Bony Hip Reconstruction in Cerebral Palsied Children with GMFCS Levels III to V:

A Systematic Review

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List of Abbreviations

Abb.	Full term
AB	*Abductor*
AD	*Adducotr*
AP	*Antroposterior*
AVN	*A Vascular necrosis*
CP	*Cerebral Palsy*
DV	*Decubitus ulcer*
GMFCS	*Gross motor function classification system*
HF	*Hardware failure*
HO	*Heterdropic ossification*
ICF	*International classification functioning*
IP	*Iiliopsoas*
MP	*Migration percentage*
N	*Number*
NR	*Not reported*
OA	*Osteoarthitis*
OCEBM	*Oxford center for evidence based medicine*
PF	*Pathologic fracture*
RCT	*Randomised control studies*
STR	*Soft tissue release*
VDRO	*Varus derotational osteotomy*

Abstract

Hip dislocation is a common source of disability in cerebral palsy children. It has been remedied by various reconstructive procedures. This review aims at providing the best evidence for bony reconstructive procedures in cerebral palsy hip migration. The literature extraction process yielded 36 articles for inclusion in this review. There is fair evidence to indicate that the comparative effectiveness of femoral versus combined pelvifemoral reconstruction favours pelvifemoral reconstruction. All except one were retrospective articles with a significant degree of selection and performance bias and confounding variables that limited the validity and generalizability of the conclusions. The findings of this systematic review provide fair evidence for the use of adequate soft tissue and combined pelvifemoral reconstruction in the management of hip migration in none and minimally ambulatory cerebral palsy children in the short and long term. This has been shown in studies with a summed sizable patient population. There is limited evidence available that would support the use of soft-tissue and isolated femoral reconstruction. In the context of these retrospective and biased studies, it is extremely difficult to identify, with great precision, predictors of surgical success. Future studies should consider prospective designs that allow for bias control, strict patient selection criteria and incorporation of validated quality-of-life scales.

Keywords

Cerebral palsied children - hip displacement - hip migration - hip subluxation - hip dislocation - hip instability.- femoral osteotomy - pelvic osteotomy - hip reconstruction - combined pelvic and femoral osteotomy.

INTRODUCTION

Cerebral palsy (CP) is the prime cause of childhood disability affecting function and development. In developed countries, the overall estimated prevalence of cerebral palsy is 2-2.5 cases per 1000 live births. [1,2]

Hip displacement is a common and weighty musculoskeletal association in children with CP. It often occurs in early childhood. The highest risk of hip displacement occurring in children and adolescents was reported among those with greater gross motor functional disability, as indicated by the gross motor function classification system (GMFCS). [1,2,3,4]

Patients with severe hip migration or dislocation are at a significantly higher risk for development of pain, perineal nursing problems and defective sitting balance. [5]

Hence, preventive treatment for hip dislocation is of paramount significance. Nevertheless in cases of dislocation, soft tissue and bony hip reconstruction is necessary to achieve stability and containment. [1,3]

Hip surveillance programmes have demonstrated effectivity in identifying high-risk patients and decreasing the incidence of hip dislocation in populations with CP. [6]

In general, bony reconstruction of the hip is effective in stabilizing the hip joint by proximal femoral osteotomy, pelvic osteotomy or combined pelvi-femoral osteotomy [7,8,9,10,11,12]

AIM OF THE WORK

The study is designed to conduct a rigorous and objective analysis of the current literature evidence of clinical practice of bony reconstructive hip surgery in cerebral palsied children. The interventions targeted by the current review were; femoral osteotomy, pelvic osteotomy, and combined pelvi-femoral osteotomy. We intend to provide decision making guidelines for the best treatment option of hip instability with respect to efficiency and effectivity. To achieve this goal we formulated the following research questions:

A. What is the best evidence for varus derotation femoral osteotomy (VDRO) practice?

B. What does an additional pelvic osteotomy “combined pelvi-femoral” add to the outcome?

C. What are the patient characteristics that are associated with best surgical treatment outcomes?

REVIEW OF LITERATURES

I. Applied Anatomy of Hip Joint

The hip is a classical ball-and-socket joint (the acetabulum represents the socket & femoral head represents the ball).

It meets the four characteristics of a synovial or diarthrodial joint: it has a joint cavity; joint surfaces are covered with articular cartilage; it has a synovial membrane producing synovial fluid, and; it is surrounded by a ligamentous capsule. Its stability is largely the results of the adaptation of the articulating surface of acetabulum and femoral head to each other. The presence of a relatively narrow neck is the mechanical factor responsible for the wide range of movement in such stable joint figure (1). [13]

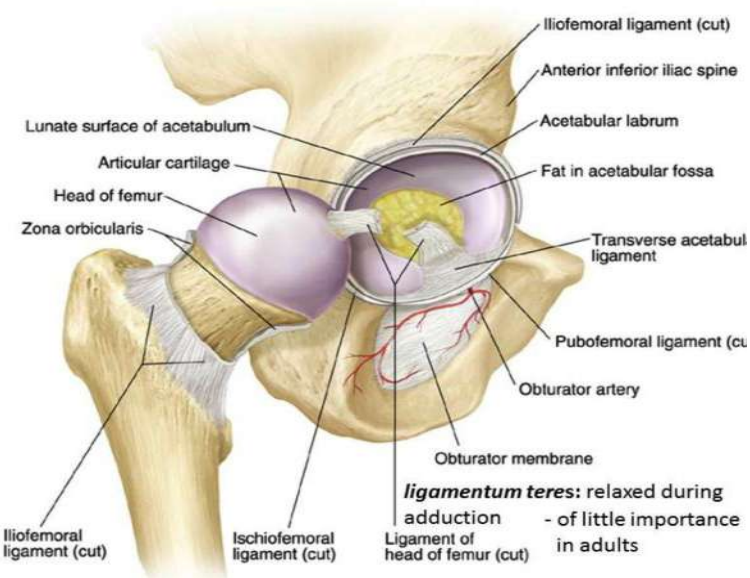

Figure (1): The hip joint. The femoral head is dislocated to demonstrate the articular surface of the acetabulum.[13]

A. Acetabulum:

The acetabulum can be described as an incomplete hemispherical socket with an inverted horseshoe-shaped articular surface surrounding the non articular cotyloid fossa.(14) This articular surface is supported by two columns of bone, described by as an inverted Y.(15)

The anterior column is composed of the bone of the iliac crest, the iliac spines, the anterior half of the acetabulum, and the pubis(15).

The posterior column is the ischium, the ischial spine, the posterior half of the acetabulum, the dense bone forming the sciatic notch.(15)

The dome, or roof, of the acetabulum is the weight bearing portion of articular surface that support the femoral head. The labrum and transverse acetabular ligament form a complete ring around the acetabulum, deepening the acetabulum cavity.(16)

Direction and position of the acetabulum:

The acetabulum is always facing forward, with an average anteversion of 7° in the newborn (females slightly exceeding males by an average of 5°). The acetabular anteversion increase with age, the average acetabular anteversion in adult is 17°.(17)

B. The proximal femur:

The femoral side of the hip is made up of the femoral head with its articular cartilage, and the femoral neck, which connect the head to the shaft in the region of the lesser and greater trochanters.

The synovial membrane incorporates the entire femoral head and the anterior neck, but only the proximal half of the neck posteriorly.[18]

i. __Femoral head:__

The femoral head forms about two- third of a sphere and joints the neck at the subcapital sulcus. Neither the femoral head nor the articular acetabular surface is completely spherical.[13]

Femoral head growth rates are not linear but more rapid in early life. The decline in growth rate of the normal head is most likely paralleled by a similar decline in acetabular growth.

The diameter of the femoral head ranges from 40 to 60 mm at maturity depending on the size of the individual**.**

The thickness of the articular cartilage varies from 4 mm at the apex of the head to 3 mm at the periphery.[14]

ii. __Femoral neck:__

The shape and size of femoral necks vary widely, for example there is a large discrepancy between those seen in small Asians and those in large blacks.[19]

The alignment of the femoral neck must be considered in the vertical plane (angle inclination) and sagittal plane angle of torsion. The angle of inclination, or neck – shaft angle, is found to be of 145° – 150° at birth and gradually diminishes with skeletal growth to an angle of 90°- 135° in the adult figure (2).[19]

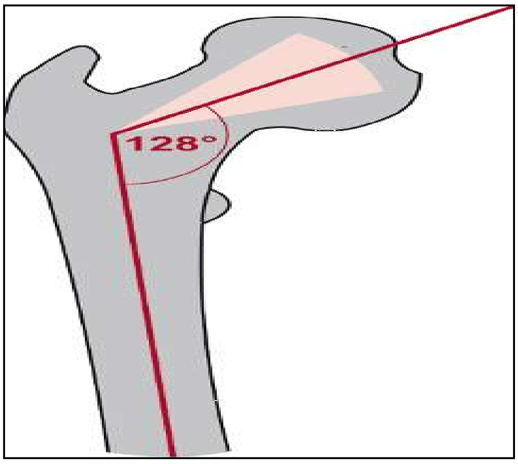

Figure (2): Measurement of the neck-shaft angle: The center of the femoral head is located with the aid of a circular template. The center of the femoral neck is also determined at its narrowest point. The two points are joined, and the resulting straight line forms the femoral neck axis. The angle formed by this line with the shaft axis constitutes the neck-shaft angle (the colored zone shows the normal range).[19]

The average angle of femoral torsion (anteversion) at birth is 35°. It becomes gradually reduced by tension of the capsule to 10-15 degrees. In contrast with the medial side of the neck as seen on an anteroposterior (AP) radiograph of the hip, the calcar femoral is a dense plate of bone that originates from the posterior medial portion of the femoral shaft, where it blends into the neck of the femur and extend superiorly toward the greater trochanter, fusing with the posterior cortex of the femoral neck, it is more of a posterior than a medial structure.[19]

Blood supply to the femoral head: figure (3)

The vascular supply to the femoral head arises from three sources. In the majority of persons, the major blood supply to the head comes via the *lateral epiphyseal vessels*, which penetrate into the bone of the femoral head at its junction with the neck.[20]

These vessels are supplied by the *synovial intracapsular arterial ring*, which derives from the ascending cervical arteries running beneath the synovium of the femoral neck. These vessels originate from *the extracapsular arterial ring* which is primarily the termination of the ***medial femoral circumflex artery*** on the posterior aspect of the hip along the intertrochanteric basicervical line.[20]

The lateral femoral circumflex artery on the anterior aspect of the neck also contributes to this blood supply. However, the medical circumflex artery usually dominates.

The artery of the ligamentum teres usually originates from the anterior obturator artery but it contributes to the blood supply of only a small area of the femoral head near the attachment of the ligamentum teres. *The interosseous cervical vessels* derived from the femoral neck also penetrate into the femoral head but are not the major blood supply.[20]

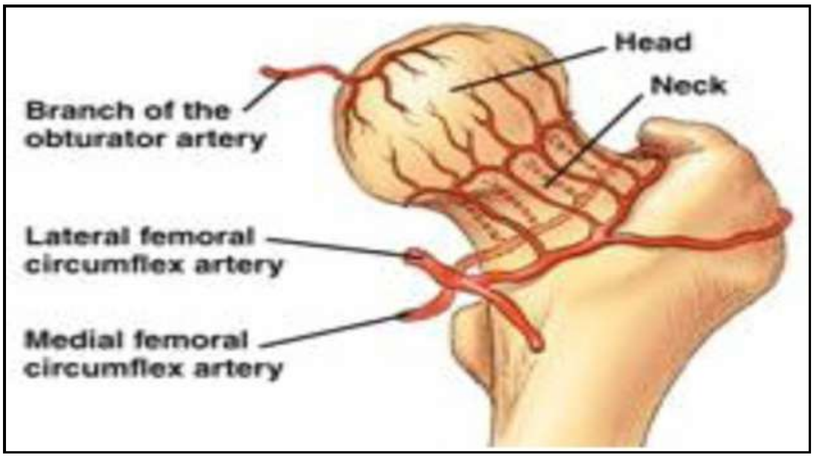

Figure (3): The hip joint. Blood supply of head of femur.[20]

II. Hip pathology with cerebral palsy

Introduction

The newborn child with cerebral palsy usually has no deformities or musculoskeletal abnormalities at birth. Scoliosis, dislocation of the hip and fixed contractures develop during the rapid growth of childhood. A combination of muscle imbalance and bony deformity leads to progressive dysplasia.[21]

There are many contracture patterns around the hip associated with cerebral palsy including:

1- Hip subluxation /dislocation.
2- Windblown hips.
3- Hip flexion contracture, hyperabducted & extended hip deformities.
4- Anteversion, coxa valga & internal rotation.
5- Hypotonic hip disease.