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Functional outcomes, complications and revision rate of hip arthroplasty in patients with sequelae of slipped capital femoral epiphysis: a systematic review

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- Background: Slipped capital femoral epiphysis (SCFE) results in alterations to femoral head anatomy, predisposing patients to degenerative hip disease at a young age. Total hip arthroplasty (THA) is performed to relieve symptoms and improve function. However, it can be associated with a variable outcomes and little evidence exists on the functional outcomes, complications and revision rate following such procedures.
- Purpose: The aim of this systematic review is to determine the safety and effectiveness of performing hip arthroplasty in patients with degenerative hips secondary to SCFE.
- Methodology: A systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A literature review was conducted of MEDLINE and Embase. Both single-arm and comparative studies were included. The outcomes of interest were functional scores, postoperative complications and revision rate.
- Results: Six studies fit the inclusion criteria. Of these, five were retrospective single-arm studies and one was a retrospective comparative study based on registry data.
- All studies reported significant improvement in hip function and quality of life after THA. An overall revision rate of 11.9% was reported, occurring at a mean of 6.5 years (0.75–18.7 years).
- THA in patients after SCFE leads to improved functional outcomes that are comparable to patients receiving THA for osteoarthritis. The revision rate appears to be higher than is reported in patients undergoing THA for osteoarthritis at mid-term follow-up. Further prospective comparative studies are needed to evaluate the efficacy of the treatment in more detail.

Keywords: arthritis; paediatric hip; slipped capital femoral epiphysis; slipped upper femoral epiphysis; total hip replacement; total hip arthroplasty

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Introduction

Slipped capital femoral epiphysis (SCFE) is a disorder of the adolescent hip. The reported average annual incidence ranges from 8.8 to 10.8 per 100,000 in children between 9 and 16 years of age.[1] SCFE is characterized by disruption of the proximal femoral physis, leading to the femoral metaphysis displacing anteriorly and externally rotating in relation to the epiphysis.[2] The morphological abnormality created by this condition predisposes the hip to femoroacetabular impingement (FAI) which may lead to increased contact stresses within the hip joint, joint degeneration and arthrosis at a relatively young age.[3] The severity of the slip and subsequent displacement are significant factors in determining the natural history of the condition, with less favourable outcomes following a severe slip.[4,5]

The mainstay of treatment includes activity and lifestyle modifications, anti-inflammatories and physiotherapy. When these measures fail, surgical intervention is generally indicated. It is estimated that 45% of SCFE patients will undergo a total hip arthroplasty (THA) within 50 years of the initial insult.[1]

THA in this unique group of patients is technically challenging because of the abnormal anatomy and

multi-planar deformities encountered in the proximal femur.[6] The long-term outcome of THA in post-SCFE patients is not well understood because of the paucity of published evidence evaluating this.

The aim of this systematic review is to assess the evidence for the use of THA in patients with end-stage degenerative changes following SCFE. Specifically, we aim to determine the patient-reported functional outcomes, post-operative complications and failure rates.

Methods

Search strategy

A systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A search was conducted of studies within the MEDLINE and Embase databases between 1 January 1974 and 1 January 2020. Keywords used for the searches were "total hip arthroplasty" OR "total hip replacement" OR "THA" OR "THR" AND "Slipped Capital Femoral Epiphysis" OR "SCFE" OR "Slipped Upper Femoral Epiphysis" OR "SUFE". The reference lists of the relevant articles were explored to find additional articles. A search of the grey literature, including Zetoc, was also conducted to find any additional articles.

Eligibility criteria

The inclusion criteria included all articles describing the clinical and functional results of THA in patients following SCFE. Isolated case reports / series with five or fewer patients were excluded. The included articles met the PICO criteria for systematic reviews (Population, Intervention, Comparison and Outcomes).

Data extraction

The titles and abstracts of the identified articles were reviewed. After screening of the titles and abstracts, the full texts of the articles included were obtained and reviewed. The authors checked the data for accuracy and any inconsistent results were handled by discussion. Data, including the number of patients, follow-up period, type of implant, type of fixation, bearing surfaces, complications, re-operations, revision rate and functional outcome, were extracted where available, and entered into a spreadsheet. Fig. 1 represents a PRISMA flowchart illustrating the search strategy and number of records screened and included.

Results

Search results

A total of 120 article titles were identified following our initial search, of which 17 were relevant. The abstracts of these articles were reviewed to determine whether they met the inclusion criteria. Initial screening identified 13 potential studies. The full texts of these studies were obtained and reviewed by the first, second and last authors independently. Seven studies were further excluded with a reason (one paper was not a case series, one study had no reported functional outcomes and five

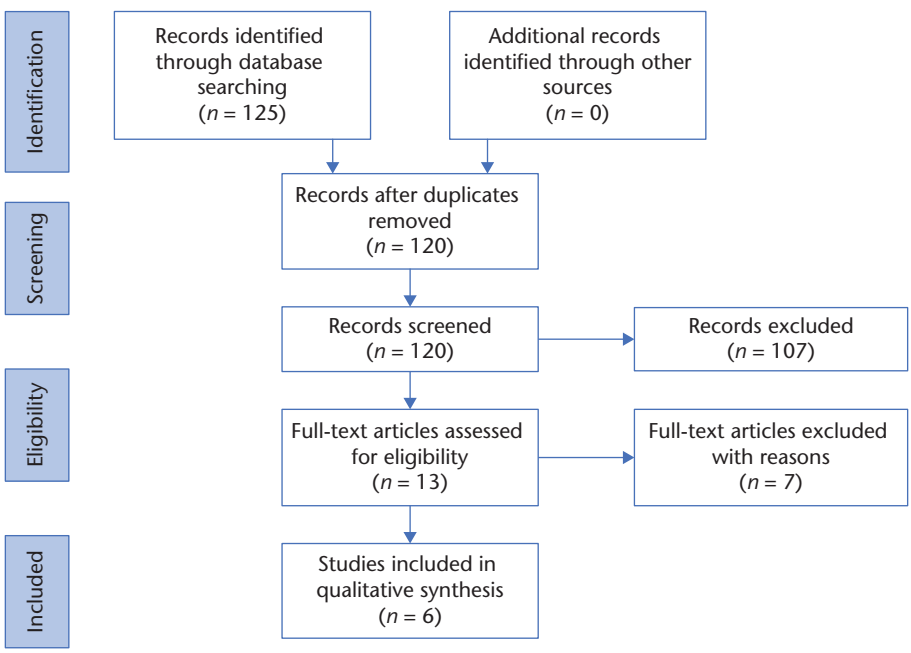

Fig. 1 PRISMA flowchart illustrating the search strategy, and number of records screened and included.

articles did not categorize improvement/complications). A total of six studies fulfilled the eligibility criteria.

Quality assessment

All studies were small to medium size retrospective case series (N = 18–117) which described the revision rate and functional outcome of THA in patients with sequelae of SCFE. The follow-up period ranged from 1 to 52 years.

Cohort characteristics

The studies included 268 surgeries performed in patients with a mean age of 43.8 years who were followed up for an average of 7.59 years. Of the 268 operations, there were 226 THAs (84.3%), 40 HRAs (14.9%) and two (0.8%) hemiarthroplasties. There were 148 cementless THAs (65.5%), 50 hybrid THAs (22.1%) and 28 cemented THAs (12.4%). Only three studies (n = 94) specified the bearing surfaces used. There were 28 metal-on-polyethylene, 23 ceramic-on-ceramic, nine ceramic-on-polyethylene and 35 metal-on-metal. The demographics of the patients in the studies are summarized in Table 1.

Outcome analysis

Functional outcome

All studies reported a significant improvement in hip function and patient satisfaction following surgery. The Harris Hip Score (HHS) improved by a mean of 41.3 points post-operatively in five studies (34 to 59).[7–11] Boyle et al[12] did not record pre-operative scores, but used the Oxford Hip Score six months post-operatively, and found the mean in the SCFE group was 42.4 and the mean in the osteoarthritis (OA) group was 40.8.

Complications

Complications reported by the studies included in this systematic review were aseptic loosening (n = 17, 6.3%), heterotopic ossification (n = 15, 6%), polyethylene wear (n = 3, 1.1%), femoral neck fracture (n = 2, 0.7%), infection (n = 1, 0.4%), lesser trochanter fracture (n = 1, 0.4%), modular neck fracture (n = 1, 0.4%) and unexplained pain (n = 1, 0.4%).

Revision rate

There were 32 failures in total necessitating revision surgery in the 268 cases (11.9%). Seven hip resurfacings failed (revision rate of 20% performed at an average of 3.7 years) secondary to aseptic loosening of the cup (n = 4), femoral neck fractures (n = 2) and unexplained pain (n = 1) at a mean time of six years. Of the 24 failed THAs (revision rate of 10.6% with average follow-up of 7.6 years), the reasons for revision were aseptic loosening (66.7%, n = 16), no reason specified (25%, n = 6) infection (4.2%, n = 1) and a modular neck fracture (4.2%, n = 1). The infected case underwent a single-stage revision nine months post-operatively. A hemiarthroplasty was also revised in the series presented by Larson et al;[14] however, the indication for revision was not described.

Discussion

This systematic review has identified five retrospective single-arm, non-comparative studies outlining the outcomes of THA in patients with a history of SCFE and one retrospective comparative study using registry data.

Functional outcomes

All non-comparative studies have demonstrated an improvement in functional outcomes (22–100)[7–11] and Boyle et al[12] demonstrated comparable early post-operative functional outcomes between the SCFE and primary osteoarthritis groups using the Oxford Hip Score. There is no evidence to demonstrate whether the functional outcomes remained comparable in the medium to long-term, and this would be important data to derive from any future studies performed on this topic.

Revision rate

Total hip replacement

Larson et al[7] present a series of patients in whom surgeries were performed from 1954–2007, demonstrating a revision rate of 35.7% at an average of 13 years, presumably with older hip prostheses implanted which are no longer in use. A variety of implants were used, including four cemented and 24 uncemented acetabular components and 5 cemented and 23 press-fit stems. The reasons for revisions were aseptic loosening of the cemented cup (n = 3), aseptic loosening of an uncemented cup (n = 1), aseptic loosening of a cemented femoral component (n = 2), aseptic loosening of a press-fit femoral component (n = 1), and polyethylene wear (n = 3).

Schoof et al reported one case of infection, which was revised at nine months, and five cases of aseptic loosening (three stems (cemented), one cup (cemented) and one stem and cup (uncemented)), all of which were revised between 31–72 months.[9] Interestingly, Schoof et al[9] excluded six patients from their retrospective study because they had already undergone revision arthroplasty by follow-up, due to prosthetic failure. The authors of this article would suggest that these six revision procedures should have been included, and would change the revision rate from 19% to 32.4% for their study. The overall revision rate for THA would subsequently increase from 10.6% to 12.9%.

A revision rate of over 30% in the studies presented by Schoof et al[9] and Larson et al[7] in patients who underwent THA for hip pathology secondary to SCFE represents a significant risk of revision. The abnormal anatomy and multi-planar deformities associated with post-SCFE hips make THA a challenging procedure, and more recent data

suggest that the risk of revision is higher following SCFE than with other paediatric hip disease. A study presenting data derived from the Nordic Arthroplasty Register Association found no significant difference in risk of revision between groups of patients undergoing THA for paediatric hip disease and those undergoing THA for primary OA.[13]

Hip resurfacing

Hip resurfacings in the study by Larson et al[7] had a revision rate of 62.5%, performed at an average of seven years after the primary procedure. Aseptic loosening of the acetabular component was the indication for revision in four out of five cases. The authors of this article are unaware of any evidence to suggest that the quality of bone in the acetabulum is impacted by the sequelae of SCFE, leading to the assumption that the high rate of acetabular loosening reported by Larson et al[7] may be as a result of deficiencies with the hip resurfacing implant used (implant details were unfortunately not provided for this series). The other series that included hip resurfacings demonstrate a revision rate of 6.3% at an average of 2.9 years, but with only an average of 4.2 years follow-up.

Cohort characteristics

Patients undergoing THA for degenerative joint disease secondary to SCFE are significantly younger than those who typically receive THA for primary OA. It is generally accepted that the more severe the initial slip, the sooner the onset of debilitating joint pain and need for arthroplasty surgery. This problem is compounded in patients who develop avascular necrosis of the femoral head.[6] Boyle et al found the average age of patients undergoing THA following SCFE was 48.5 years, which was significantly younger than those with primary OA, whose average age was 67.6 years.[12]

Previously, higher revision rates in younger patients undergoing THA have been attributed to excessive polyethylene wear. However, significant progress has been made in the understanding of the biomechanics of THA, tribology and implant design.[7] In a case series of 113 ceramic-on-ceramic THAs, in patients under the age of 20 years, Hannouche et al reported an overall survival rate of 90.3% at 10 years. Within this series, 12 cases (11%) were performed where the sequelae of SCFE was the indication for THA. Of these, only two were revised as a result of aseptic loosening.[14]

Surgical approach and heterotopic ossification

Traina et al[8] reported that heterotopic ossification (HO) was seen in 15 hips (47%) in the same series, but it was not documented if this caused any functional deficit. Of 32 THAs in this series, 31 were performed using an anterolateral approach. Boyle et al[12] reported that 42.9% of patients in their registry-based study underwent THA using the anterolateral approach; however, radiological outcomes were not reported. Schoof et al[9] and Su et al[10] used the posterior approach in all patients and reported no cases of HO.

Management of femoral deformity

The use of modular and custom hip implants is often advocated to address the spectrum of deformities present in hips with severe slips (Fig. 2 and Fig. 3).[15] Modular

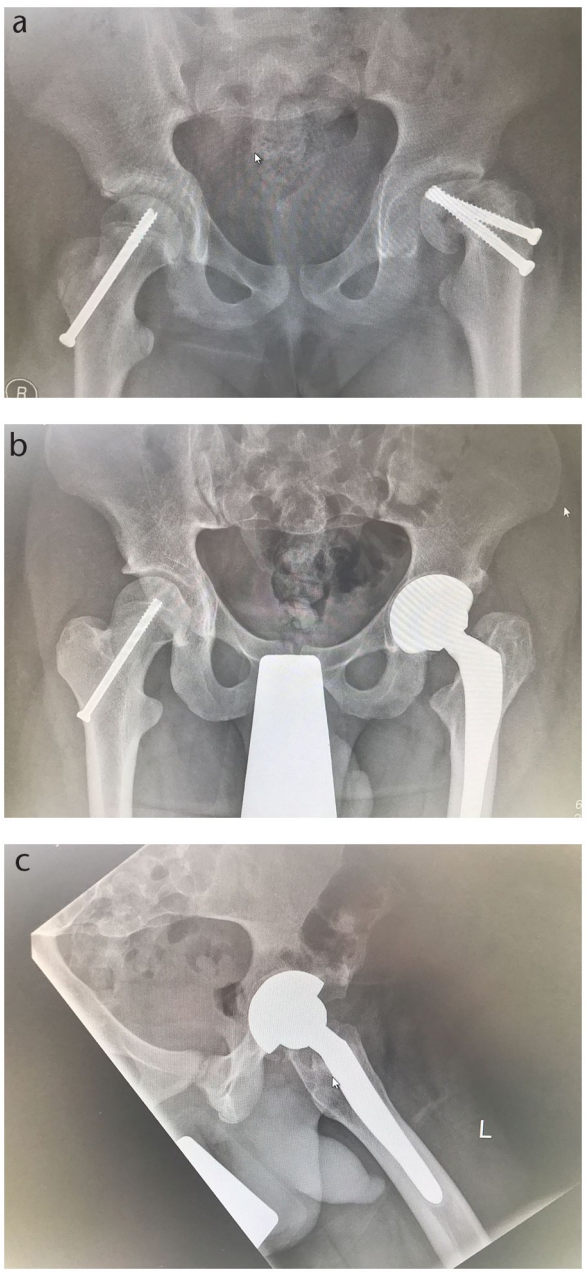

Fig. 2 (a) Plain radiograph of a left sided SCFE in a female patient that had previously undergone in-situ stabilisation on the left hip, with prophylactic stabilisation of the right hip. (b & c) Post-operative AP and lateral radiographs following treatment with a custom total hip arthroplasty implant.

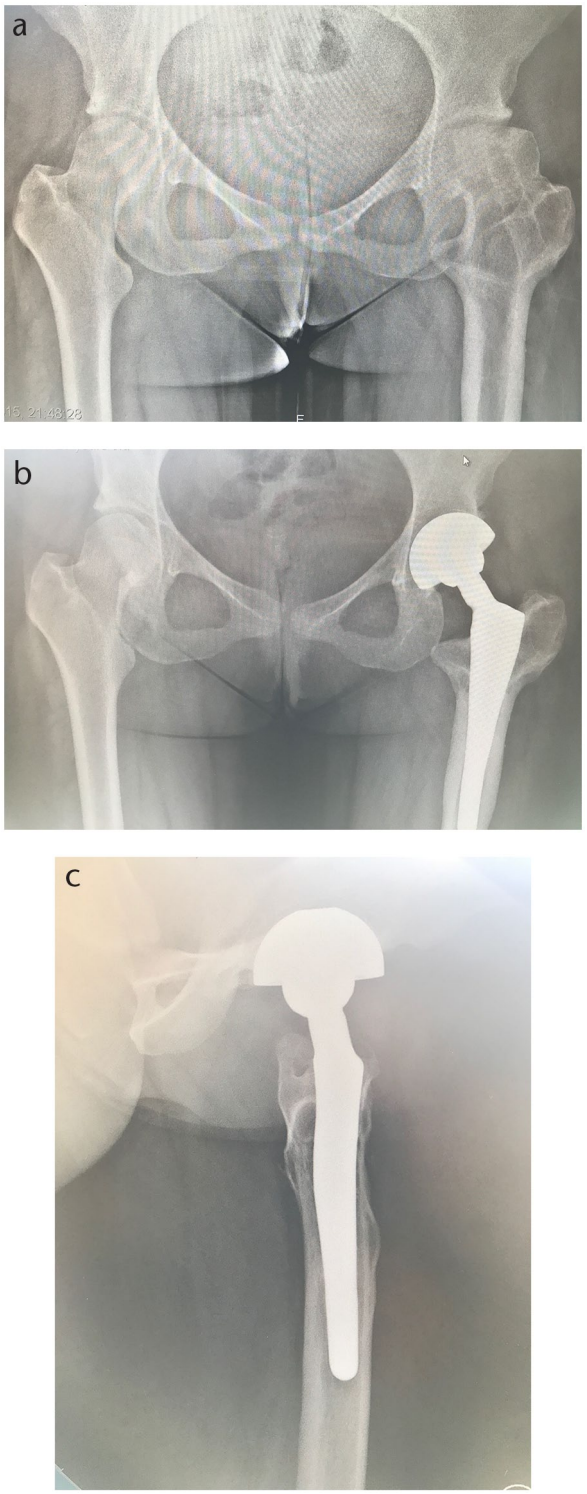

Fig. 3 (a) Plain radiograph of a SCFE of the left hip in a female patient. (b & c) AP and lateral radiograph demonstrating a custom total hip arthroplasty implant..

systems reportedly enable the surgeon to adjust offset, neck length and version. Unfortunately, none of the studies describe any correlation between the degree of femoral deformity and subsequent functional outcomes or revision rate. Some use of modular/custom hip implants has been demonstrated to be associated with taper fretting, corrosion and modular neck fractures.[16]

Outcomes of THA for other paediatric hip conditions

Lehmann et al[17] presented a study of 592 hips undergoing THA, where 29 (5%) were performed in patients with a prior history of SCFE. The EQ-5D, a standardized instrument for measuring general health status, was demonstrated to be higher in the SCFE group at 81, than for the other paediatric conditions of dysplasia or Legg–Calve–Perthes disease or the arthritic group, with mean scores of 69, 74 and 71 respectively.[17] The statistical significance was not reported.

Nerve injury

The incidence of neurological injury was reported as 0% in the studies reviewed. This incidence is less than normally seen after a THA, which is reported to be between 0.06% and 7.6%, and higher in revision arthroplasty.[15] This is likely be an underreporting of this complication in this cohort. Causes of neurological injury include significant leg lengthening, extravasation of cement and manipulation, all of which may be likely in post-SCFE surgery. Schoof et al[9] speculated it was due to using the posterior approach, in which the sciatic nerve can be visualized/palpated, but this approach was not used in the Traina et al series.[8]

Leg length discrepancy

Although leg length discrepancy was not a primary outcome measure for this systematic review, Schoof et al[9] reported that mean leg length discrepancy was found to have reduced from an average of 13.5 mm pre-operatively to 4.5 mm post-operatively.

Conclusion

Total hip arthroplasty in this unique group of patients is technically challenging because of the abnormal anatomy and multi-planar deformities encountered in the proximal femur.[6] The findings of this review show a need for further studies into the long-term outcome of THA post SCFE. However, the evidence demonstrates that young patients undergoing THA as a result of the sequelae of SCFE are at significant risk of requiring revision surgery.[14] The current literature cautiously supports the use of THA to alleviate hip pain and improve function in patients with advanced hip OA or avascular necrosis secondary to SCFE. Given the advances in tribology and implant design, along with patient-specific or custom implants and 3D printing, better results can be anticipated; however, no scientific evidence currently exists to confirm this.

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