EPIPHYSEAL DISTRACTION
FOR LIMB LENGTHENING

ESSAY

Submitted for partial fulfillment of the requirements
for master degree of orthopaedic surgery

BY

WALEED HUSSEIN YOUSEF
M.B.B.Ch.

UNDER SUPERVISION OF

Prof. Dr. EZZAT M. EL HAWI
Professor of orthopaedic surgery
Faculty of medicine
Ain Shams University

Dr. AHMED HASSAN YOUSRI
Lecturer of orthopaedic surgery
Faculty of medicine
Ain Shams University

Faculty of medicine
Ain Shams University
2010

Acknowledgment

First thanks to Allah,

It is pleasure to thanks Prof. Dr. Ezzat Mohamad El Hawi who gave me great support not only to finish this work but also to grow my experience in orthopaedic surgery.

I wish to to express my deepest thanks to Dr. Ahmed Hassan yousry who gave me a lot of his time and effort.

Finally, I am so grateful to my professors, colleagues and my wife.

Aim of the Work:

To evaluate epiphyseal distraction as a method for limb lengthening and to discuss its side effects, its complications and compare it with other methods for limb lengthening.

The list of Tables

The list of Figures

INTRODUCTION

Limb length discrepancy is a frequent and complex problem in pediatric orthopedics. In the past, not all the limb discrepancies were operatively treated by lengthening. Observation, shoe lifts and epiphysiolysis were all options that were used. This is no longer the case as the different lengthening techniques are now better understood and more widely used. Of the many methods of limb elongation, lengthening by physeal distraction is among the newest. It is a good method for moderate and simple limb lengthening. (1)

The choice of the method of limb lengthening is still controversial as needs further investigations. If a simultaneous deformity correction and limb lengthening requires joint-neighboring, the best methods are distraction epiphysiolysis and metaphyseal lengthening. It is common that during limb lengthening the angular deformity correction is performed at the same time. (2)

Limb length inequality is more than simple skeletal shortening. The adjacent soft tissues, including neurovascular structures, are all involved and have to be carefully considered in contemplating a corrective procedure. The aetiology of shortening may be congenital, traumatic or infectious. Infrequently tumours or the treatment of a malignancy may affect growth. (1)

Epiphyseal distraction can be classified into two types, chondrodiatasis and distraction epiphysiolysis.

De Bastiani el al in 1979 gave the name chondrodiatasis" to the slower type of epiphyseal lengthening that results in controlled,

symmetric distraction. Chondrodiatasis can be performed with safety throughout the entire growth period beginning at an age when the patient can actively cooperate with the treatment. (3)

In 1969 llizarov and Soibelman of the Soviet Union reported limb lengthening by distraction epiphysiolysis , in which transverse fracture separation of the by epiphyseal plate is induced by distracting the growth plate with a modified external fixator.

Transepiphyseal distraction is used frequently for correction leg length inequality in the skeletally immature. It is especially appropriate for correction of leg-length inequality with associated deformity close to the epiphysis. There are still some areas for concern with this type of procedure, the main one being the influence of the distraction upon further growth of the distracted physis. (5)

Maturity of the epiphysis however, be difficult to assess; epiphyseal distraction may be performed either too early, which may lead to subsequent loss of length due to fracture of the plate or too late, so that very large potentially damaging distraction forces may have to be used. Hence, if the process of chondrodiatasis is possible in patient close to skeletal maturity, it should be advantageous. (5)

The biology of physeal distraction consists of three stages, which are well differentiated. Firstly; the physeal fracture gives place to a hematoma which, in approximately three weeks, is substituted by collagen fibers. Once fibrous tissue substitutes the hematoma, it begins to ossify at its upper and lower ends and in the periphery as well. The type of ossification observed there is a direct one which goes from fibrous tissue to bone tissue with no intermediate cartilaginous cell. This process

is more reminiscent of "desmal" ossification than "endochondral ossification". [6]

Frank and coauthors (1990) compared distraction epiphysiolysis and metaphyseal corticotomy, and analysed their advantages and disadvantages. They concluded that the main goal of metaphyseal lengthening was to avoid premature closure of the growth cartilage that occurs during distraction epiphysiolysis, metaphyseal lengthening can be done throughout childhood. After metaphyseal lengthening is achived the epiphyseal cartilage started to function in all patients and premature growth cartilage fusion was not observed during follow-up, the authors suggested that physeal distraction is a good method for moderate and simple limb lengthening. [7]

The possibility of non destructive epiphyseal lengthening is of considerable interest since there is some disagreement in published reports about epiphyseal function after distraction. Premature epiphyseal fusion has been noted, but Jani (1975) reported disturbance of growth plate architecture with no alteration in function. This has been confirmed by Sledage and Noble (1978). [4]

More recently this work has been repeated by De Bastiani et al (1986b); they recommended a fixed rate of distraction 0.25mm twice daily as that needed to achieve non destructive lengthening. [8]

The technique has significant advantages over other correction methods that involve osteotomies. Despite this fact, surgeons are often reluctant to use it. This is due mainly to concerns regarding the long-term viability of the growth plate and the effects of screws placed in the epiphysis. [3]

The most common applications for epiphyseal distraction are bone lengthening due to congenital deficiencies of long bones, post traumatic injuries with bone defects and infected bone loss. Epiphyseal distraction can be used in correction of angular deformities and preservation of epiphysis after tumoral resection in benign tumors where an en-block resection is indicated. [9]

Epiphyseal distraction is preformed using external fixation, which can be unilateral or circular (ring) external fixator. Examples of unilateral external fixators are: Orthofix fixator, Wanger device, Mefsto external fixator. The circular external fixators as llizarov apparatus consist of complete or partial rings attached to each other by longitudinal threaded rods allowing gradual separation of the rings and their attached wires thus allowing lengthening the bone .[10]

Bone lengthening by distraction epiphysiolysis can be considered a feasible alternative to invasive methods; the process is easy to perform and minimally traumatic. The only surgical intervention involved is the application of the distraction apparatus by means of Kirschner wires which pierce the skin, soft tissues and bone; thus no dissection is required. In the application of this method for clinical practice, the chief obstacle has been a psychological resistance against inducing a fracture in growing cartilage. [9]

Epiphyseal distraction leaves minimal scars; there is no risk of infection of the lengthened segment, and always reossifies spontaneously. Reported complications are generally those of limb lengthening techniques such as pin –tract infection, deformity during the lengthening procedure especially with distraction epiphysiolysis and delay until it is

safe to bear weight but the main specific complication is affection of the growth potential due to fracture through the distracted physis. [5]

Paley (1990) Classified complications into major and minor complications. Major complications included appearance of pseudoarthrosis, delayed regeneration, fracture or deformity of the regenerate, ankylosis or subluxation of the joint and osteomyelitis. Minor complications were minimal loss of lengthening, equines deformity, and superficial infection around pins, transient signs of nerve stretching and swelling. The rate of major complications was 20.6% and that minor complications was 10.6%, altogether 31.2%. [11]

Indications of Epiphyseal Distraction

Epiphyseal distraction is a technique to correct short and/or angulated limbs in a single operation while the epiphyseal cartilage is still open before skeletal maturity. The causes of short limbs in which epiphyseal distraction can be used are either congenital or acquired.

Congenital Causes

These are classified into diseases causing bilateral shortening and those causing unilateral shortening leading to limb length discrepancy.

Causes of bilateral shortening **:**[12]

1) Achondroplasia

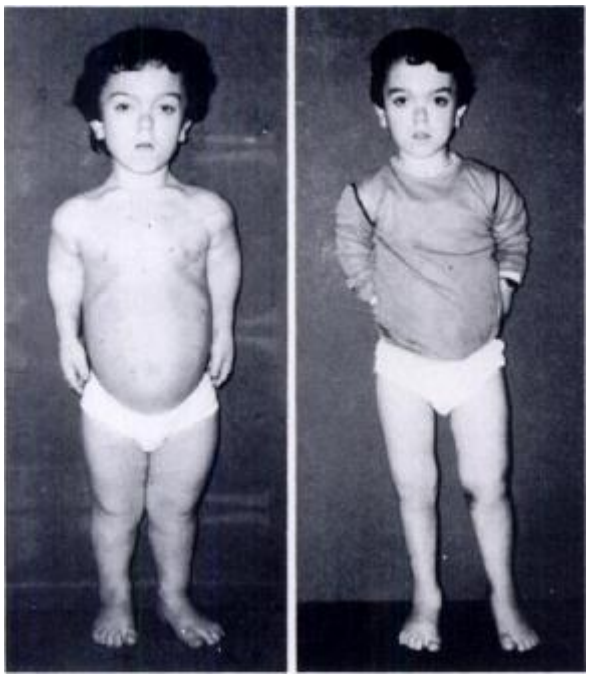
Achondroplasia is the most common form of dwarfism (Fig.1); histology reveals disturbed endochondral ossification, without affection of intramembranous bone formation. Pathologic study of the growth plate shows marked abnormalities in the zone of hypertrophy, with loss of normal columnation of chondrocytes and accumulation of excess matrix. Periosteal bone formation is histologically normal. Additionally, the epiphysis itself is not affected by the dysplasia.

2) Dyschondrosteosis

In this disorder there is disproportional shortening of the limbs, but it mainly affects the middle segments of the forearm and the legs

3) Metaphyseal chondrodysplasia

This term describes a type of short limbed dwarfism in which the epiphyses are unaffected but metaphyseal segments adjacent to the growth plates are broadened and mildly scalloped.



(A) (B)

Fig. 1 An achondroplastic patient aged I 3 years 2 months at the beginning of treatment. (A)Clinical appearance before treatment (B) after 16.5cm lengthening of both legs.[12]

4) Multiple epiphyseal dysplasia

This disorder is characterized by abnormal development and ossification of the epiphyses, resulting in distortion of the bone ends. There is wide spread involvement. The limb length may be affected. The radiological changes are apparent from early childhood. Epiphyseal ossification is delayed and when it appears it is irregular or abnormal in outline.

***Causes of unilateral shortening*: [13]**

1) Proximal focal femoral deficiency (PFFD) : which consists of a partial skeletal defect in the proximal femur (Fig. 2) with unstable hip joint, shortening, and associated other anomalies as club foot and spinal dysphasia. There are many classifications of PFFD but the earliest

classification is Aitken's four-part classification which divided the condition into 4 classes:

Class A:

There is normal acetabulum and femoral head with shortening of the femur and absence of the femoral neck.

Class B:

Acetabulum is present but femoral head is more rudimentary and defiency of proximal femoral shaft is more significant.

Class C:

Acetabulum is shallow, femoral head is absent and proximal femur is represented only by small tuft.

Class D:

Acetabulum and femoral head are absent and deficiency of femoral shaft is more significant.

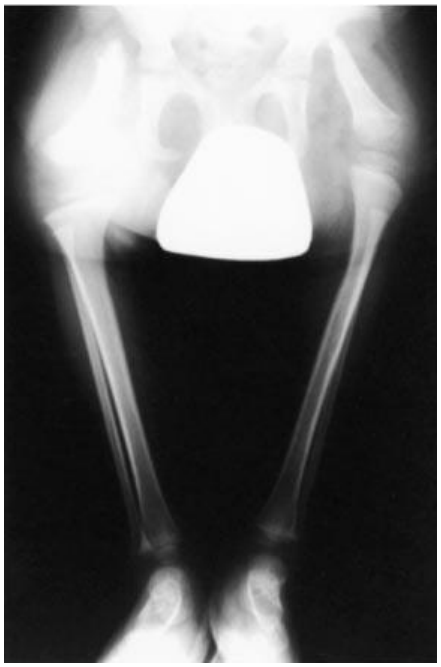


Fig. 2 Severe bilateral proximal femoral focal deficiency in 3-year-old boy; note total lack of formation of acetabulum.[13]