A review of the clinical approach to persistent pain following total hip replacement

YF Lam *, PK Chan *, Henry Fu, CH Yan, KY Chiu

ABSTRACT

Total hip arthroplasty is effective in reducing pain and improving functional outcome for a variety of hip pathologies. Approximately 27% patients, however, complain of pain at 6 months' follow-up following surgery. The pain may worsen over time and can become severe and chronic in around 4% of patients who ultimately require revision surgery. Therefore, it is important for clinicians to comprehensively assess patients undergoing total hip arthroplasty in order to identify the underlying pathology of a painful hip and then offer prompt treatment. Causes of hip pain after total hip arthroplasty are analysed in this article, as well as the systematic approach to evaluation and appropriate diagnostic investigations.

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[1] **YF Lam *,** MB, ChB, MRCS (HKIBSC)
[2] **PK Chan *,** FHKCOS, FHKAM (Orthopaedic Surgery)
[2] **H Fu,** FHKCOS, FHKAM (Orthopaedic Surgery)
[2] **CH Yan,** FHKCOS, FHKAM (Orthopaedic Surgery)
[2] **KY Chiu,** FHKCOS, FHKAM (Orthopaedic Surgery)

[1] *Department of Orthopaedics and Traumatology, Princess Margaret Hospital, Laichikok, Hong Kong*
[2] *Department of Orthopaedics and Traumatology, Queen Mary Hospital, Pokfulam, Hong Kong*

* Corresponding authors: pmjraphael@gmail.com / cpk464@yahoo.com

Introduction

Total hip arthroplasty (THA) is an effective means of relieving pain and improving functional outcome[1-3] in a variety of hip pathologies. In Hong Kong, the most common reasons for THA are osteonecrosis, osteoarthritis, and post-traumatic arthritis of the hip.[4] Although surgical techniques and implant quality of THA have evolved over the last two decades, approximately 27% patients complain of pain at the first 6-month follow-up after THA.[5,6] The pain may worsen with time: up to 4% of patients develop severe chronic pain and require revision surgery.[5] Therefore, it is important for clinicians to comprehensively assess patients undergoing THA to determine the pathology of a painful hip and offer prompt treatment.

In this article, we analyse the causes of hip pain following THA, the systematic approach to evaluation and the appropriate diagnostic investigations. Several patients with similar complaints of painful hip but different pathologies will be presented.

Causes

Traditionally, the causes of hip pain following THA are classified as intrinsic or extrinsic. Intrinsic causes include pathologies arising from the hip region, and can be further classified as intra-capsular or extra-capsular. Intra-capsular causes relate to components of the implant and include infection, loosening, instability, and implant failure. Extra-capsular causes include pathologies from the surrounding soft tissue such as iliopsoas tendon and trochanteric bursa, as well as heterotrophic ossification. Extrinsic causes include pathologies arising outside the hip region. A very common example is lumbar spine pathology such as lumbar stenosis, disc herniation, or spondylosis. Common intrinsic and extrinsic causes are summarised in the Table.

History

A comprehensive history can undoubtedly provide most of the important clues to diagnosis. Pain should be explored from different aspects including temporal onset, its nature, location, exacerbating factors, and severity. Whether the patient has a pain-free period following THA is important. If there has been an initial pain-free period followed by later onset of hip pain, events that occurred before the onset of pain should be carefully explored. For example, if the patient has recently fallen or sustained a trauma to the hip then pain may be due to a periprosthetic fracture. A recent dental procedure or infection elsewhere could lead to haematogenous spread of bacteria and subsequent prosthetic joint infection. Other causes of pain that appears after a pain-free period include aseptic loosening, instability, osteolysis, and soft tissue irritation. The nature of pain when it is persistent should then be clarified. If it is similar to that which was present before surgery, then the initial indications for THA should be reviewed. If they were misdiagnosed, then there may be untreated hip pathology. Persistent infection of the joint could also be a cause.

全髖關節置換術後持續性疼痛的臨床方法綜述

藍遠輝、陳秉強、傅俊謙、忻振凱、曲廣運

全髖關節置換術能有效減輕各種髖部病變所帶來的疼痛和改善活動能力。然而，約有27%患者於術後6個月的隨訪中表示出現疼痛現象，且病情會隨時間惡化。約有4%患者更演變成嚴重慢性疾病，最終須進行修復手術。因此，臨床醫生必須全面評估接受全髖關節置換術的患者，以識別疼痛的源頭並盡快提供治療。本文分析全髖關節置換術後髖關節疼痛的原因，並且有系統地作出評估和提供適當的診斷方法。

Different types of pain can indicate different pathologies. Mechanical pain may reflect aseptic loosening, stress fracture, or instability of implants. Constant, nocturnal, and rest pain may be a sign of infection or, rarely, malignancy. Burning pain at the right hip, associated with numbness or radiation from the back could be referred pain of lumbar spine pathology. Sharp pain occurs following periprosthetic fracture or soft tissue irritation. Deep and dull pain may indicate intrinsic causes such as infection or osteolysis.

Exacerbating factors should be sought when assessing hip pain. Pain that increases with initiation of movement or during weight bearing, and is relieved by rest could indicate loosening of components. Pain that begins after a certain level of exacerbation or activity suggests vascular or neurogenic claudication. Pain aggravated by climbing stairs or rising from a seated position may be due to iliopsoas tendinitis.

The location of pain may provide a clue as to the location of the pathology or defective components. Groin pain may indicate a failing acetabulum component. Other intrinsic causes of groin pain include iliopsoas impingement or tendinitis. Extrinsic causes include local neurological or vascular pathology, inguinal hernia, spinal pathology or radiculopathy or, rarely, malignancy. Thigh pain may suggest involvement of the femoral component and relate to stem loosening, subsidence and instability, modulus mismatch, or impingement on bone cortex. Nerve injury, for example to the lateral femoral cutaneous nerve, may present as thigh pain. Buttock and leg pain could be secondary to spinal stenosis or radiculopathy.

Perioperative details such as the model and size of implant used, urinary catheterisation, wound, and other systemic infections during the recovery period could be important.

In addition to details about the pain and surgical history, a routine general medical history should not be ignored. In patients with a history of immunosuppression, inflammatory arthritis, obesity or diabetes, there may be a higher rate of prosthetic joint infection. Patients who are depressed or overemotional may be more prone to chronic pain or complex regional pain syndrome. Those prescribed long-term immunosuppressants, biologics, or steroids are at high risk of infection and hence adjustment of these drugs before operation is necessary.

Physical examination

A complete physical examination of the hip should include the painful as well as the contralateral side, the spine and knees as well as a neurological examination of the lower limbs—all critical to making the right diagnosis. The conventional approach to hip examination is to 'look, feel, and move'. For inspection, we examine the surgical incision that will indicate the approach of the previous THA and quality of postoperative wound healing. Hyperplasia of the surgical scar may indicate previous wound infection. Signs of infection such as erythema, pain, swelling, and increased warmth should be noted if present. The presence of sinus tracts indeed is pathognomonic for prosthetic joint infection. Muscle wasting may be due to deconditioning or

TABLE. Common intrinsic and extrinsic causes of hip pain after total hip arthroplasty

Intrinsic cause	Extrinsic cause
Infection	Spinal disease (eg spinal stenosis, prolapsed disc, spondylosis)
Mechanical loosening	Vascular disease
Instability	Peripheral neuropathy (eg diabetes)
Osteolysis	Nerve injury (femoral, sciatic, lateral femoral cutaneous nerve)
Modulus mismatch	Complex regional pain syndrome
Periprosthetic fracture	Malignancy (primary or secondary)
Stress fracture	Metabolic disease (eg Paget's disease, osteomalacia)
Trochanteric bursitis	Hernia (inguinal, femoral, obturator)
Iliopsoas tendinitis	

nerve injury. Gait analysis is also important as it may reflect abductor insufficiency if the patient walks with a Trendelenburg gait. Short limb gait may indicate leg length discrepancy. When assessing leg length, patients should be asked if they have noted any progressive change in leg length discrepancy, as it may suggest subsidence of the femoral stem. For palpation, sites of local tenderness should be sought as these may pinpoint the exact location of hip pathology. Any swelling at the groin must be carefully examined. Characteristics such as nature, margin, tenderness, fluctuance, compressibility, emptiability, pulsatility, and positive Tinel's signs should be noted. A reducible mass in the groin with or without cough impulse could be an inguinal, femoral, or obturator hernia. A pulsatile mass could be a true or pseudo-aneurysm. A vague, deeply seated tender swelling could be an 'aseptic lymphocyte-dominated vasculitis-associated lesion' if a metal-on-metal bearing or a modular metal-on-metal head-neck articulation has been used. During assessment of patient movement, the range and any tenderness triggered by a specific movement or manoeuvre should be noted. Reproducible pain upon extreme range of movement may indicate instability or impingement by implants. Pain elicited during active movement may indicate instability or loosening while that which appears during passive movement could be due to infection. Any pain triggered by active or resisted hip flexion may be due to acetabulum component loosening, iliopsoas tendinitis, or impingement.

Laboratory tests

Serological, microbiological, and cytological investigations are important in the assessment of patients with painful THA. Common serum inflammatory markers that could indicate prosthetic joint infection are white blood cell count (WBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP). Spangehl et al[7] reported the sensitivity and specificity of WBC of >11.0 x 10^9 /L as 0.2 and 0.96, that of ESR as 0.82 and 0.85, and that of CRP as 0.96 and 0.92, respectively. It has been suggested that interpretation of ESR and CRP together improves sensitivity and specificity. In the presence of abnormal serum parameters and/or clinical suspicion of infected THA, aspiration should be performed to obtain synovial fluid for microbiological and cytological examination.[8] Gram smear and bacterial culture are routinely requested, while fungal and tuberculosis culture are ordered selectively if indicated. Nonetheless, the sensitivity of Gram staining is low, ranging from 10% to 67%.[9,10] Hip aspirate culture is reported to have a variable sensitivity of 50% to 86%.[11-13] To increase the yield of bacterial culture, all aspirated specimens should be processed immediately.[14] Font-Vizcarra et al[15] advocated transport of aspirated synovial fluid in a blood culture bottle to achieve higher sensitivity and specificity. Cell count with neutrophil differential also provides an important clue for prosthetic joint infection. Different cut-off values of cell count and neutrophil percentage have been suggested. An international consensus on periprosthetic joint infection in 2013 proposed 3000 cells/μL and neutrophil differential of >80% as being indicative of active infection.[16] Parvizi et al[17] suggested use of leukocyte esterase reagent strips as a rapid, inexpensive, highly sensitive and specific test to detect periprosthetic joint infection.

Radiological investigations

Plain radiographs are always the first-line investigation for a painful hip following THA. The anteroposterior view of the pelvis, and the anteroposterior and lateral views of the affected hip, including the tip of the stem area, are standard. These often provide clues about pre-existing hip disease, fixation method of the prosthesis, and design features of the prosthesis and articulations—all of which are important in determining the cause of hip pain. For example, cementless femoral stems, especially extensively porous-coated long stems, could cause mid-thigh pain due to modulus mismatch and stress shielding. Osteolysis is not uncommonly present in metal-on-polyethylene articulation. Details of the procedure should also be evaluated. The abduction angle, horizontal and vertical positions, and version for the socket, as well as the coronal alignment, grades of cement mantle for cemented stem and canal filling for cementless stem are important and should be reviewed. Malalignment of the socket and/or stem can result in instability and increase the risk of early loosening, polyethylene wear, and dislocation. Quality of the cement mantle can be assessed by the Barrack classification that grades according to the percentage of radiolucency present in the medullary canal.[18] A poor grade of cementation may lead to loosening and early failure of the implant. To assess loosening of a cemented femoral stem, Harris criteria described three categories: definite, probable and possible, depending on the size of radiolucent zone at the cement-bone interface, subsidence, and presence of fractured cement mantle or stem.[19] DeLee and Charnley[20] divided the cement-bone area around the cemented socket into three types—radiolucent lines at the lateral one third as type I, involvement at the middle one third as type II, and complete involvement of the cement-bone interface as type III. If one zone is involved, the rate of loosening of the cup is 7%. The risk significantly increases to 71% and 94% in type II and III, respectively.[21] For cementless stems, as described by Engh's classification,[22] presence of spot welding and parallel demarcation lines indicates stable bone ingrowth

and fibrous fixation, respectively. Subsidence, calcar hypertrophy, and pedestal at the tip of the stem are signs of unstable stem fixation. For cementless cups, signs of loosening include change in abduction angle of >8°, migration of ≥3 mm, implant failure, halo around screws, and shredding of porous coating.[23] Endosteal scalloping and periosteal reaction are classic signs of infection. Presence of osteolysis on plain radiographs may indicate particle disease.

Computed tomography (CT) can be useful in evaluating the complications of THA, provided proper parameter modifications are adopted to reduce artefact from the prosthesis.[24,25] Accurate measurement of the acetabulum cup version can be achieved with CT because of the ability to measure in multiple orthogonal planes.[26-29] Other potential uses of CT include preoperative assessment of bone loss for acetabulum and femur, evaluation of bone density for stress shielding, and detection of osteolysis, liner wear, and metallosis. Magnetic resonance imaging (MRI) is excellent for evaluation of the periprosthetic soft tissue and hence detection of THA complications. Nonetheless, its use, as with CT, is limited by the occurrence of artefact from the prosthesis. To improve the diagnostic value of MRI in the evaluation of THA complications, metal artefact reduction sequence (MARS)–MRI has been developed and achieves better visualisation of the periprosthetic soft tissue structure that is obscured by signal void in conventional MRI sequences.[30,31] The imaging, MARS-MRI, has a high sensitivity to detect particle diseases that can result in proliferative synovitis, pseudotumours, loosening, and osteolysis.[32-34] Involvement of superficial and deep soft tissue surrounding the prosthesis can also be assessed by MRI.

A nuclear medicine scan such as technetium-99 is often advocated when there is no obvious diagnosis despite extensive investigations. It has a high sensitivity to detect a wide variety of complications including infection, loosening, instability, and stress fractures. Nonetheless, the specificity is rather low and increased uptake can occur for 2 years in uncomplicated THA.[35] If a technetium-99 scan is positive, indium-111 white cell scan may be used to differentiate between an infective or non-infective pathology.[36]

Local anaesthetic test

To differentiate between the intrinsic or extrinsic source of pain, a local anaesthetic agent such as marcaine 0.5% can be injected with an 18-Gauge spinal needle under fluoroscopic guidance to the tender spots. Immediate pain relief following injection will confirm the exact site of pathology. Crawford et al[37] reported sensitivity of up to 96% for this technique that offered a rapid, reliable diagnostic test with low morbidity.

Illustrative cases

Case 1

A 66-year-old woman prescribed a long-term steroid for systemic lupus erythematous underwent Austin-Moore arthroplasty in 1978 for avascular necrosis of bilateral femoral heads. She underwent multiple revision surgeries on both hips due to infective loosening. The latest operation in 2011 was revision of the loosened right acetabulum cup due to infection. The femoral stem was retained at that time as it was well fixed. She enjoyed a pain-free period and could walk with a stick. Serial radiographs showed no loosening of components. She complained of right hip pain during follow-up in 2014, however, and radiographs of the right hip showed endosteal scalloping over the THA (Fig 1a, 1b). Blood tests revealed an elevated ESR and CRP. Hip aspiration was performed and 2 mL of turbid synovial fluid was aspirated. Bacterial culture was negative but cell count was 33 400 cells/μL. The provisional diagnosis was an infected right THA and a two-stage revision was proposed. While waiting for revision, she was admitted for worsening right hip pain for 2 weeks. Radiographs showed a radiolucent line across all Gruen zones and lucent lines were present at zones I and II around the acetabulum cup. Periosteal reaction and endosteal scalloping were also noted. Serum inflammatory markers were all elevated. Extended trochanteric osteotomy, removal of implant, and placement of antibiotic-loaded cement spacer was performed (Fig 1c). Multiple specimens were taken for culture. *Erysipelothrix rhusiopathiae* was cultured from the anterior capsule granulation tissue. Postoperatively she was given intravenous ampicillin for 4 weeks and switched to oral ampicillin for a further 8 weeks. Levels of ESR and CRP returned to normal. Repeated right hip aspiration, after antibiotics had been stopped for 2 weeks, were negative on bacterial culture. Cell count was 325 cells/μL with neutrophils of 27%. Second-stage revision with cementless acetabulum cup and extensive porous-coated long stem prosthesis was performed and was uneventful (Fig 1d). After 3 months, she had no hip pain and could walk with a stick for more than 30 minutes. Radiographs showed no interval change in alignment nor loosening.

Case 2

A 65-year-old woman had a medical history of tuberculosis of the right hip with auto-fusion, followed by conversion to THA in 1995. She underwent acetabulum cup revision in 2004 due to aseptic loosening. The procedure was uneventful and she was asymptomatic afterwards. Twelve years later she complained of right hip pain for 2 weeks with no history of trauma. She had been febrile for several days with chills and rigor. She denied any respiratory,

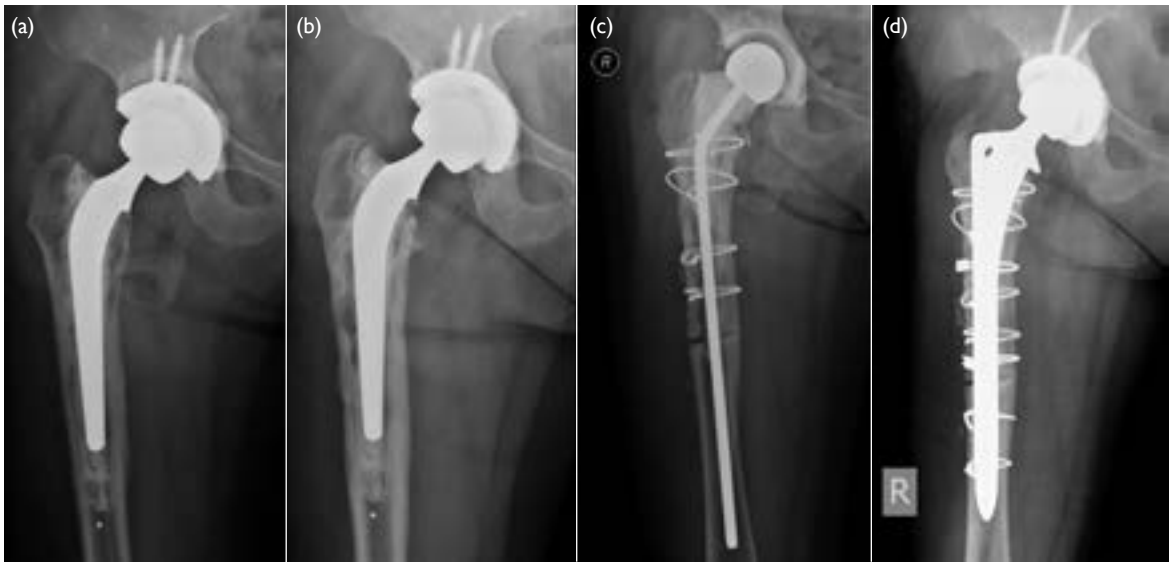

FIG 1. Case 1: right hip in anteroposterior view
(a) Early postoperative film in 2011 after acetabulum cup revision. (b) Film taken on admission in 2014 when the patient presented with right hip pain. (c) Removal of infected implants with placement of antibiotic-loaded cement spacer. (d) Second-stage revision with cementless cup and screws on acetabulum and an extensively porous-coated long stem on femur

abdominal, or urinary symptoms. She walked with a limping gait after onset of pain. Examination upon admission revealed a high fever with stable vital signs. Palpation of her right groin revealed a vague, tender swelling that was neither compressible, reducible, nor pulsatile. Active and passive range of movement of the right hip was significantly limited by pain. Pain was aggravated by internal rotation of the affected hip. Neurovascular status appeared intact. Radiographs of the right hip showed no loosening or migration of THA components. No periosteal reaction or endosteal scalloping was noted. Serum WBC, ESR, and CRP were all elevated (WBC, 14 x 10^9/L; ESR, 104 mm/h; CRP, 9.26 mg/L). In view of her febrile state and tender groin swelling, CT right hip with contrast was arranged. No abnormal increase in periprosthetic hypodensities was noted and loosening was unlikely but a rim-enhancing lesion of 3.3 x 6.8 x 11 cm in size at the right iliopsoas was noted and psoas abscess was diagnosed. Then CT-guided drainage was performed by radiologists and 30 mL of blood-stained purulent fluid was aspirated. The aspirate was sent immediately for bacterial culture and revealed *Parabacteroides merdae* sensitive to rifampicin. She was treated with antibiotics according to the sensitivity tests. Colonoscopy was arranged as the cultured bacteria is usually of gastrointestinal origin. After aspiration of the psoas abscess and administration of antibiotics, she improved clinically. Hip pain resolved, fever subsided, and she was able to walk unaided without pain. Blood tests showed reducing ESR and CRP. Serial CT abdomen and pelvis showed regression of psoas abscess (Fig 2). Despite her clinical improvement and reassuring radiological and serological tests, it remained uncertain whether the right THA was infected. Hip aspiration posed a risk of introducing the bacteria into the hip joint because of the close proximity of the psoas abscess, causing 'iatrogenic' prosthetic joint infection. She is being closely monitored and surgical drainage can be offered if she deteriorates in future.

Case 3

A 75-year-old woman underwent dynamic hip screw for fixation in 1991 due to intertrochanteric fracture of the right proximal femur. In 1992 she underwent cementless THA for the cut-through dynamic hip screw. Unfortunately during follow-up she was noted to have subsidence of the femoral stem with impingement at the lateral cortex. Infection was excluded and revision THA was offered but refused by the patient who could walk with a stick for 30 minutes and had no hip pain. In 2010, she was diagnosed with carcinoma of the transverse colon and right hemicolectomy was performed. Intra-operative specimens showed clear margins and there was no evidence of local or distant metastasis. She defaulted from surgical follow-up, however. In 2014, 22 years after the THA, she complained of insidious onset of right groin and thigh pain for several months. She experienced nocturnal pain at the right hip and an intermittent low-grade fever. Unexplained weight loss over 1 month was noted. She could only walk with a stick for 5 minutes since the onset of thigh pain. Examination showed shortening of the right

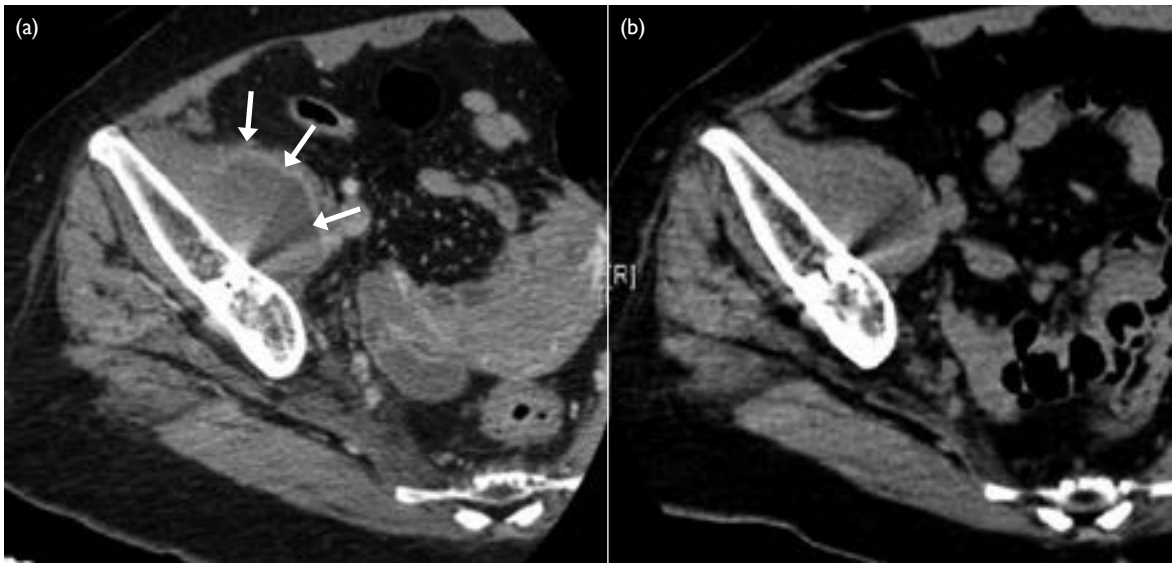

FIG 2. Case 2: axial views of computed tomographic abdomen and pelvis on admission
(a) A rim-enhancing lesion at right psoas muscle (arrows), compatible with abscess formation and (b) psoas abscess showing regression of signs after administration of antibiotics for 2 weeks

lower limb by 2 cm and tenderness at the right femur shaft. Serum WBC was slightly elevated (12.5 x 10^9 /L), and both ESR and CRP were markedly increased (ESR, 111 mm/h; CRP, 13.3 mg/L). Serum tumour marker levels were normal and carcinoembryonic antigen level was static. Radiographs showed extensive osteolytic lesions at the anterior and posterior aspects of the acetabulum cup. Migration of the cup position was noted (Fig 3). In view of the history of malignancy of the transverse colon and abnormal radiographs of the right hip, CT pelvis and right hip with contrast was performed and revealed a large soft tissue mass in the right pelvis with extensive bony erosion of the acetabulum, ilium, ischium, and superior pubic ramus with loosening of the implant (Fig 4). The diagnosis was bone metastasis to the pelvis with erosion. Exploration was performed and a large friable soft tissue mass with extensive destruction of the acetabulum was noted. Intra-operative specimens were revealed on frozen section to be metastatic adenocarcinoma. In view of the massive bone loss over the acetabular side, her advanced age and underlying medical condition, excision arthroplasty was performed in the same operation. Further histopathological tests of intra-operative specimens confirmed metastatic adenocarcinoma that was likely of colorectal origin. All other specimens for microbiological culture, including tuberculosis culture, were negative. She was referred to oncologists and underwent radiotherapy for local control of disease. Her right groin and thigh pain was much relieved after operation. She tolerated sitting well and could ambulate in a wheelchair. The patient was referred to a hospice and finally succumbed 4 months later due to a chest infection.

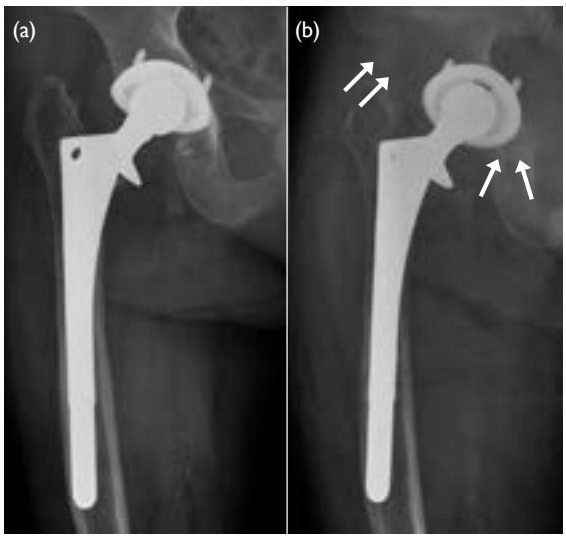

FIG 3. Case 3: (a) radiograph of right hip before onset of right groin and thigh pain. (b) Film repeated after admission for right hip pain showing extensive osteolytic lesion over the anterior and posterior column of acetabulum with migration of cup (arrows)

Case 4

A 50-year-old woman with osteoarthritis of the left hip secondary to untreated developmental hip dysplasia underwent total hip replacement in the private sector in January 2012. She gained

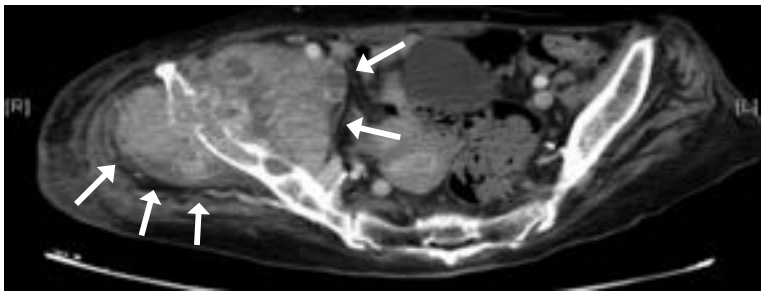

FIG 4. Case 3: axial view of computed tomographic abdomen and pelvis showing a large soft tissue mass at the right ileum with extensive bone destruction (arrows)

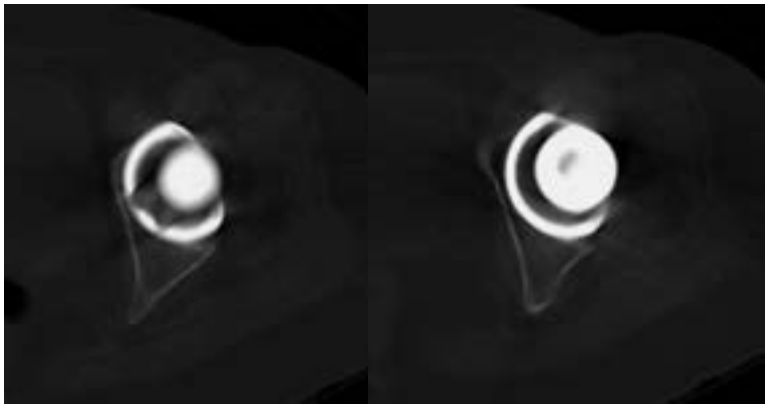

FIG 5. Case 4: axial view of computed tomography showing protrusion of anterior rim of acetabular cup

satisfactory pain relief at her left hip until March 2012 when she presented with increased left hip pain that was aggravated by active flexion, stair walking, getting out of bed, and getting on public transport. Examination showed her left lower limb to be lengthened by 1 cm. No local tender spot at the left hip was noted. Active range of flexion was 0° to 110°. Severe pain was noted during active flexion of hip. Blood tests were all unremarkable. Ultrasound-guided aspiration of the left hip showed no growth. Computed tomography of the left hip showed protrusion of the anterior rim of the acetabular cup (Fig 5). After excluding infection, a working diagnosis of iliopsoas tendon impingement due to severe pain triggered by active hip flexion was proposed. Ultrasound-guided injection of local anaesthetic to the left iliopsoas tendon insertion to the lesser trochanter was performed to relieve the pain although it returned 1 week later. Arthroscopic release of the left iliopsoas tendon was performed and was uneventful. Upon follow-up at 6 weeks after operation, her left hip pain was much improved and no pain was noted on walking upstairs or active flexion of left hip.

Conclusion

Any pain that appears after THA should not be overlooked. Making an accurate diagnosis of the pain requires a detailed history, thorough clinical examination, and appropriate investigations. Large-scale reviews in the literature report instability, mechanical loosening, and infection as the three main causes of implant failure necessitating revision surgery[38,39] and all should be considered during evaluation. Patients who have undergone THA but have postoperative hip pain should be reviewed by the operating surgeon for further management after an initial assessment. The ultimate goal is to unearth the underlying cause and offer timely treatment, hence preventing unnecessary revision surgery and facilitating the patient's return to normal activity.

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Declaration

All authors have disclosed no conflicts of interest.

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