Hip replacement in children with femoral head collapse and hip joint degeneration. Two case reports.

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Abstract

There are several pathological conditions in children, such as Legg-Calvé-Perthes disease, slipped capital femoral epiphysis, femoral head avascular necrosis, which can progress to disabling hip joint destruction. These children undergo surgeries, such as hip arthrodesis, in an attempt to postpone hip replacement so that it can be done at an older age. Unfortunately, hip arthrodesis significantly limits their ability to actively engage in activities that require full hip mobility. For these children, active participation in games and sports activities remains an important factor for their physical development and mental health. On the contrary, hip arthroplasty can ensure a pain-free, unrestricted range of hip movement, but are doubts as to its viability over time, especially in young people who exhibit intense activity.

We report successful hip replacement in two children, fourteen years of age and younger, with femoral head collapse and disabling joint degeneration due to avascular necrosis of the femoral head, whom the hip replacement was considered the only surgical treatment ensuring a painless hip joint. For the clinical assessment of these two hips, we used the online Harris hip score, preoperatively and postoperatively. No intraoperative or early postoperative complications occurred. Follow-up was conducted at six weeks, six months, and then at an annual clinical and Radiological evaluation. At the final seven-year- follow-up, these two children had greatly improved their function hip score considerably.

Hip arthroplasty can ensure a pain-free, unrestricted range of hip movement in young children when their hip joint is severely affected.

Introduction

Avascular necrosis (AVN) of the femoral head is a pathologic process that results from the interruption of the blood supply to the bone (1). Femoral head ischemia, traumatic or non-traumatic, causes the death of the bone marrow and usually results in the collapse of the necrotic segment (2, 3). Traumatic causes of femoral head AVN in children include femoral neck fractures, traumatic hip dislocation, and slipped femoral capital epiphysis (4, 5). The non-traumatic form of AVN of the femoral head in children is mainly associated with septic arthritis, thrombocytosis, chemotherapy, radiation, Gaucher disease, sickle cell disease, high doses of corticosteroids, and finally with idiopathic avascular necrosis (6, 7). The Avascular necrosis (AVN) of the femoral head can progress to disabling joint degeneration and lead to osteoarthritis of the hip joint in relatively young adults.

Case Reports

Case 1. Idiopathic AVN of the femoral head (TimeLine)(Fig. 1).

Patient Information

A 14-year-old boy was referred to our institution for treatment of his painful and rigid left hip joint, a condition that made him unable to walk without the help of crutches.

Past History

His symptoms started one year ago with an insidious onset of pain in his left groin region. The X-Ray of the hip was normal at that time (Fig. 2a). The laboratory blood tests were negative for the presence of infection of the hip. The physician recommended bed rest for a few days and restriction from sports activities for a few months. Four months later, the gradual increase of the pain and stiffness in the left hip necessitated the patient's hospitalization for ten days to ensure hip immobilization. The laboratory blood tests were again negative for the presence of infection of the hip. The X-Ray at that time revealed a flattening of the lateral half of the capital femoral epiphysis (Fig. 2b). Ten months later, due to deteriorating hip symptoms, he was referred to our institution for further treatment. The X-ray revealed the collapse of the femoral epiphysis (Fig. 2c).

Clinical findings

On clinical examination, a fixed 30° flexion deformity of the left hip was obvious, accompanied by a severe restriction of its movements.

Therapeutic interventions

Hip replacement was considered the only surgical treatment capable of ensuring a painless hip joint. The patient received a femoral head resurfacing implant (no traditional THR) utilizing an uncommon implant (Birmingham Mid Head Resection Prosthesis). It is a metal-on-metal articulation. Although the use of a metal-to-metal prosthesis for adolescents is controversial now, the Birmingham Mid head resection implant (BMHR) was chosen, wrong in my current opinion, as the most suitable for this patient at that time (Fig. 2d). This decision was based on the belief that this ensures the preservation of the femoral neck and 1/3 of the femoral head, postponing the total hip replacement for much later, thus gaining time, which is very important for this patient, mainly due to his young age.

Surgical technique

To avoid failure of the femoral component of the arthroplasty, and the possible femoral neck fracture, the placement of the femoral component of the prosthesis in the valgus position, was considered obligatory. Placing the femoral component in the valgus position increases the required compression forces and reduces the harmful shear forces, acting on the preserved femoral neck. In addition, the placement of the femoral component in the valgus position obliges the most horizontal placement of the acetabulum

component (reduced angle of inclination of the acetabulum, 22°), thereby ensuring the congruity of the hip joint implant (Fig. 2d).

Follow up

For the clinical evaluation of the patient preoperative and postoperative, we used the online Harris hip score (Orthotoolkit) (Table 1). No intraoperative or early postoperative complications occurred. The clinical and radiographic follow-up was conducted at six weeks, six months, and then annually (Fig. 3). Full weight-bearing without aids allowed 4 weeks postoperatively.

Case 2. Traumatic AVN of the femoral head due to slipped capital femoral epiphysis (TimeLine) (Fig. 4).

Patient Information

A 13-year-old overweight boy was referred to our hospital for treatment of his painful and rigid right hip joint, a condition that made him unable to walk without the help of crutches.

Past History

It was started with an unstable, acute slipped capital femoral epiphysis (25° posterior tilt), that was partially reduced and treated surgically with fixation of the slipped capital femoral epiphysis with a single screw. The clinical and radiographic follow-up conducted at six weeks, and then at regular intervals of two months, revealed a progressive deterioration of the pain and stiffness of the right hip and progressive destruction of the capital femoral epiphysis due to avascular necrosis. The follow-up, thirteen months postoperatively, revealed femoral head collapse and disabling degeneration of the hip joint (Fig. 5a). The single hip screw was removed five months later (Fig. 5b, c). Hip replacement was considered the only surgical treatment capable of ensuring a painless hip joint and was performed five months after the removal of the hip screw.

Clinical findings

On clinical examination, a fixed 40° flexion deformity of the right hip was obvious, accompanied by a severe restriction of its movements.

Therapeutic interventions

Total hip replacement was considered again the only surgical treatment capable of ensuring a painless hip joint. Autologous Bone grafting of the reconstructed acetabulum, using as graft the excised femoral neck, was considered necessary, due to the thinning of the acetabular wall after the acetabular reaming. The patient underwent a traditional THR [Smith & Nephew Short Modular Femoral Stem (SMF), Oxinium Femoral Head - R3 cup. Oxinium on highly cross-linked polyethylene (HXLPE) liner] (Fig. 6, 7).

Follow up

For the clinical evaluation of the patient preoperative and postoperative, we used the online Harris hip score (Table 1). No intraoperative or early postoperative complications occurred. The clinical and radiographic follow-up was conducted at six weeks, six months, and then annually. Full weight-bearing without aids allowed 4 weeks postoperatively. On the immediately post-operative AP radiograph, the acetabular component of the implant appears to penetrate the medial wall of the acetabulum, but seven years postoperatively, the position of the acetabular component of the implant appears to be unchanged (Fig. 7d).

Results

In the first case, during the seven-year follow-up, the hip function score improved significantly from 29.55 points preoperatively to 93 points postoperatively (**Table 2**). In the second case, during the seven-year follow-up, despite the radiographic appearance of the penetration of the acetabular component of the implant through the medial acetabular wall, the function hip score greatly improved from 38.45 points preoperatively to 97 points postoperatively (**Table 3**).

Discussion

Children with disabling joint destruction are unable to participate in sports activities that require full hip mobility. These children undergo surgeries, such as hip arthrodesis, in an attempt to postpone hip replacement so that it can be done at an older age. Unfortunately, hip arthrodesis significantly limits their ability to actively engage in activities that require full hip mobility. For these children, active participation in games and sports activities remains an important factor for their physical development and mental health. On the contrary, hip arthroplasty can ensure a pain-free, unrestricted range of hip movement, but are doubts as to its viability over time, especially in young people who exhibit intense activity (8, 9, 10). Additionally, there are worries concerning inadequate bone stock, leg length discrepancies, small acetabulum, and small femoral canals.

Total hip replacement is the most common hip arthroplasty. The entire hip structure is replaced with artificial components. The neck and head of the femur is replaced with an artificial femoral component and the natural socket in the hip joint is replaced with an artificial cup.

Hip resurfacing removes 2/3 of the femoral head, preserving the neck and 1/3 of the femoral head. To the preserved femoral head a ceramic or metal ball is attached. An artificial cup with metal or ceramic lining replaces the socket in the acetabulum.

In the past, in young patients with rheumatoid arthritis, bone cement was commonly used to hold hip implants in place (10, 11). Nowadays, in young patients, uncemented implants are regularly used, with the results of the uncemented THA being more positive than those of cemented THA (12, 13, 14, 15). Uncemented implants have a textured surface that allows the bone to grow into it and fasten it. In the hybrid total hip replacement, the cup is positioned firmly into the socket cementless while the femoral component is placed into the femoral canal with cement for its stabilization.

The materials that are used to make hip implants are made of polyethylene (plastic), metal, ceramic, or a combination of them.

Metal-on-Polyethylene (MoP) is the most commonly used hip arthroplasty worldwide. The cup has a plastic lining or is made entirely of polyethylene, while the femoral ball is made of metal. The smooth surface of the plastic ensures a little friction during the movement of the femoral ball within the socket. Nevertheless, plastic materials can generate plastic debris, which can eventually cause the implant to fail.

Metal-on-Metal (MoM) implants are no longer available in the United States since worries have been upraised about the potential long-term systemic effects of metal ions toxicity in the blood due to the fact that metal materials can shed metal particles into the bloodstream, causing serious health problems such as cancer, heart failure (16). However, large cohort studies have currently observed that patients with metal-on-metal hip bearings are not at increased risk of cancer, heart failure, or mortality compared to other hip replacement patients (17).

Ceramic-on-Polyethylene (CoP) devices combine a ceramic ball with a plastic cup. The plastic cup can create plastic debris, which can cause the implant to fail.

Ceramic-on-Metal (CoM) devices combine a ceramic ball with a cup that has a metal lining. This hip device is available in the United States since 2011.

Ceramic-on-Ceramic (CoC) hip devices combine a ceramic head with a cup that has a ceramic lining. The results of using ceramic on ceramic-bearing surfaces in young patients are very encouraging (18, 19, 20). The most common failures of these devices are associated with loosening of the lining and fracture of the components.

Conclusion

Due to the demands for increased durability and survival of hip arthroplasty, a cementless prosthesis is currently recommended for THR in children (21), and we agree with this view.

Declarations

i. Funding:

There is no financial support for this manuscript.

ii. Conflicts of interest/Competing interests:

We have no conflicts of interest to disclose.

iii. Ethics approval:

We insure you that all procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

iv. Consent to participate:

Parental consent was obtained for the two participants included in this study.

v. Consent for publication:

Parental consent for publication was obtained for the two participants included in this study.

vi. Availability of data and material:

my manuscript and associated personal data will be shared with Research Square for the delivery of the author dashboard.

vii. Code availability:

Not applicable for this section.

viii. Authors' contributions:

Corresponding author. Surname: Megremis. First Name: Panos

Contribution: Surgical technique, study design, performed measurements, manuscript preparation, photo editing.

Co-author. Surname: Megremis. First Name: Orestis

Contribution: study design, manuscript preparation, photo editing.

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Tables

Tables are only available as a download in the Supplemental Files section.

Figures

Figure 1

Case 1. Idiopathic AVN of the femoral head. TimeLine

Figure 2

Case 1. Idiopathic AVN of the femoral head. Birmingham Mid Head Resection (BMHR) hip replacement system.

a: Painful left hip. The X-Ray of the hip was normal at that time. The physician recommended bed rest for a few days and restriction from sports activities for few months.

b: Four months later, the gradual increase of the pain and stiffness in the left hip necessitated the patient's hospitalization for ten days to ensure hip immobilization. The X-Ray at that time revealed a flattening of the lateral half of the capital femoral epiphysis

c: Ten months later. The X-ray revealed the collapse of the femoral epiphysis due to necrosis of the femoral head.

d: The Birmingham Mid Head Resection (BMHR) surgical procedure was chosen as more appropriate for this patient. To avoid failure of the femoral component of the arthroplasty, and the possible femoral neck fracture, the placement of the femoral component of the prosthesis in the valgus position, was considered obligatory. In addition, the placement of the femoral component in the valgus position obliges the most horizontal placement of the acetabulum component (reduced angle of inclination of the acetabulum, 22°), thereby ensuring the congruity of the hip joint implant.

Figure 3

Case 1. Idiopathic AVN of the femoral head. Birmingham Mid Head Resection (BMHR) hip replacement system.

a: X-ray: Anteroposterior view image. Seven years postoperatively.

b: X-ray: Lateral view image. Seven years postoperatively.

Figure 4

Case 2. Traumatic AVN of the femoral head due to slipped capital femoral epiphysis. TimeLine.

Figure 5

Case 2. Traumatic AVN of the femoral head due to slipped capital femoral epiphysis.

a: Unstable slipped capital femoral epiphysis that was partially reduced and treated surgically with fixation of the slipped capital femoral epiphysis with a single screw. X-ray: Anteroposterior view image thirteen months postoperatively. Femoral head collapse and disabling degeneration of the hip joint.

b, c: Five months later. Hip screw removal. Anteroposterior and lateral view images.

Figure 6

Total hip replacement. Intraoperative images. Insertion of R3 Acetabular Cup with XLPE liner.

a: Excised, saddle-shaped femoral head.

b, c: Acetabular reaming

d, e, f: R3 acetabular cup implant insertion with XLPE liner, step by step.

Figure 7

Total hip replacement. Intraoperative images. Short Modular Femoral Stem insertion with Oxinium Femoral Head.

a, b: Femoral canal reaming.

c: Assembled trial modular neck and trial femoral head

d: Assembled Short Modular Femoral Stem with Oxinium Femoral Head in position.

Figure 8

a: On the immediately post-operative AP radiograph, the acetabular component of the implant appears to penetrate the medial wall of the acetabulum.

b: Seven years postoperatively, the position of the acetabular component of the implant appears to be unchanged.

Supplementary Files

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- [Table1HarrisHipScore.pdf](#)
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