Case Report 2
Hip Arthroplasty

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Case Summary :
A 68- year old gentleman presented to outpatients clinic complaining of pain in his right hip, 10 years after undergoing a total hip replacement. Following a thorough history, physical, lab and radiographic investigations, aseptic loosening of the hip prosthesis was diagnosed. One-stage revision surgery was carried out and the patient is currently undergoing rehabilitation and being followed up.

Aim:
This report will review the history, examination, investigations and management of a case of aseptic loosening of a total hip arthroplasty (both acetabular and femoral components). It will also serve as an excellent illustration of the various examination techniques and other investigations which are made use of for the diagnosis of hip (and other orthopaedic) conditions. Apart from describing the main surgical therapy required in this case i.e. revision arthroplasty, the case report will also deal with the complex yet equally essential perioperative drug management which complements the surgical treatment. Moreover, this case highlights the holistic approach to patient care, requiring a multidisciplinary team (including proper nursing, physiotherapy etc.).

Case Presentation

Presenting Complaint:
The patient was complaining of right hip pain which was worse on exertion and increasing in intensity over the past few months. Pain was limiting his activities of daily living and was persisting during the night, altering his normal sleep pattern. He described recent onset of limping.

History of Presenting Complaint:
The patient had been experiencing this pain for the past one and a half years. He describes it as being discomforting and intermittent. He had felt severe pain following some exercise. He started using a crutch on the left side in order to try and reduce some of the pain.

Past Medical History & Surgical History:
Medical:
Well-controlled non insulin dependent diabetes
Septicemia post-prostate biopsy two years ago

Surgical:
Right hip replacement in March 2000 due to a dislocation of the right femoral head following a traffic accident.
Left inguinal hernia repair
Open hip biopsy done in March 2011; no infection was found.

Drug History:
Vitamin B complex – 1 tablet
Combodart – 1 tablet
Metformin – 500mg bd
No known drug allergies

Family History:
Father had pacemaker

Social History:
A married pensioner.
Patient smokes 7 cigarettes per day.

Systemic enquiry:
Shortness of breath only on severe exertion
Cough especially in the morning
Sputum in morning only
Numbness in both hands
Nocturia: woken up 4 to 5 times every night
No urgency or dysuria

Physical examination:
Patient being a mild smoker has SOB on mild exertion with cough and sputum.
The right lower limb was found to be slightly shorter than the left. There was minimal tenderness on deep palpation of right groin. The hip could be fully extended and flexed. There was tenderness on internal rotation, but none on external rotation. The left hip was found to be normal.
The left and right knee were completely normal.
Antalgic gait was observed on the right side.
Trendelenburg test was found to be positive on right side, while Thomas' test was negative both for left and right.

Differential diagnosis:
- Septic hip
- Aseptic loosening
- Muscular pain
- Back pain

Investigations
a) Lab exams
Bone biopsies were taken from acetabulum and femur before and during the operation. Both turned out to be negative (no bacteria were cultured).
Bone scans (three-phase bone scintigraphy of the femur following IV administration of Tc 99m MDP) were performed to check for any infection present. Moderate increase in tracer uptake was noted around the right hip prosthesis (particularly in the intertrochanteric points), in all three phases in keeping with ongoing bone re-modelling. Active sepsis was excluded.
Blood tests were also carried out:
CBC: WBC: 16.6x109 /L
Haemoglobin: 12.7
Urea: 5.60 mmol/L
Na+: 141.0 mmol/L
K+: 4.05 mmol/L
Creatinine: 60 µmol/L
APTT: 26.1 s
PT: 12.00 s
INR: 1.14 ratio
Random blood glucose was also taken as the patient was diabetic. 8.2mmol/L

(b) Plain radiographs:

Findings on X-rays pre-op:

- Radiolucent lines between cement and femoral stem (areas of osteolysis).
- Radiolucent lines between cement and acetabular cup (areas of osteolysis).
- Migration of femoral stem into varus position (distal end pointing medially).
- Head off centre in cup - wear in acetabular cup plastic
- An old Charnley monoblock hip prosthesis

Treatment

Surgical Therapy

Pre-op :

A standard clinical examination was carried out, and a complete history was taken. Pre-op investigations included blood tests; (CBC, U&E, RBG, CREAT, INR and APTT). An ECG and CXR were also performed together with a pelvis X-Ray.

Operation:

An antero-lateral skin incision was made, over the previous incision, together with a radical capsulectomy. Excess soft tissue was excised. The loose cemented Charnley cup was removed en masse with cement in situ. There was moderate residual bone stock present in acetabulum but a large cavity was in place. The mesh over the superior lip of acetabulum was reinforced and held with two screws. The acetabulum was filled with impaction grafting (using autograft) to accept a52mm cup. There was good containment from all areas. Antibiotic-impregnated cement (with rifampicin) was used. The femoral site was prepared and extraction of the Charnley prosthesis with the surrounding cement was carried out, using ultradrive. The membrane was removed as well. A size 16 standard offset Corail femoral stem was used. Trial (zero) head was placed and the joint relocated. There was stable reduction with no telescoping. Routine closure was carried out with vicryl and skin clips.

4 units of blood were transfused in theatre.

Drugs:

Vitamin B complex
Combodart (dutasteride/ tamsulosin) – for benign prostatic hyperplasia
Metformin
Rivaroxaban - for 5 weeks
Gentamycin
Flucloxacillin – 3 doses after operation
Paracetamol, Morphine & Diclofenac
Prochlorperazine
Actrapid – Short-acting insulin

Outcome and Follow-up

Immediately postoperatively, analgesia was administered to relieve pain. Blood pressure and temperature were recorded. Pressure areas were checked 2 hourly while the wound was checked hourly. Intravenous infusions (including 5% Dextrose in 0.45% N/saline and 5mLs KCl set up at 100mL/ hr), were started and fluid balance were recorded and maintained. Urine passed was monitored due to catheterization (>30mL/hr passed). Thromboprophylaxis was administered. Pain score at rest and on movement was less than 5. During the first day post operatively, legs were kept in abduction, with a Charnley pillow kept between the knees, as this may help prevent dislocation of the operated hip. Patient was mobilised with great care, under supervision. He was discharged from hospital on day 6 post op with strict instructions as to avoid full weight bearing for at least 6 weeks. At two weeks the skin clips were removed.

Follow up appointments were organised at 6 weeks when a check X-ray and a general overview will be performed. The final appointment will be at 6 months post operatively.

Image post-op shows:

- Mesh to hold autograft in situ (taken from iliac crest)
- Revision stem (Exeter stem, modular)

Case Discussion:
Total joint arthroplasty, including total hip arthroplasty (THA), can be considered to be one of the greatest advances in medicine in the 20th century. For patients with hip arthritis, THA has proved to be a successful and effective procedure, improving the quality of life drastically by reducing pain, increasing mobility, improving sleep, as well as social and sexual function. Long-term follow up studies suggest that around 85% of hip replacements would still be functioning by 20 years after surgery. The need for a revision THA can be either due to failure of the implant, or due to loosening. A failure of an implant is indicated by repeated dislocations. Causes of failure include incorrectly positioned implants, material interposed in the joint and fracture of the bone around the implant, secondary to surgery or trauma. Loosening is subdivided into septic and aseptic. Septic loosening usually involves infection by a low-grade pathogen such as Staphylococcus epidermidis [1]. Aseptic loosening occurs 10 to 20 years after THA surgery as a result of a chronic inflammatory reaction in response to implant particulate debris, leading to progressive osteolysis around the implant. It is the single major limitation of THA long-term success, requiring revision surgery. With the increasing life expectancy and frequency of THAs in younger, heavier, more active patients, aseptic loosening and the consequent revision surgery are becoming more prominent issues in the field of orthopaedics [2].

Pathophysiology
Following numerous histopathological analyses, it has been established that the peri-prosthetic bone loss in THA aseptic loosening is secondary to wear debris which accumulates and mediates a chronic, granulomatous inflammatory reaction. Total joint arthroplasties involve creating an interface between artificial materials and the skeleton. At such an interface a combination of mechanical and biologic factors contribute to the generation of an osteolytic response. Relative motion between the implant and the surrounding bone, due to metal/bone modulus mismatch and possibly poor implant fixation, is responsible for the generation of particulate debris. Such wear debris is biologically active and in the early stages, a pseudomembrane forms, surrounding the implant. Within this membrane, various cell types are stimulated by the wear debris to release pro-inflammatory cytokines. Different particle sizes, shapes and compositions have been found to produce different interactions. In fact, the polytetrafluoroethylene (PTFE) acetabular components which were previously used required revision after 1-3 years, and a dramatic decrease in revision surgery frequency followed the introduction of the polyethylene cups.

Macrophages and phagocytes are stimulated by the debris particles to release a variety of pro-inflammatory cytokines including TNF, IL-1, IL-8, IL-11, PGE2 and RANKL. Normal bone remodeling involves a dynamic balance between bone resorption by osteoclasts and bone deposition by osteoblasts. The cytokines and growth factors released in large quantities and over a long period of time (owing to particle resistance to enzymatic degradation), lead to a disturbance in this balance, favouring bone resorption by relative osteoclastic over-activity. The RANK/RANKL pathway is thought to be the principal pathway leading to increased osteoclastogenesis. RANKL binds to its cognate receptor RANK on osteoclast precursors, with resulting activation of NF-kB transcription factors and osteoclast differentiation [3]. Knowledge of the pathophysiologic mechanisms involved can be exploited to provide targets for pharmacologic agents to inhibit the particle-induced osteolysis, thus providing alternatives to surgical therapy.

Clinical presentation and examination
This case involves a patient presenting with hip pain and a history of THA for that same hip 10 years ago. A detailed history and clinical examination can be very helpful in narrowing down the potential sources of this hip pain, especially by determining if the source of pain is intrinsic (involving the THA) or extrinsic. Aseptic loosening and sepsis are by far the most common intrinsic causes of hip pain in a patient with a THA. Extrinsic causes are many and include lumbar spine disease such as spinal stenosis and disc disease, trochanteric bursitis, sciatic or obturator nerve impingement, claudication, abductor or iliopsoas tendonitis and stress fractures of the pubic ramus. [4]

This patient had tenderness mostly in the groin, which is typical of loosening (especially the acetabular component) but it may also indicate iliopsoas tendonitis. Lumbar spine disease would more likely present as posterior buttock and thigh pain, extending distal to the knee. Trochanteric bursitis would be indicated if pain was felt directly over the greater trochanter.
The fact that the pain came about with weight-bearing but was relieved with rest, further points to a diagnosis of aseptic loosening. Lumbar spine disease may be accompanied by neurological features such as radiation below the knee, numbness and parasthesia.
Of note is the patient's history of diabetes and smoking, and perhaps even a family history of heart disease. Thus, with these risk factors for atherosclerosis it would be reasonable to think of peripheral vascular disease in the differential diagnosis. Pain secondary to vascular insufficiency would have a history of intermittent claudication i.e. pain starts after walking a roughly constant distance, and is relieved by stopping.

The history may also indicate whether this is a case of aseptic loosening or sepsis. Pain by septic loosening often starts within months of the primary THA and the severity of the pain would be greater than expected, possibly even constant and not relieved with rest. Furthermore, a history of fever and chills would be suggestive of sepsis.

During the physical examination any hip function abnormalities and reproduction of pain are sought for. Evaluation of the gait can give important clues, and in this patient, the antalgic gait with a positive Trendelenburg test further point to an intrinsic source of hip pain. The observation that the right lower limb is longer than the left can be expected, as a result the primary THA in the right hip. Loosening often causes pain at extremes of motion and which can be reproduced by internal or external rotation. Iliopsoas or abductor tendonitis would be diagnosed following careful muscle testing. Checking the peripheral pulses, skin temperature and lower limb arterial flow with an ultrasound Doppler probe will exclude peripheral vascular disease as the cause of hip pain.
In summary, the history and examination revealed hip pain, especially in the groin on palpation, which was felt upon weight bearing, relieved by rest and reproduced by internal rotation. Moreover, an antalgic gait, positive Trendelenburg test but normal lumbar spine, neurologic, muscle and vascular examinations were recorded. These findings exclude an extrinsic source of pain, and are consistent with aseptic loosening.
In cases of THA loosening it is imperative to determine if there is sepsis or not, as a revision THA with an undiagnosed occult sepsis would have disastrous consequences. Laboratory tests include white blood cell count (WBC), C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), although the value of these tests (sensitivity and specificity) is doubted. A raised WBC may indicate sepsis but in isolation is of no significance. A normal ESR and CRP exclude the diagnosis of infection, but if both are elevated there is a high probability of infection. Needle aspirations of the synovial fluids may also be used to check for infection, but the definite diagnosis can often only be made by frozen section histology during revision surgery.
Technetium-99m (Tc-99m) methylene diphosphonate (MDP) bone scintigraphy is often used to assess the fixation of cemented components. MDP bone images are very sensitive indicators of bone turnover and activity, but they are not very specific. Increased radionuclide uptake can be caused by infection, loosening, heterotopic ossification, stress fracture, Paget disease and tumours. In this case, the bone scans showed a pattern of uptake which suggested loosening rather
than infection.

Plain radiographs can provide many clues which help in making the diagnosis of a loose prosthesis. However, it must always be kept in mind that radiographs tend to underestimate the degree of osteolysis around the components. Whenever possible, radiographs should be compared to previous radiographs in order to note any changes, for example in the position of the components and any new radiolucent areas. A change in the position of the components, as was the case in this patient, is pathognomonic of loosening. One should also look for any radiolucencies at the cement-bone interface. Radiological lines of demarcation at this interface which are more than 2mm in thickness, progressive and surrounding the whole interface strongly indicate loosening. Other radiological signs which indicate loosening include new radiolucencies at the cement-metal interface as well as cement fractures [2]. Since the radiographs showed new radiolucencies between the cement and both prosthetic components and changes in the position of the components, the diagnosis of aseptic loosening could be confirmed.

Therapy
Once aseptic loosening is diagnosed, revision of total hip arthroplasty should be considered. However, the decision to carry out this procedure should be taken after careful consideration of many factors. Revision surgery is often indicated if the patient experiences significant symptoms, notably pain, which have an effect on their activities of daily living. The orthopaedic surgeon may rarely even recommend surgery in the absence of symptoms if serial radiographs indicate substantial osteolytic lesions, before bone loss becomes too severe for revision. In cases of loosening, periodic follow ups may be necessary to monitor the rate of progression of loosening and thus intervene promptly when impending failure is suspected.

Primary THA and revision arthroplasty share the same goals i.e. to restore a pain free, functional hip and hence follow the same general principles. However, revision THA is markedly more complex and technically demanding. Compared to primary THA, in revision arthroplasty the poorer bone quality makes component fixation more difficult. In addition, revision surgery involves removing loose components, osteolytic lesions and particle generators, making the procedure more extensive. Moreover, patients undergoing revision surgery are older and often with more comorbidities, which may render them less tolerant to long surgical procedures.

The surgical goals of one-stage revision surgery include: removal of loose components and associated cement; reconstruction of bony defects with bone graft and metal augmentations; and placement of stable revision implants. Preoperative planning is crucial as the majority of challenging features of a revision can be predicted. The state of fixation of the components must be determined (loose or well-fixed) in order to plan for component extraction (e.g. trochanteric osteotomy may be required for well-fixed components). The amount of bone loss must also be assessed, thereby possibly indicating the need for bone grafts. In this case, such a graft was required for the acetabular roof. This was necessary since stability of the revision acetabular cup can only be achieved with an intact acetabular rim. Segmental defects and decreased bone stock will require a structural allograft, supported by a reconstructive cage [5].

Whenever possible, the incision (and thus the approach) of revision surgery should be done over the previous scar, although it is more extensive with revision in order to gain greater access. The soft tissues are released to allow dislocation of the hip. In the anterolateral approach, the main soft tissues encountered are the fascia lata and the gluteus medius and vastus lateralis muscles. Great care must be taken during surgical dislocation of the hip to expose the femur, since at revision the femur would be weakened due to cavitation and cortical defects and fractures are more likely. Once the hip is well exposed, the pseudocapsule is removed and implant removal carried out, before the revision components are inserted and secured [6]. As can be noted by comparing the preoperative and postoperative radiographs, the femoral component inserted in the revision surgery was an Exeter block, in contrast to the Charnley monoblock used in the primary THA. The Exeter block is a modular component, with a screwable head, thus allowing for different head dimensions and neck orientation, making it more stable in comparison to the monoblock.

Revision surgery produces less satisfactory results and has more frequent complications in comparison to primary THA.

Mahomed et al. reported that while the rates of adverse outcomes are quite low, they are significantly higher after revision than after primary total hip replacement [7].

Table 1 below shows the rates of some complications occurring within 90 days of primary and revision total hip replacements:

	Mortality	Pulmonary Embolism	Wound Infection	Hospital Readmission	Hip Dislocation
Primary THA	1%	0.9%	0.2%	4.6%	3.1%
Revision THA	2.6%	0.8%	0.95%	10%	8.4%

Table 1: Rates of complications occurring within ninety days, following primary and revision THA

During the operation, blood loss can be significant during revision THA and thus blood transfusions may be necessary. Complete blood counts taken pre operatively are used to see if the patient is anaemic, and if this is the case, it should be corrected before the operation since studies have shown that even mild degrees of anaemia are associated with increased postoperative 30-day risk of mortality and cardiac event following major non-cardiac surgery, especially in elderly, male patients [8].
Many postoperative complications can be reduced or avoided by a carefully designed drug regimen. Infection is a possible complication of every surgical procedure, but in joint replacement surgery even more stringent precautions must be taken since infection can lead to a failure of the joint replacement. Among the various precautions taken (sterilized instruments, theatres with air filters and laminar flow etc.), antibiotic prophylaxis is an essential part of perioperative care. Since this case involves a prosthesis, a combination of Gentamicin (an aminoglycoside) and Flucloxacillin (a β-lactamase-resistant penicillin) was used, in accordance with Infection Control Unit recommendations. Also of note, although the diagnosis was that of aseptic loosening, antibiotic-impregnated cement (Rifampicin combined with cement) was used, in case an occult infection was missed and to prevent an infection developing postoperatively.

Postoperative pain must be controlled by a variety of analgesics. This patient was given drugs from three different classes of analgesics. Paracetamol and Diclofenac, a Non-steroidal anti-inflammatory drug (NSAID), are COX-inhibitors and therefore decrease prostaglandin production. While being effective in reducing pain, thereby decreasing opioid drugs in managing the pain, Diclofenac is given only for 1 week, due to its numerous side effects, especially gastric ulceration, typical of all NSAIDs. Morphine, an opioid, was administered by a system of Patient Controlled Analgesia (PCA), which involves intravenous infusion of doses of morphine via an electronic pump that is controlled by the patient. Since effective pain relief requires flexible and individualized dosage regimens, PCA helps to improve pain control, decrease postoperative morbidity and hence leads to greater patient satisfaction [9]. However, opioids are well known to cause nausea and vomiting, by their action in the chemoreceptor trigger zone (CTZ) in the area postrema within the medulla. Therefore, prochlorperazine (an antipsychotic drug) was administered as an antiemetic, by acting as an antagonist to dopamine D2 receptors in the CTZ.

While deep vein thrombosis (DVT) is a common complication following surgery, it is even greater in joint replacement surgery, and even more so in revision THA due to longer operating times and hospital stays with little mobility (due to high risks of dislocation). Antithrombotic therapy is important to reduce risks of DVT and the possible secondary pulmonary embolism. This patient was given rivaroxaban, a relatively new drug that acts as a direct factor Xa inhibitor, thus blocking both extrinsic and intrinsic pathways of the coagulation cascade. It is indicated for thromboprophylaxis following hip and knee replacements, and studies are showing greater effectiveness with rivaroxaban, compared to other anti-thrombotic drugs such as enoxaparin [10].

Being a diabetic, the patient's drug therapy had to include hypoglycemic agents. Glucose control is important in patients for elective surgery. High blood glucose levels can lead to increased risks of wound breakdown and infections. The patient was administered Actrapid, since the patient would be starved before the operation and thus, this short-acting insulin is less likely to result in a hypoglycemic event.

Rehabilitation & follow-up

Following revision THA there is a high risk of hip dislocation and this implies that patient should be mobilized gradually with great care. Rehabilitation is important postoperatively to maximize functional performance and improve the patient's ability to carry out activities of daily living. However, several physical impairments must be overcome, namely pain, limitations with hip movement and muscular weakness. These physical impairments can cause great disability which limit the benefits obtained by surgery. Rehabilitation must be carried out by an interdisciplinary team, which includes surgeons, physiotherapists, occupational therapists and nurses, in order to provide a holistic recovery. The benefits of rehabilitation are mostly seen within 3-6 months after surgery, although improvements are noted for up to 2 years. There are a number of biomedical factors which influence the final outcome of rehabilitation including fixation method, the surgical approach used, any complications and comorbidities, and patient factors such as strength, coordination, weight and cognition.

Rehabilitation involves a variety of aspects. Patient education helps to reduce the risk of dislocations during functional mobility and self-care. For example, with the anterior approach, patients are advised to avoid extreme external rotation, adduction and extension of the operated hip. A number of exercises can be carried out by the patient to regain muscle strength and endurance. In particular, strengthening the hip abductors helps maintain a level pelvis during the stance phase, preventing the contralateral hip from swinging laterally during the swing phase. Despite such exercises, various studies indicate that the muscles in both lower limbs, but even more so in the operated limb, never regain their full strength [10].

It is important to supervise and help patients to perform functional tasks. In the postoperative period, patients are instructed regarding transfers, such as how to get out of bed or into an armchair, how to walk on level and uneven ground, how to climb and descend stairs and even lower extremity dressing. Instructing and supervision is crucial to reduce the risks of dislocations of the operated hip and to allow the patient regain independence in self-caring. An important consideration is the type of weight-bearing permitted postoperatively and the need for aiding devices. Weight-bearing restrictions are prescribed by surgeons to prevent any adverse effects on the operated joint. They range from partial weight bearing, to non-weight bearing, as was the case in this patient. Weight-bearing restrictions imply the need for assisting devices which help in joint unloading during mobility. Wheel chairs, walkers, canes and crutches greatly help in making the patient more independent and carry out basic activities. The best device should be chosen for each individual, for example patients with hand joint involvement due to rheumatoid arthritis may not be able to use a walker, or their residence may not be accessible to wheel chairs or walkers. With the increasing urgency to shorten the length of hospital stays, patients are often discharged before having obtained full functional level, and thus it is imperative that the patient's social background is taken into account, and family training and education can be beneficial in allowing the patient to continue regaining functional ability outside of hospital.

Learning Points:

- Aseptic loosening is the most common cause of failure of total hip replacements.
- Aseptic loosening is a result of osteolysis around the prosthetic components secondary to a chronic granulomatous in flammatory response generated by particulate debris.
- Patients present with hip pain (around 10 or more years after primary THA), which may limit their daily activities, and with tenderness particularly in the groin and the thigh.
- The diagnosis of aseptic loosening can be made by taking a thorough history and carrying out a complete physical ex amination. Plain radiographs can confirm the diagnosis and monitor progressive osteolytic lesions.
- It is essential to rule out septic loosening as this would change the management. White blood cell count, ESR and CRP levels can provide an indication of sepis, together with bones scans, and joint aspiration. However, due to the sensitivity and specificity levels of these tests, results must be interpreted with caution.
- Revision surgery is indicated in aseptic loosening. It is significantly more complex, technicaly demanding and associated with higher risks of complications, compared to primary THA.
- Following revision THA, patients must be followed periodically, and emphasis must be placed on rehabilitation by a multidisciplinary team in order to facilitate a faster and holistic recovery.

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