Multimodality treatment of a complex series of parallel pathologies in a 16-year-old male that ultimately leads to bilateral hip arthroplasty surgery: A case report

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1. Introduction

Femoral head osteonecrosis is associated with significant sequelae for the patient in the long-term. A combination of factors are thought to contribute to the pathophysiology behind this debilitating disease process. We report a 16-year-old adolescent male requiring staged bilateral hybrid hip arthroplasty within 3 years of diagnosis of acute lymphoblastic leukaemia that ran a complicated course of multimodality treatment. The case examines the literature on femoral head osteonecrosis in this population cohort and the challenge for the orthopaedic surgeon in the management of this increasingly prevalent condition.

2. Presentation of case

We report on a male patient that presented at the age of 13 to the paediatric services after developing a series of vague symptoms, complaining of generalised weakness, intermittent abdominal pain and polyarthropathy with fatigue, having lost 8 kg in the preceding month. Clinically he was pale with a nontender hepatosplenomegaly of approximately 3 cm. There was no lymphadenopathy and an otherwise normal systemic evaluation. Haematological profile showed a pancytopenia (Hb of 9.1 g/dl, WBC of 2.6 × 10^9 L^{-1}, ANC of 0.4 × 10^9 L^{-1} and platelets of 99 × 10^9 L^{-1}) and hyperuricaemia (uric acid of 633 μmol/L (range 150–330)) for which uric oxidase was given and rehydration therapy commenced. A diagnosis of acute lymphoblastic leukaemia (ALL) was made following a bone marrow analysis. Immunophenotype and histochemical studies indicated an early pre-B cell ALL subtype with cytogenic studies showing high hyperdiploidy. A course of multimodality treatment was commenced within 10 days of presentation. The treatment protocol was based on UKALL 2003 regimen B induction chemotherapy of four drugs—dexamethasone, vincristine, asparaginase and doxorubicin. Subsequent consolidation/intensification and maintenance phase treatment followed over the next 38 months. A total of 2.64 g of dexamethasone was given over this time frame. Within 3 weeks following induction treatment (at which time 330 mg or 12.5% of the total quantity of steroid had been administered) the patient began to complain of groin pain and had a right-sided limp. Plain imaging revealed a grade I right-sided slipped capital femoral epiphysis (SCFE) (Fig. 1) for which he went on to have an in situ pinning and contralateral pinning 1 month later for similar symptoms. Within 2 months following the second surgery he represented with bilateral lateral hip to groin pain and a pyrexia. Plain radiographs revealed progression of the SCFE on the right (from grades I to II) with epiphyseal collapse (Fig. 2) and subsequent investigations revealed a septic arthritis of the hips bilaterally. Cultures grew coagulase negative staphylococcus aureus. He went on to have both pins removed with subsequent multiple washouts and debridements over a 4-month period with selective intravenous antibiotic therapy (intravenous Vancomycin 10 mg/kg followed by Linezolid 10 mg/kg and Ciprofloxacin 15 mg/kg orally). The...
patient continued with his cycles of chemotherapy throughout this time. At the age of 16 and following 38 months of cyclic chemotherapy and in remission, he continued to complain of diffuse joint pains with progressive inability to ambulate secondary to pain and decreased range of motion of both hips, being wheelchair bound at presentation to the orthopaedic services. Plain imaging revealed osteonecrotic collapse of the femoral heads bilaterally (Fig. 3). Having considered the options, he underwent a two-stage primary hybrid hip replacement using an uncemented femoral component (Accolade; Stryker Orthopaedics, Mahwah, NJ) and a cemented acetabular component (Exeter Contemporary Ultra-High-Molecular-Weight (UHMW) flanged cup; Stryker, Howmedica, UK) with a 32 mm alumina head (Stryker, Howmedica, UK) on the right and interval procedure on the left side (Fig. 4). Impaction grafting with morcelised femoral head allograft on the acetabular side was required. Intraoperatively, there was no evidence of macroscopic infection with negative gram stains. This was confirmed postoperatively with microscopic analysis. The patient is now 3 years on from the second arthroplasty procedure and is doing well. He is mobilising and fully weight bearing unaided with a normal gait pattern and equal leg lengths. Abductor and quadricep power has returned to normal. He remains in remission.

3. Discussion

The current multidisciplinary and intensive multimodality treatment for ALL has progressively improved the survival rate from approximately 10% in the early 1970s to 80% at 5 years in 2008. Achieving these high survival rates over a relatively short period has refocused attention on the potential toxic effects of treatment intensification in this subgroup of patients. The potential long-term musculoskeletal sequelae can be devastating in a young population cured from this form of malignancy. This poses a significant challenge for the Orthopaedic Surgeon.

The literature has described how hormonal imbalance can change physeal physiology in adolescence. Harper et al. published work in the 1980s suggesting that chemotherapy agents alone may be responsible in the pathophysiology of avascular necrosis of the femoral head, amongst other sites. Several studies have linked osteonecrosis to the UKALL treatment regime for ALL which was used in this case. Is it possible that the SCFE occurred due to an iatrogenic shift of physeal physiology at an age where the physis widens and periostem thins within 3 weeks following chemotheroidal treatment, both of which being implicated in the literature.
in the pathogenesis of ON. Several other studies cite a combination of chemoradiotherapy as a causal factor for ON regardless of the type of cancer or the age of the patient.\textsuperscript{10–12} Ojala et al. report a 32% incidence (9/28) of osteonecrosis (ON) in a paediatric population undergoing treatment for ALL of which 14.3% were symptomatic.\textsuperscript{13} All patients that developed ON in their cohort were in the intermediate to high risk category and received a combination of chemotherapy (vincristine, doxorubicin, cyclophosphamide, mercaptopurine, cytosine, teniposide and methotrexate), steroidal treatment and cranial irradiation.\textsuperscript{13} Gebhard and Maibach suggest that steroids are the key player in atraumatic ON in the femoral head.\textsuperscript{14} Overall, there is a lack of consensus in the literature on the aetiopathogenesis of ON in these patients.\textsuperscript{15,16} In this case, a combination of factors are likely to have played a role in the rapid deterioration to end-stage ON of the femoral head bilaterally. The patient received a combination of high dose steroids and polychemotherapy at an age of pubertal growth. Surgery was indicated for the slip at a time of maximum immunosuppression from concurrent treatment, increasing the risk of peri-operative infection. The post-operative complicated course of events following SCFE pinning led to the decision for staged unilateral followed by contralateral arthroplasty surgery.

4. Conclusion

This group of young, adolescent patients are a challenge to the orthopaedist. They have an underlying malignant condition that requires an intensive, potentially curative, medical treatment regime, the long-term consequences of which can carry significant debilitating sequelae. Even in an adolescent patient, it is important to have arthroplasty surgery as part of the management armamentarium.

Conflict of interest

None.

Funding

None.

Ethical approval

We have obtained written consent from the patient and their parents and this can be provided at your request.

Author contributions

None.

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