# FEMORAL OVERGROWTH FOLLOWING SURGICAL TREATMENT OF LONG-ESTABLISHED DYSPLASIA OF THE HIP

*João Paulo Freire Martins de Moura, Renato de Figueiredo Radaeli, Oreste Lemos Carrazone, Eiffel Tsuyoshi Dobashi, Carlo Milani, Akira Ishida*


## ABSTRACT

*Objective:* To measure femoral overgrowth using radiographic scanning in patients with long-established Developmental Dysplasia of the Hip treated with femoral shaft shortening, open reduction and acetabuloplasty. *Methods:* We studied 30 children (33 hips) submitted to surgical treatment including femoral shaft shortening, open reduction according to Scaglietti & Calandriello's procedure and Salter acetabuloplasty without preliminary traction. There were 29 females and 1 male, with mean age = 4 years and 5 months at the time of operation. According to Zionts & MacEwen's classification, 23 hips were classified as type III (69.6%), 5 (15.2%) as type I and 5 (15.2%) as type II. The average femoral shortening was 45.12 mm (range: 30.00 mm to 80.00 mm). The mean follow-up time was 10 years and 2 months (range: 2 years and 3 months to 18 years) and we noticed a mean femoral discrepancy of 13.48mm (range: 0.00 mm to 60.00 mm) using plain scanning images. *Results:* All patients evolved to femoral overgrowth; in 18 cases (54.6%), the leg length discrepancy found was <30 mm, 11 (33.3%) showed no LLD, and 4 (12.1%) presented with a discrepancy >30mm. *Conclusion:* We noticed a significantly decreased discrepancy of femurs after surgical treatment when compared to the measurements obtained during outpatient follow-up.


**Keywords:** *Hip dislocation, congenital. Osteotomy. Surgery. Radiography. Evaluation. Follow-up studies.*

**Citation:** *Moura JPFM, Radaeli RF, Carrazone OL, Dobashi ET, Milani C, Ishida A. Femoral overgrowth following surgical treatment of long-established dysplasia of the hip. Acta Ortop Bras. [online]. 2009; 17(3):139-43. Available from URL: http://www.scielo.br/aob*

## INTRODUCTION

Among the therapeutic modalities for treating long-established Developmental Dysplasia of the Hip, there are authors who advocate the use of bloodless reduction[1-3], and others advocating surgical treatment[4-6] for this condition.

Regardless of the selected method, the applied approach should target the reestablishment of the anatomy and biomechanics of the thigh-femur joint in a less traumatic way, preventing complications, particularly the avascular necrosis of the proximal femoral epiphysis[3], allowing patients to reach to mid-age before the first signs of thigh-femur degeneration are noticed. Children with DDH reaching the age of gait untreated will show permanent morphologic and X-ray changes later in life.

The ANPFE would be caused by an increased pressure of the acetabulum over the hyaline cartilage of the femoral epiphysis[7] due to: an unstable reduction or to extreme positions of internal rotation and abduction, as well as vascular changes.[8,9]

Femoral shortening is regarded as one of the key resources in the treatment of long-established dislocations, facilitating the reduction of proximal epiphysis on the acetabulum and minimizing avascular necrosis rates.[10] However, there are no references regarding the size of femoral fragment to be resectioned. Some authors presented methods to calculate femoral ostectomies.[10] We didn't find references in literature about the functional consequences caused by anisomelia resulting from this procedure.

The present study was carried out aiming to measure through scan images the length of lower limbs of patients living with long-established DDH submitted to surgical treatment by femoral shortening, bloody reduction and Salter acetabuloplasty.[11] Early postoperative anisomelia resulting from femoral shortening surgery was assessed with scan images and compared with measurements made after at least 2 years of outpatient follow-up. Thus, residual anisomelia, when present, was assessed by taking into account: the potential for femoral overgrowth, the potential functional and cosmetic implications, and, lastly, the offset modalities and the potential future treatments. This biological response is seen in children with femoral fractures and treated with a bloodless approach, where the "bayonet" overlay is recommended between bone fragments with the purpose of avoiding future anisomelia.[12]

All the authors state no potential conflict of interest concerning this article.

***Department of Orthopaedics and Traumatology, Paulista Medical School/UNIFESP, SP, SP, Brazil***

***Correspondences to: Rua Borges Lagoa, 783 - São Paulo - SP - Brasil - CEP 04038-032. Email:joaopaulo.moura@gmail.com***

Received in: 05/02/08; approved in: 10/07/08

## MATERIALS AND METHODS

First of all, this research project was submitted to the Committee of Medical Ethics of the Federal University of São Paulo – "Paulista" Medical School for appreciation, under the registration number 485/98, which was approved.

Our study is composed by 33 hips of 30 patients with long-established congenital dislocations who were submitted to surgical treatment between November 1992 and September 1997. Regarding gender, 29 females and only one male were included in the study. Regarding ethnicity, 23 were Caucasian, and 7 were non-Caucasian. As for the affected side, we found 25 patients with unilateral condition (83.33%) and five with a bilateral condition (16.67%), where 8 (out of 10) hips had been operated. Of the 33 hips of 30 patients, 14 involved the right side, and 19 the left side. The mean age of patients at the moment of surgery was 4 years and 5 months (ranging from 1 year and 8 months to 12 years and 4 months). The mean age of patients at the moment of anisomelia assessment was 11 years and 7 months (range: 4-24 years). The follow-up time ranged from 2 years and 3 months to 18 years, with a mean time of 10 years and 2 months. We graded the severity of the dislocation of the affected hip by using the concepts described by Zionts and MacEwen[13] who classified dislocations into 3 degrees. Type III dislocations were prevalent in 23 (69.6%) hips according to the classification by Zionts and MacEwen.[13] Type I dislocations were found in 5 patients (15.2%), while Type-II dislocations were found in 5 (15.2%). (Table 1)

### Surgical methodology

We captured X-ray images of patients' acetabulum at anteroposterior and Lauenstein planes, strictly following the technical requirements.[14-16] In the preoperative planning, a millimeter-graded ecran or a radiopaque rule were attached to the chassis of the acetabular radiogram, like that used on scanning, and then X-ray images were captured at anteroposterior plane. The amount of bone segment removed from femoral shaft was quantified by measuring the distance between the upper femoral epiphysis end and the upper edge of the shutter foramen, i.e., at Gage and Winter's level +1.[17] Thus, in this patient series, a femoral shaft segment of 45.12 mm in average (range: 30 to 80 mm) was removed. Femoral shortening was provided in all patients and the osteosynthesis was performed using a small-fragment plate, with four or six holes, and cortical screws. Femoral rotation or varusing osteotomy was not associated. Therefore, as the femur was shortened, these measurements reflect preoperative anisomelia.

After reducing dislocated hips according to the recommendations by Scaglietti and Calandriello[18], the hips were submitted to Salter

**Table 1** – *Data of the 30 patients submitted to surgery (33 hips), following the numeric sequence, patients' initials, gender, ethnicity, age in months at the time of surgery on each hip, uni- or bilateral involvement, and treated side.*

| N | Gender | Ethnicity | Age | Involvement | Side | Dislocation degree | Femoral shortening (mm) | Procedures | Femoral discrepancy (mm) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F | NC | 63 | unilateral | L | III | 30 | FS + BR + SM | 20 |
| 2 | M | Cau | 33 | unilateral | L | II | 30 | FS + BR + SM | 10 |
| 3 | F | Cau | 53 | unilateral | L | II | 40 | FS + BR + SM | 15 |
| 4 | F | Cau | 28 | unilateral | L | II | 30 | FS + BR + SM | 5 |
| 5 | F | Cau | 28 | unilateral | L | III | 39 | FS + BR + S | 25 |
| 6 | F | Cau | 55 | unilateral | L | III | 50 | FS + BR + SM | 20 |
| 7 | F | Cau | 113 | unilateral | R | III | 80 | FS + BR + SM | 60 |
| 8 | F | Cau | 148 | unilateral | R | I | 70 | FS + BR + C | 20 |
| 9 | F | Cau | 58 | unilateral | L | III | 40 | FS + BR + SM | 20 |
| 10 | F | NC | 20 | unilateral | R | III | 30 | FS + BR + S | 15 |
| 11 | F | Cau | 127 | unilateral | L | I | 40 | FS + BR + C | 0 |
| 12 | F | NC | 30 | bilateral | R | III | 55 | FS + BR + S | 0 |
| 13 | F | NC | 24 | bilateral | L | III | 40 | FS + BR + SM | 0 |
| 14 | F | NC | 23 | unilateral | L | III | 30 | FS + BR + SM | 0 |
| 15 | F | Cau | 60 | unilateral | L | III | 60 | FS + BR + SM | 35 |
| 16 | F | NC | 25 | unilateral | L | I | 36 | FS + BR + S | 0 |
| 17 | F | Cau | 34 | unilateral | R | III | 40 | FS + BR + SM | 0 |
| 18 | F | Cau | 86 | bilateral | R | III | 76 | FS + BR + SM | 0 |
| 19 | F | Cau | 96 | bilateral | L | III | 70 | FS + BR + SM | 15 |
| 20 | F | Cau | 25 | unilateral | R | I | 30 | FS + BR + S | 10 |
| 21 | F | Cau | 26 | unilateral | R | III | 30 | FS + BR + S | 10 |
| 22 | F | NC | 44 | unilateral | R | III | 30 | FS + BR + SM | 0 |
| 23 | F | Cau | 48 | bilateral | R | III | 42 | FS + BR + SM | 35 |
| 24 | F | Cau | 36 | bilateral | L | III | 48 | FS + BR + S | 0 |
| 25 | F | Cau | 46 | unilateral | R | III | 55 | FS + BR + SM | 10 |
| 26 | F | Cau | 102 | unilateral | R | I | 65 | FS + BR + C | 35 |
| 27 | F | Cau | 71 | unilateral | L | III | 60 | FS + BR + S | 20 |
| 28 | F | Cau | 87 | unilateral | R | III | 60 | FS + BR + SM | 20 |
| 29 | F | NC | 28 | unilateral | L | II | 30 | FS + BR + S | 10 |
| 30 | F | Cau | 38 | unilateral | L | III | 43 | FS + BR + S | 0 |
| 31 | F | NC | 35 | unilateral | L | III | 50 | FS + BR + S | 20 |
| 32 | F | Cau | 27 | unilateral | L | III | 30 | FS + BR + SM | 5 |
| 33 | F | Cau | 28 | unilateral | R | II | 30 | FS + BR + SM | 0 |

Table labels 1: C – Chiari osteotomy[22]; FS – Femoral Shortening; N – Sequential number; BR – Bloody Reduction; S – Salter osteotomy[11]; SM – Salter osteotomy[11], **modified** osteotomy[11] as classically described and modified by the author. Instead of using a graft from the iliac wing, we used the resectioned femoral bone segment. In 11 hips, Salter osteotomy was performed[11]; in 19 hips, the modified[10,19-21] Salter surgery[11]; and, in three, the Chiari surgery was performed.[22]

Between six and eight weeks, in average, immobilization was removed and the rehabilitation of the operated hip could be initiated under the guidance of physical therapists. The Kirschner wires fixating the bone graft were removed after full union with the adjacent bone tissue or when Chiari osteotomy[22] showed evidences of union. From that moment on, gait with support was allowed.

### Methodology for X-ray evaluation

We applied the classification described by Kalamchi and MacEwen[23] who sorted the avascular necrosis of proximal femur into four groups: GROUP I – ossification nucleus changes; GROUP II – compromised lateral physis; GROUP III – injury on central physis; GROUP IV – full injury of femoral epiphysis and physis.

All patients were submitted to X-ray evaluation (scan) to determine length discrepancy between both lower limbs after at least two years of dislocation treatment. From the measurement in millimeters of the shortened femoral segment compared to late postoperative measurements, we could determine how the overgrowth phenomenon could minimize the effects caused by femoral ostectomy. (Table 2)

### Statistical method

For the analysis of results, parametric and non-parametric statistic tests have been used, taking into account the nature of distributions and of the variables studied: Chi-squared test, Fischer's exact test, Mann-Whitney test. In all tests, the null hypothesis rejection level adopted was 0.05 or 5%, marking significant results with an asterisk.

## RESULTS

All femurs evolved with overgrowth, with 18 cases (54.6%) showing anisomelia < 30 mm, 11 (33.3%) achieving comparable lengths, and 4 (12.1%) showed discrepancy > 30 mm.

We built Table 2 with the purpose of showing the intraoperative measurements of the resectioned femoral segment and the measurements of femoral discrepancy observed on late postoperative period.

We distributed the patients on Table 3 according to determined age groups, considering absolute frequency, relative frequency, cumulative frequency, cumulative percentage, and the formula employed for obtaining the decrease percentage. As we found only two hips that were included in the age group of zero to two years old, these were incorporated to the interval between two and four years.

On Table 4, the 33 hips of the 30 patients are distributed according to the age group and considering the following variables: femoral shortening, femoral discrepancy, and the difference between these variables, mean value for the measurements, standard deviation of minimum and maximum values, and of the statistical analysis result. Therefore, we noticed that the three age groups showed a significant decrease ($p=0.001^*$). When the groups are compared to each other, we can see a significant difference concerning this decrease ($p=0.0042^*$). We found that the age group between four and six years significantly differ from the other, where the ages of which are below four years ($p<0.05^*$). The group composed by children in the age group of four to six years shows a lower

**Table 2** – *Distribution of the 33 hips of the 30 patients considering the ostectomized segment of the femur, femoral discrepancy, mean, standard deviation, median, minimum and maximum values.*

| | Total | Mean | Standard Deviation | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|
| **Femoral shortening** | 33 | 45.12 | 15.31 | 40.00 | 30.00 | 80.00 |
| **Femoral discrepancy** | 33 | 13.48 | 14.17 | 10.00 | 0.00 | 60.00 |

**Table 3** – *Distribution of patients according to age groups, considering absolute frequency, relative frequency, cumulative frequency, cumulative percentage and the formula employed to obtain the decrease percentage.*

| Age (years) | Frequency | % | Cumulative frequency | Cumulative % |
|---|---|---|---|---|
| 0-2 | 2 | 6.1 | 2 | 6.1 |
| 2-4 | 17 | 51.5 | 19 | 57.6 |
| 4-6 | 7 | 21.20 | 26 | 78.80 |
| ≥6 | 7 | 21.20 | 33 | 100.00 |

**Table 4 –** *Distribution of the 33 hips of the 30 patients by age groups, variables (femoral shortening, femoral discrepancy, and the difference between these variables); mean value for the measurements, standard deviation, minimum and maximum values, and result of the statistical analysis.*

| Age (years) | Total | Variable | Mean | Standard Deviation | Minimum (mm) | Maximum (mm) |
|---|---|---|---|---|---|---|
| | | Shortening | 37.16 | 9.09 | 30.00 | 55.00 |
| 0-4 | 19 | Discrepancy | 6.32 | 7.61 | 0.00 | 25.00 |
| | | Difference | -82.16 | 20.40 | -100.00 | -35.90 |
| | | Shortening | 46.00 | 11.20 | 30.00 | 60.00 |
| 4-6 | 7 | Discrepancy | 25.00 | 8.16 | 15.00 | 35.00 |
| | | Difference | -44.40 | 17.19 | -66.67 | -16.67 |
| | | Shortening | 65.86 | 13.17 | 40.00 | 80.00 |
| >=6 | 7 | Discrepancy | 21.43 | 20.96 | 0.00 | 60.00 |
| | | Difference | -69.69 | 27.32 | -100.00 | -25.00 |

*The three age groups show a significant decrease (p=0.001*). A significant difference is found concerning such decrease (p=0.0042*).*

decrease compared to the one composed by children below the age of four.

X-ray evaluation of anisomelia between lower limbs after surgical treatment showed an average of 16.5 mm, ranging from 0 mm to 70 mm. Twenty-two patients (73.3%) evolved with a shortening smaller or equal to 25 mm, seven (23.3%) had a shortening above 25 mm and below or equal to 50 mm, and only one had a shortening above 50 mm.

## DISCUSSION

The most feared complication after femoral epiphysis reduction on the acetabulum of patients with DDH is avascular necrosis. Femoral shortening is provided with the purpose of allowing an appropriate reduction, though not leading to an increased pressure over the hyaline cartilage of the joint.

The goal of long-lasting DDH treatment is to reestablish the biomechanics and anatomy of the thigh-femur joint. Based on this principle, we noticed a strong concern in literature among investigators with detecting this condition as early as possible.

There is a challenge involving children living with this malformation, which is the difficulty to find an optimal solution, because hip joint shows anatomicopathological changes with several involvement levels, some of them definitive. Therefore, orthopaedic literature is divided, because there are authors that are in favor of bloodless treatment, even in older children. according to these authors, the methodology would be less aggressive and would provide a good remodeling of the involved structures.

Those in favor of surgical treatment claim that the incorporated anatomical changes would not be recovered without acetabular repositioning and the surgical removal of intra- and extra-joint barriers.[24]

In addition to allow a smooth reduction of the femoral head on the acetabulum, the femoral ostectomy provides, when necessary, correction of femoral anteversion and severe valgus.

The degree of dislocation according to Zionts and MacEwen[13] was predominantly type III (23 hips – 69.6%). This shows more severe dislocations in our sample, therefore, the measurements of the femoral fragment removed were bigger in order to facilitate the reduction of dislocated hips and to reduce the incidence of femoral head necrosis.

Although the critical importance of femoral shortening in these cases, this procedure must follow a careful surgical technique. Complications such as postoperative infection, internal fixation failure between bone fragments, delayed union and pseudoarthrosis, angle and rotational deviations, neurovascular injuries, and postoperative muscular weakness are mentioned. The latter, although frequent, is usually temporary, with a full functional recovery by implementing an appropriate physiotherapeutic program and by applying exercises and increasingly strong physical activities. None of the mentioned complications were found in our series.

After a follow-up period ranging from 2 years and 3 months to 18 years (mean: 10 years and two months) we noticed that the shortening of the limb was offset due to femoral overgrowth, with anisomelia returning from 43.3 mm in average to 16.5 mm (range: 0 mm to 70 mm). The overgrowth phenomenon would be caused by an increased vascularization of the hypertrophic layer of the proximal and distal growth physis.

Literature reports that discrepancies below 30 mm, can usually be treated by wearing higher shoes or offset palms and achieving excellent functional results. Approximately 50% of the patients can be benefited by wearing offset mechanisms in the shoes. Gross[25] says that differences below 20 mm do not require treatment. Ambulation for patients with up to 20 mm of anisomelia does not present change on the gait laboratory analysis compared to the general population.[26] Gait would reach a favorable biomechanical condition, since the physiologic mechanisms such as pelvic bending, scoliosis and lower mobilization of the mass center would give rise to a functional offset mechanism. The great majority (73.3%) of the patients included in this study showed a shortening smaller or equal to 25 mm. Laboratory analysis of the gait was not performed in this study.

A difference of 25 mm to 50 mm between limbs is preferably treated with surgical procedures. Bloodless treatment for such a big discrepancy would require great offset mechanisms in the shoe and also in the sole, being cosmetically inferior. Thus, the patient would then be rather to undergo surgical treatment despite of the inherent risks. Among the methods described on literature, we found the epiphysiodesis, the contralateral femoral shortening and bone elongation. There are some contraindications to the use of epiphysiodesis or bone shortening procedures, such as in patients having shortening and angle deformity or short height. In shorter patients, an increased height reduction would compromise patient's appearance and self-esteem. Patients with shortening in this measurement range in our study (23.3%) are included in a limb equalization program, with the surgical methodology being preferred in this service by femoral elongation by corticotomy and use of Ilizarov's rounded external fixator following the criteria of Moseley's straight line graph.

Patients with discrepancies of the lower limbs above 50 -60 mm should be treated with the ipsilateral elongation of the member affected by DDH or by contralateral bone shortening, as described by literature. Amputation and/or replacement with prostheses should be saved to very specific circumstances when patients cannot be treated by other methods. Currently, the application of the Ilizarov's technique provides a safe elongation of the limb when performed by qualified surgeons. However, there are some disadvantages in employing this method such as: joint shrinkage, joint dislocation or subdislocation on unstable hips or with insufficient acetabular coverage, muscular weakness by muscle transfixation, vascular and nervous injury, deformation or delay on bony regenerate formation, and, mostly, infection on pin's path. Good results can be achieved in those patients showing great discrepancies by combining limb elongation with Ilizarov's technique and contralateral epiphysiodesis.

Despite of having been submitted to a femoral shortening of 80 mm, one of the patients evolved with a discrepancy of as much as 70 mm between limbs. By reviewing the postoperative X-ray images, we found that the patient had a serious avascular necrosis involving the whole femoral head and a portion of proximal physis (type III, according to the classification by Bucholz and Ogden[27]). The dislocation degree was also more serious (Type III), and this patient was a little too old for this kind of disease. We believe that these factors were significant for compromising longitudinal growth of the limb. It must also be reminded that a careful surgical technique must be employed, because an excessive dissection of soft tissues can lead to an extensive circulatory injury. Even the use of preoperative traction causing a stretching of soft tissues should be considered in the genesis of avascular necrosis of the proximal femoral epiphysis. We didn't use previous traction because of the social and economic status of patients that usually seek our service; so, the surgical procedures were performed in a single step.

We can conclude by this study that the femoral shortening technique intended to reduce the rates of avascular necrosis of the proximal epiphysis may course with anisomelia directly related to a femoral segment removal. The progressive minimization of this effect is explained by the bone overgrowth phenomenon frequently seen in femoral fractures of childhood treated by using a bloodless approach, the obtained reduction of which was anatomical. Although most of the patients is included in the group with discrepancies smaller than 25 mm, this should be further discussed, because we still don't accurately know which the smaller measurement would assure the low avascular necrosis rates established by bloody reduction with acetabuloplasty preceded by femoral shortening. Therefore, the minimum limits for shortening must be exhaustively studied, because the risks of avascular necrosis can be avoided, as well as the risks associated to surgical procedures for lower limbs equalization.

## REFERENCES


1. Krämer J, Schleberger R, Steffen R. Closed reduction by two-phase skin traction and functional splinting in mitigated abduction for treatment of congenital dislocation of the hip. Clin Orthop Relat Res. 1990;(258):27-32.
2. Yamada N, Maeda S, Fujii G, Kita A, Funayama K, Kokubun S. Closed reduction of developmental dislocation of the hip by prolonged traction. J Bone Joint Surg Br. 2003; 85:1173-7.
3. Brougham DI, Broughton NS, Cole WG, Menelaus MB. Avascular necrosis following closed reduction of congenital dislocation of the hip: review of influencing factors and long-term follow-up. J Bone Joint Surg Br. 1990;72:557-62.
4. Berkeley ME, Dickson JH, Cain TE, Donovan, MM. Surgical therapy for congenital dislocation of the hip in patients who are twelve to thirty six months old. J Bone Joint Surg Am. 1984;66:412-20.
5. Dobashi ET, Kiyohara RT, Matsuda MM, Milani C, Kuwagima SS, Ishida A. Tratamento cirúrgico do quadril displásico inveterado. Acta Ortop Bras. 2006;14:183-9.
6. Dhar S, Taylor JF, Jones WA, Owen R. Early open reduction for congenital dislocation of the hip. J Bone Joint Surg Br. 1990;72:175-80.
7. Ogden JA. Anatomic and histologic study of factors affecting development and evolution of avascular necrosis in congenital hip dislocation. In: The hip: Proccedings of the second open scientific meeting of the Hip Society. St. Louis: C.V. Mosby; 1974. p.125-53.
8. Chung SMK. The arterial supply of the developing proximal end of the human femur. J Bone Joint Surg Am. 1976;58:961-70.
9. Trueta J; Amato VP. The avascular contribution to osteogenesis. III. Changes in the growth cartilage caused by experimentally induced ischemic. J Bone Joint Surg Br. 1960;42:571-87.
10. Milani C, Ishida A, Laredo Filho J, Napoli MMM, Kuwajima SS, Dobashi ET, Adames MK. Avaliação do índice de necrose avascular na luxação congênita do quadril inveterada pelo encurtamento femoral e acetabuloplastia de Salter modificada. Rev Bras Ortop. 1996;31:67-74.
11. Salter RB. Innominate osteotomy in the treatment of congenital dislocation of the hip. J Bone Joint Surg Br. 1961;43:518-39.
12. Etchebehere EC, Caron M, Pereira JA, Lima MC, Santos AO, Ramos CD et al. Activation of the growth plates on three-phase bone scintigraphy: the explanation for the overgrowth of fractured femurs. Eur J Nucl Med. 2001;28:72-80.
13. Zionts LE, MacEwen GD. Treatment of congenital dislocation of the hip in children between the ages of one and three years. J Bone Joint Surg Am. 1986;68:829-46.
14. Tönnis D. Normal values of the hip joint for the evaluation of X-rays in children and adults. Clin Orthop Relat Res. 1976;(119):39-47.
15. Traina GC. Congenital dislocation of the hip: a protocol for early diagnosis. Ital J Orthop Traumatol. 1989;15:393-9.
16. Albiñana J, Morcuende JA, Delgado R, Weinstein SL. Radiologic pelvic asymmetry in unilateral late-diagnosed developmental dysplasia of the hip. J Pediatr Orthop. 1995;15:753-62.
17. Gage JR; Winter RB. Avascular necrosis of the capital femoral epiphysis as a complication of closed reduction of congenital dislocation of the hip. J Bone Joint Surg Am.1972;54:373-88.
18. Scagglietti O. Calandriello B. La riduzione cruenta della lussazione congenita dell'anca. Relazione nº 8 Congresso della Societá Internazionale di Chirurgia Ortopedica e Traumatologia, New York, 1960.
19. Milani C, Ishida A, Laredo Filho J, Napoli MMM, Kuwajima SS, Dobashi ET et al. MK, Tratamento cirúrgico da luxação congênita do quadril inveterada pelo encurtamento femoral e acetabuloplastia de Salter modificada. Rev Bras Ortop. 1996;31:1-10.
20. Milani C, Ishida A, Lourenço A, Kuwajima SS, Dobashi ET, Damaceno FL. Estudo comparativo da freqüência da necrose avascular da cabeça femoral no tratamento cirúrgico da luxação congênita do quadril com e sem osteotomia de encurtamento do fêmur. Rev Bras Ortop. 1995;30:21-4.
21. Milani C, Ishida A, Pinto JA, Dobashi ET, Viveiros MEM. Avaliação clínica e radiográfica de pacientes com luxação congênita inveterada do quadril submetidos ao tratamento cirúrgico. Rev Bras Ortop. 1999;34:27-36.
22. Chiari K. Beckenosteotomie zur pfannendachplastik. Wien Med Wochenschr. 1953; 103:707-14.
23. Kalamchi A, MacEwen GD. Avascular necrosis following treatment of congenital dislocation of the hip. J Bone Joint Surg Am. 1980;62:876-88.
24. Klisic P, Jancovic L. Combined procedure of open reduction and shortening of the femur in treatment of congenital dislocation of the hips in older children. Clin Orthop Relat Res. 1976;(119):60-9.
25. Gross RH. An evaluation of tibial lengthening procedures. J Bone Joint Surg Am. 1971;53:693-700.
26. Kaufman KR, Miller LS, Sutherland DH. Gait asymmetry in patients with limb-length inequality. J Pediatr Orthop. 1996;16:144-50.
27. Bucholz RW, Ogden JA. Patterns of ischemic necrosis of the proximal femur in non-operatively treated congenital hip disease. In: The hip: Proceedings of the sixth open scientific Meetin of the Hip Society. St. Louis: C.V. Mosby; 1978. p.43-63.