year follow-up (17). Butler et al. (34) reported that poor preoperative status at Mental Component Score on the SF-12 is associated with a higher incidence of thigh pain and a lower satisfaction score.

HIP pain causes

Sequential plain radiographs is the universally used method for THA evaluation and often reveals helpful features in diagnosing post-operative pain. Surgeon directly face with x-rays at standard follow-up control so it is useful to divide the causes of hip pain in relation to the presence of radiographics sign.

Positive X-rays

1. Aseptic Loosening: typical X-rays features are progressively increasing lucent lines, cement fracture and component migration, possible presence of osteolytic areas or even bone fractures. Pain characteristics: presence of a pain-free interval following the operation, pain increased with activity or weight bearing and relieved with rest, pain that begins when starting to walk after sitting, sometimes pain presence at rest and at night also (35). Tigh and leg pain indicate shaft mobilization, while groin and buttock symptoms are related to acetabular problems (36), even if totally mobilized cups can be completely asymptomatic.
2. Septic loosening: typical X-rays features are endosteal scalloping and multilamellar periosteal new bone formation, sometimes focal lysis of bone is present (37). Pain characteristics: it may present after a pain-free interval following the operation or be persistent since surgery in relation with late or early onset of infection respectively, it compares usually at rest and during night (38). Infection is the most difficult and the main exclusion diagnosis to do principally when there are no radiographics sings yet.
3. Osteolysis: Pain characteristics: presence of a pain-free interval following the operation, osteolysis is often silent, but in cases of severe bone loss, pain may be related to an impending fracture in the greater trochanter, in the acetabulum or in the femoral shaft. Lysis without looseness has been described as a cause of hip pain in both cemented and uncemented hip replacements (39).
4. Micromotion: X-ray features: initially negative, corticalis thickenssing, sclerotic lines that evolve in radiolucent lines. Micromotion lead to aseptic loosening during time. Pain characteristics: pain that begins when starting to walk after sitting and during activity (40). In advanced stages pain has the same pattern as in aseptic loosening.
5. Heterotopic ossification: is the abnormal formation of lamellar bone in nonosseous soft tissues. Even if the radiographic prevalence is reported to be as high as 90% only the 8% of patients experience pain (40). Pain characteristics: is often an activity related pain (41).
6. Stress shielding and tip of stem effects: Stress shielding is the adaptive bone remodeling in responses to load shift due to femoral stem presence and can be manifested radiographically as proximal bone resorption and distal bone hypertrophy. It was reported with different implant design (42) and it is not correlated with post-operative pain. When the modulus mismatch between a stiff cementless femoral stem and the less stiff surrounding bone fail to distribute equally the stress the load concentrate at the tip of the stem (43). In this case pain may be present also in absence of visible radiographic signs. Callaghan et al. reported thigh pain in as many as 18% of patient with extensively porous coated stem (44).

Negative X-rays

1. Reactive synovitis: MRI has been proposed to assess reactive synovitis and osteolysis due to particle debris. Osteolysis can be detected before it comes evident on x-ray. Cooper et al. (45) studied with MRI a group of young patients (43-65 years) three years after surgery. They found reactive synovitis in 39%, no signs of osteolysis and no correlation with synovitis and pain.
2. Aseptic lymphocytic vasculitic associated lesion (ALVAL): is a localized hypersensivity reaction and immunologic response to metal wear debris (46). It may present as groin pain, or effusions

or soft tissue masses, even with night sweats (47). Metal-on-metal THAs may present with pain due to hypersensitivity 1 to 3 years following arthroplasty (48).

3. Prosthesis impingement: Nasser et al. (49) reported that 21 of 116 (18%) of the patients undergone hip resurfacing referred persistent groin pain due to insufficient head/neck offset, an uncovered acetabular component, or both. Possible explanations are ripetitive contact on the capsulae or friction over the ileopsoas tendon. Also Bartelt et al. confirmed higher groin pain due to impingement in resurfacing arthroplasty than conventional THA.
4. Ileopsoas tendinitis: Pain characteristics: activity related pain, pain that begins when starting to walk after sitting, the localization is to the groin or to the buttock. Malposition of the acetabular component may be associated with psoas tendon impingement that becomes symptomatic with active flexion of the hip (51, 52). The incidence of ileopsoas tendinitis in conventional THAs ranges between 0.3% and 4.3% (49).
5. Abductor muscle damage: Muller et al. (53) investigated with MRI patient one year post surgery. They found gluteus minus damages in 50% of patient but they didn't found any correlation with pain. Similar results are reported by Pfirrmann et al. (54). Instead gluteus medius tendon rupture after total hip arthroplasty presented clinically with lateral pain, limp, and a positive Trendelenburg test secondary to severe abductor weakness (55).
6. Trochanteric bursitis: Pain characteristics: pain over the great trochanter persistent for several months, described as neuropathic burning with dysesthesia and allodynia (56). Sometimes there is a correlation with radiographics signs of trochanteric periosteal remodeling or ossification.
7. Lumbar spine disease: Patients with severe hip osteoarthritis often complain low back pain (LBP) due to abnormal spinal sagittal alignment and wobbling gait configuring the hip spine syndrome. Hip arthritis and lumbar spine arthritis coexist in 10% to 15% of patients and often present with similar signs and symptoms (57). At 24 months follow-up after THA these patient referred a further improvement in hip function corresponded with continued improvement of spinal function and reduced LBP (58). Some patients may find an initial worsening in their symptoms after successful THA because of increased activity levels. Pain characteristics: pain that begins when starting to walk after sitting. Severe osteoarthritis, spinal stenosis, lumbar degenerative disk or disc herniation present with different pain pattern in relation to the anatomic involvement, but all of them may present as referred hip pain and must be investigated during clinical examination.
8. Nerve injuries: Neurologic complications following THA are usually noted immediately after surgery, but delayed onset is possible even when due to intraoperative events. Nerve injury can manifest days after surgery as a result of direct pressure or formation of a hematoma. Farrel et al. (59) reported a clinically evident nerve injury incidence of 0,6-1,3%. The most compromised is the sciatic followed by the femoral, the obturator and the superior gluteal nerves. Brown et al. (60) reviewed the literature finding an incidence of 0.09%-3.7% and no association with single risk factor.
9. Hernia femoral, inguinal, obturator: may present with groin pain. In this case differential diagnosis is simple, an ecotomography may be helpful (35, 39).
10. Referred pain. Affections to internal organs may refer pain to the hip region. Pain history and pattern must be taken in account to assess its true origin (38).

Conclusion

The aim of THA surgery is a satisfied patient with optimal pain relief and satisfaction and an essentially normalized health-related quality of life. Despite the optimal results some patient may face with new or persistent pain after surgery (9). Despite a better understanding of the pathophysiology of pain in some cases is impossible to understand the causes of persistent pain. We reviewed prognostic factors of pain finding that age (11, 14, 17) and waiting time for surgery (18, 32, 33) is not significantly associated with hip pain. While poor pre-operative scores (11, 26-28), low level of education (26, 28), expectation of increase in nonessential activity with the operation (31) are all predictive of post-operative pain. Depression and poor mental status have a positive association with pain at 2 years follow-up (17, 34). Gender is weakly correlated with post-operative pain as some studies reported more pain in woman (15, 16, 19), while a large cohort study referred more pain in men (10). BMI seems not to influence postoperative pain only at early follow-up (23-25) while at 5 years more heavy patient (BMI > 35) complain more pain. The widely variable nature of painful prostheses makes it extremely difficult to construct criteria for assessment. Careful history taking, physical examination, and plain radiographs are believed to provide crucial information. Surgeon must keep in mind all the causes of hip pain to make a correct differential diagnosis.

Many studies examined patient characteristics as potential predictors of pain and function outcomes (11, 12), but were limited to small samples of patients (<300 cases) (15, 18, 23, 24) and reported contradictory results (13, 15-18). The small sample size makes them underpowered to detect significant associations, thereby leading to false negative results. Additional research into pain characteristics needs to shift from retrospective cohort studies to longer-term large prospective investigations.

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References

1. Soderman P, Malchau H, Herberts P, et al. Outcome after total hip arthroplasty: Part II. Disease-specific follow-up and the Swedish National Total Hip Arthroplasty Register. Acta Orthop Scand. 2001;72:113-119.
2. Berry DJ, Harmsen WS, Cabanela ME, et al. Twenty-five year survivorship of two thousand consecutive primary Charnley total hip replacements: factors affecting survivorship of acetabular and femoral components. J Bone Joint Surg Am. 2002;84:171-177.
3. Ethgen O, Bruyere O, Richy F, et al. Health-related quality of life in total hip and total knee arthroplasty. A qualitative and systematic review of the literature. J Bone Joint Surg Am. 2004;May 86-A(5):963-74.
4. Arden NK, Kiran A, Judge A, et al. What is a good patient reported outcome after total hip replacement? Osteoarthritis Cartilage 2010 (article in press).
5. Hayes JH, Cleary R, Gillespie WJ, et al. Are clinical and patient assessed outcomes affected by reducing length of hospital stay for total hip arthroplasty? J Arthroplasty. 2000;15,448-452.
6. Holtzman J, Saleh K, Kane R. Effect of baseline functional status and pain on outcomes of total hip arthroplasty. J Bone Joint Surg Am. 2002;84,1942-1948.
7. Keener JD, Callaghan JJ, Goetz DD, et al. Long-term function after Charnley total hip arthroplasty. Clin Orthop Relat Res.2003;471,148-156.
8. Keisu KS, Orozco F, Sharkey PF, et al. Primary cementless total hip arthroplasty in octogenarians. Two to eleven-years follow-up. J Bone Joint Surg Am. 2001;83,359-363.
9. Nikolajsen L, Brandsborg B, Lucht U, et al. Chronic pain following total hip arthroplasty: a nationwide questionnaire study. Acta Anaesthesiol Scand. 2006;50:495-500.
10. Garellick G, Kärrholm J, Rogmarket C, et al. Swedish Hip Arthroplasty Register. Annual Report 2008. Department of Ortopaedics, Sahlgrenska University Hospital. October 2009. www.shpr.se, www.jru.orthop.gu.se.
11. Montin L, Leino-Kilpi H, Suominen T, et al. A systematic review of em-

pirical studies between 1966 and 2005 of patient outcomes of total hip arthroplasty and related factors. J Clin Nurs. 2008;17, 40-45.
12. Santaguida PL, Hawker GA, Hudak PL, et al. Patient characteristics affecting the prognosis of total hip and knee joint arthroplasty: a systematic review. J can chir. 2008;51(6) décembre, 428-436.
13. Roder C, Parvizi J, Eggli S, et al. Demographic factors affecting long-term outcome of total hip arthroplasty. Clin Orthop Relat Res 2003;417:62-73.
14. Clarke H, Kay J, Mitsakakis N, et al. Acute pain after total hip arthroplasty does not predict the development of chronic postsurgical pain 6 months later. J Anesth. 2010;24:537-543.
15. McGuigan FX, Hozack WJ, Moriarty L, et al. Predicting quality-of-life outcomes following total joint arthroplasty. Limitations of the SF-36 Health Status Questionnaire. J Arthroplasty. 1995;10:742-7.
16. Halket A, Stratford PW, Kennedy DM, et al. Using Hierarchical Linear Modeling to Explore Predictors of Pain After Total Hip and Knee Arthroplasty as a Consequence of Osteoarthritis. J Arthroplasty. 2010;25(2 February), 254-62.
17. Singh JA, Lewallen D. Predictors of pain and use of pain medications following primary Total Hip Arthroplasty (THA): 5,707 THAs at 2-years and 3,289 THAs at 5-years. BMC Musculoskelet Disord 2010;May 13;11:90.
18. Nilsdotter AK, Lohmander LS. Age and waiting time as predictors of outcome after total hip replacement for osteoarthritis. Rheumatology (Oxford). 2002;41:1261-7.
19. Caracciolo B, Giaquinto S. Determinants of the subjective functional outcome of total joint arthroplasty. Arch Gerontol Geriat. 2005;41:169-176.
20. Visuri T, Koskenvuo M, Honkanen R. The influence of total hip replacement on hip pain and the use of analgesics. Pain 1985;23:19-26.
21. Bogoch ER, Olschewski E, Zangger P, et al. Increased tender point counts before and after total hip arthroplasty are associated with poorer outcomes but are not individually predictive. J Arthroplasty. 2010;25(6 September), 945-950.
22. Burton BT, Foster WR, Hirsch J, et al. Health implications of obesity: an NIH consensus development conference. Int J Obes.1985;9:155-170.
23. Ibrahim T, Hobson S, Beiri A, et al. No influence of body mass index on early outcome following total hip arthroplasty. Int Orthop 2005;29: 359-361.
24. Kessler S, Kafer W. Overweight and Obesity: Two Predictors for Worse Early Outcome in Total Hip Replacement? Obesity. 2007;15(11 November), 2840-2845.
25. Bolland BJRF, Culliford DJ, Maskell J, et al. The effect of hip and knee arthroplasty on oral antiinflammatory use and the relationship to body mass index: results from the UK general practice research database, Osteoarthritis Cartilage. 2010;doi:10.1016/j.joca.2010.10.012.
26. MacWilliam CH, Yood MU, Verner JJ, et al. Patient-related risk factors that predict poor outcome after total hip replacement. Health Serv Res. 1996;31:623-38.
27. Fortin PR, Clarke AE, Joseph L, et al. Outcomes of total hip and knee replacement: preoperative functional status predicts outcomes at six months after surgery. Arthritis Rheum. 1999;42:1722-8.
28. A Nilsdotter, F Isaksson. Patient relevant outcome 7 years after total hip replacement for OA - a prospective study. BMC Musculoskelet Disord.2010, 11:47
29. Rissanen P, Aro S, Sintonen H, et al. Quality of life and functional ability in hip and knee replacements: a prospective study. Qual Life Res. 1996;5:56-64.71.
30. Mahomed NN, Liang MH, Cook EF, et al. The importance of patient expectations in predicting functional outcomes after total joint arthroplasty. J Rheumatol. 2002;29:1273-9.
31. Mancuso CA, Salvati EA, Johanson NA et al. Patients' expectations and satisfaction with total hip arthroplasty. J Arthroplasty 1997;12:387-396.
32. Williams JI, Llewellyn Thomas H, et al. The burden of waiting for hip and knee replacements in Ontario. Ontario Hip and Knee Replacement Project Team. J Eval Clin Pract. 1997;3:59-68.64.
33. Mahon JL, Bourne RB, Rorabeck CH, et al. Health-related quality of life and mobility of patients awaiting elective total hip arthroplasty: a prospective study. CMAJ. 2002;167:1115-21.
34. Butler RA, Rosenzweig S, Myers L, et al. The Impact of Socioeconomic Factors on Outcome After THA. A Prospective, Randomized Study. Paper presented at the Hip Society Meeting 2010. Clin Orthop Relat Res DOI 10.1007/s11999-010-1519-x.
35. Duffy P, Masri BA, Garbuz D, et al. Evaluation of patients with pain following total hip replacement. Instr Course Lect 2006;55:223-232.
36. Stavrev VP, Stavrev PV. Complications in total hip replacement. Folia Med (Plovdiv). 2004;46(2):25-30.
37. Garvin KL, Backstein D, Pellegrini Jr VD et al. Dealing with Complications. J Bone Joint Surg Am. 2009 Aug;91(5):18-21.
38. Robbins GM, Masri BA, Garbutz DS et al. Evaluation of pain in patients with apparently solidly fixed total hip arthroplasty components. J Am Acad Orthop Surg 2002;10:86-94.
39. Evans CA, Cuckler JM. Evaluation of the painful total hip arthroplasty. Orthop Clin North Am. 1992;23:303-11.
40. Pellegrini VD Jr. Management of heterotopic ossification. In: Lieberman JR, Berry DJ, editors. Advanced reconstruction: hip. The Hip Society. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2005. p 247-56.
41. Bozic KJ, Rubash HE. The painful total hip replacement. Clin Orthop 2004;420:18-25.
42. Engh CA Jr, Young AM, Engh Sr CA et al. Clinical Consequnces of stress shielding after porous-coated total hip arthroplasty. Clin Orthop Rel Res 2003;417:157-163.
43. Bulow JU, Scheller G, Arnold P et al. Uncemented total hip replacement and thigh pain. Int Orthop. 1996;20:65-69.
44. Callaghan JJ, Dysart SH, Savoy CG. The uncemented porous coated anatomic total hip prosthesis: two year results of a prospective consecutive series. J Bone Joint Surg 1988;70(A):337-346.
45. Cooper HJ, Ranawat AS, Potter HG et al. Early Reactive Synovitis and Osteolysis after Total Hip Arthroplasty. Clin Orthop Relat Res. 2010;468:3278-3285.
46. Watters TS, Cardona DM, Menon KS et al. Aseptic Lymphocyte-Dominated Vasculitis-Associated Lesion: A Clinicopathologic Review of an Underrecognized Cause of Prosthetic Failure. Am J Clin Pathol. 2010 Dec;134(6):886-893.
47. Molvik H, Hanna SA, de Roeck NJ. Failed Metal-on-Metal Total Hip Arthroplasty Presenting as Painful Groin Mass With Associated Weight Loss and Night Sweats. Am J Orthop. 2010;39(5):E46-E49.
48. Cuckler JM. Unexplained Pain After THR: What Should I Do? Orthopedics. September 2010;33(9):648.
49. Nasser AB, Beaule´ PE, O'Neill M et al. Incidence of Groin Pain After Metal-on-Metal Hip Resurfacing. Clin Orthop Relat Res. 2010;468:392-399.
50. Bartelt RB, Yuan BJ, Trousdale RT et al. The Prevalence of Groin Pain After Metal-on-Metal Total Hip Arthroplasty and Total Hip Resurfacing. Clin Orthop Relat Res. 2010;468:2346-2356.
51. Lachiewicz PF, Kauk JR. Anterior iliopsoas impingement and tendinitis after total hip arthroplasty. J Am Acad Orthop Surg. 2009;17(6):337-344.
52. Jasani V, Richards P, Wynn-Jones C. Pain related to the psoas muscle after total hip replacement. J Bone Joint Surg Br.2002;84:991-993.
53. Müller M, Tohtz S, Winkler T et al. MRI Findings of gluteus minimus muscle damage in primary total hip arthroplasty and the influence on clinical outcome. Arch Orthop Trauma Surg. 2010:130:927-935.
54. Pfirrmann CW, Notzli HP, Dora C et al. Abductor tendons and muscles assessed at MR imaging after total hip arthroplasty in asymptomatic and symptomatic patients. Radiology. 2005;235:969-976.
55. Fehm MN, Huddleston JI, Burke DW et al. Repair of a Deficient Abductor Mechanism with Achilles Tendon Allograft After Total Hip Replacement. J Bone Joint Surg Am. 2010;92:2305-11.
56. Yakovlev AE, Resch BE, Karasev SA. Treatment of intractable hip pain after THA and GTB using peripheral nerve field stimulation: a case series. Wisconsin Medical Journal. 2010;109(3):149-152.
57. Brown MD, Gomez-Martin O, Brookfield KF, et al. Differential diagnosis of hip disease versus spine disease. Clin Orthop 2004;1:280.
58. Ben-Galim P, Ben-Galim T, Rand N et al. Hip-spine syndrome: the effect of total hip replacement surgery on low back pain in severe osteoarthritis of the hip. Spine. 2007 Sep 1;32(19):2099-2102.
59. Farrell CM, Springer BD, Haidukewych GJ et al. Motor nerve palsy following primary total hip arthroplasty. J Bone Joint Surg Am. 2005;87:2619-25.
60. Brown GD, Swanson EA, Nercessian OA. Neurologic injuries after total hip arthroplasty. Am J Orthop (Belle Mead NJ). 2008 Apr;37(4):191-7.