Nonoperative treatment of slipped capital femoral epiphysis: a scientific study

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Abstract

Background: Treatment of the Slipped Capital Femoral Epiphysis remains a cause of concern due to the fact that the true knowledge of the etiopathogeny is unknown, as well as one of its major complications: chondrolysis. The conservative treatment remains controversial; it has been overlooked in the studies and subjected to intense criticism. The purpose of this study is to investigate the results of treatment on the hip of patients displaying slipped capital femoral epiphysis, using the plaster cast immobilization method and its link to chondrolysis.

Methods: The research was performed based on the study of the following variables: symptomatology, and the degree of slipping. A hip spica cast and bilateral short/long leg casts in abduction, internal rotation with anti-rotational bars were used for immobilizing the patient’s hip for twelve weeks. Statistical analysis was accomplished by Wilcoxon’s marked position test and by the Fisher accuracy test at a 5% level.

Results: A satisfactory result was obtained in the acute group, 70.5%; 94%; in the chronic group (chronic + acute on chronic). Regarding the degree of the slipping, a satisfactory result was obtained in 90.5% of hips tested with a mild slip; in 76% with moderate slip and 73% in the severe slip. The statistical result revealed that a significant improvement was found for flexion (p = 0.0001), abduction (p = 0.0001), internal rotation (p = 0.0001) and external rotation (p = 0.02). Chondrolysis was present in 11.3% of the hips tested. One case of pseudoarthrosis with aseptic capital necrosis was presented. There was no significant variation between age and chondrolysis (p = 1.00). Significant variation between gender/non-white patients versus chondrolysis (p = 0.031) and (p = 0.037), respectively was verified.

Conclusions: After analyzing the nonoperative treatment of slipped capital femoral epiphysis and chondrolysis, we conclude that employment of the treatment revealed that the method was functional, efficient, valid, and reproducible; it also can be used as an alternative therapeutic procedure regarding to this specific disease.

Background

The contributions and reasons for the use of the non-operative management of Slipped Capital Femoral Epiphysis (SCFE) are as follows:

- applicability: non-operative treatment of SCFE allows the use of this method at any hospital, even for surgeons who have very little hands-on experience with this specific disease;

- elucidation: the work elucidates the employment of a principle and the method of treatment little exploited by world literature;

- knowledge: this research offers the opportunity for orthopedic surgeons to employ a method based on biology, contributing to further knowledge of SCFE, thereby also promoting the possibility of a wide debate on the subject;

- reproducible: the easy use of this method allows the treatment to be repeated in other innovating medicine centers by an execution of a general procedure to a widespread application, adding value to knowledge;

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- results: the work has proven its effectiveness based on statistical data obtained, thereby demonstrating its importance and feasibility;

- therapeutic: the use of the plaster cast method revealed the possibility of obtaining favorable results for its use;

- prognosis: early diagnosis, associated with the simplicity of the SCFE method, favors a good prognosis and low morbidity for the disease.

This work posits that the benefits and application of the therapeutic criteria based on biology comprise a valid method of treatment, considering disease prognostic uncertainty.

**Patients and Methods**

The Committee of Ethics of the Jesus Children’s Hospital in Brazil, Rio de Janeiro, have analyzed and approved the Research Project entitled, Nonoperative treatment of slipped capital femoral epiphysis, which was also evaluated by the Ethics Committee for Research of the Federal University of Rio de Janeiro (UFRJ), Brazil.

The typology of the design employed in this sample was a study of a single cohort with observational, longitudinal and retrospective characteristics. In this research, chondrolysis was the dependent variable. A consecutive series of 106 hip joints in eighty-four patients affected, the great majority of them obese, displaying SCFE, were treated by means of plaster cast (Table 1 and Table 2). Patients’ age varied at the time of diagnosis, ranging from 7.6 to 15.8 years. The duration of the follow-up ranged from 12 months, with the complete growth-plate closure, to 146 months, an average of 51 months. Thirteen patients were younger than eleven, 55 patients were between the ages of 11 and 13; and 16 patients were between the ages of 13 and 16. The average age was 12.5, males having the average age of 14.5 and females 10.5. Forty-four patients were males, and 40 females. Regarding race, 43 were white, and 41 were non-white. Unilateral involvement was present in 62 left hips and 44 right hips. Bilateral displacement (simultaneous involvement) of hips was present in 19 patients. Three patients were detected as displaying involvement of the contra lateral hip in different periods (sequential bilaterality), comprising, in total, 22 bilateral slip patients.

The methods used were evaluated based on symptomaticatology, and categorized as acute, chronic, or acute on chronic, according to Fahey and O’Brien [1]; also, slip degrees were documented by the standard method of thirds and classified as mild, moderate, or severe, according to Wilson, Jacobs, Schecter [2]; MacEwen and Ramsey who use the three grades of slip percentage [3]. The hips were systematically evaluated roentgenographically, as well as functionally, according to Heyman and Herndon’s criteria [4], being also categorized as satisfactory and unsatisfactory by means of Aadalen, Weiner, Hoyt, Herdon and Herdon’s criteria [5]. The radiographic methods used to analyze joint cartilage and detect chondrolysis were based on Ingram, Clarke, Clark and Weiner’s criteria [6].

**Treatment Protocol**

The main objective of the SCFE treatment is to avoid progressive displacement, with the use of the safest and the most effective technique to arrest growth plate. The routine methodology employed was based on the conservative principle with the use of spicas (earlier cases) and bilateral short/long leg casts in abduction, and a slight internal rotation (15°) with antirotational bars (later cases), aiming at immobilizing the patient’s hip for 12 weeks.

Skin traction was used in order to avoid slip progression pre-casting in those patients displaying muscle spasms. Traction was also used to limit the patient’s motion in order to reduce pain, and to prevent irritability (pain when moved through passive or active range of motion) [7]. Skeletal traction was also applied. This type of traction was used in these patients in an attempt to improve the neck-femoral head relationship. Reduction of the degree of slip by skeletal traction was not found in this series. For this reason, this type of traction was abandoned in SCFE pre-treatment.

Anaesthesia was administered as needed in the presence of pain and/or discomfort during plaster hip spica and short/long-leg cast application, in preparation for resting the hip.

Manipulation under anesthesia was performed as an alternative procedure to improve epiphysis position. In very few cases, Leadbetter’s maneuver was gently applied prior to cast application, with the intention of improving the displacement of the neck/femoral head relationship, this being carefully carried out in chosen hips [8].

Cast immobilization was carried out for 12 weeks, in accordance with the casting protocol. No weightbearing was permitted during the “casting period”. A hip spica was used in earlier cases; as time went on, and we gained more “experience” in the matter, choice was made of changing the method of plastering to short leg casts, on account of this being an easier application, allowing the patients to set hips and knees into motion in flexion and extension, thus performing muscle exercises (dynamic method). This type of immobilization was based on King’s work, being also used to facilitate the patient’s movement in a wheelchair [9].

The criteria adopted for interruption of the plaster cast use were based on the physeal stability of the head with the femoral neck in the affected hip. Stability, which is the ability to walk without hip pain, was reached regardless of the progress and stage of the
Table 1 Data on the Patients

| Case | Age at Diagnosis (Yrs.) | Sex* | Race | Hip Treated | Classification | Grade of Slip | Type of Traction | Time in cast (Days) | Type of cast | Follow-up Analysis (Months) |
|------|-------------------------|------|------|-------------|----------------|---------------|-------------------|---------------------|--------------|----------------------------|
| 1    | 11.8                    | F    | N-W  | R           | Chronic        | Mild          | Skin              | 198                 | 1 1/2 Spica  | 144                        |
| 2    | 11.6                    | F    | N-W  | L           | Chronic        | Mild          | -                 | 106                 | 1 1/2 Spica  | 96                         |
| 3    | 10.6                    | M    | W    | L           | Chronic        | Mild          | -                 | 93                  | 1 1/2 Spica  | 66                         |
| 4    | 11.8                    | M    | W    | R+L         | Acute          | Acute         | Severe            | 84                  | Double Spica | 116                       |
| 5    | 12.1                    | F    | N-W  | L           | Acute          | Moderate      | Skin              | 114                 | Double Long Leg Casts | 60                        |
| 6    | 12.6                    | F    | N-W  | L           | Chronic        | Mild          | Skin              | 119                 | 1 1/2 Spica  | 144                       |
| 7    | 9.10                    | F    | W    | R+L         | Acute          | Acute         | Mild,Mild         | 84                  | 1 1/2 Spica  | 96                         |
| 8    | 13.0                    | M    | N-W  | L           | Chronic        | Severe        | Skeletal          | 90                  | 1 1/2 Spica  | 50                         |
| 9    | 12.2                    | F    | W    | R           | Chronic        | Mild          | Skin              | 119                 | 1 1/2 Spica  | 60                         |
| 10   | 11.4                    | F    | N-W  | R           | Chronic        | Mild          | Skin              | 119                 | 1 1/2 Spica  | 57                         |
| 11   | 12.0                    | F    | N-W  | L           | Acute          | Mild          | Skin              | 91                  | 1 1/2 Spica  | 52                         |
| 12   | 11.7                    | F    | N-W  | R           | Chronic        | Moderate      | Skin              | 77                  | 1 1/2 Spica  | 84                         |
| 13   | 12.8                    | M    | W    | R           | Chronic        | Mild          | Skin              | 105                 | 1 1/2 Spica  | 12                         |
| 14   | 13.10                   | M    | N-W  | L           | Chronic        | Mild          | Skin              | 84                  | 1 1/2 Spica  | 118                        |
| 15   | 10.2                    | F    | N-W  | R+L         | Acute, Chronic | Mild, Mild     | -                 | 91                  | Double Spica | 45                         |
| 16   | 12.0                    | M    | N-W  | R           | Chronic        | Moderate      | -                 | 91                  | 1 1/2 Spica  | 58                         |
| 17   | 11.9                    | F    | N-W  | R+L         | Chronic, Chronic| Mild,Mild     | Skin, Skin        | 84                  | Double Spica | 12                         |
| 18   | 14.0                    | M    | N-W  | L           | Chronic        | Moderate      | Skin              | 101                 | 1 1/2 Spica  | 43                         |
| 19   | 12.2                    | F    | N-W  | R           | Chronic        | Mild          | -                 | 84                  | 1 1/2 Spica  | 65                         |
| 20   | 12.6                    | M    | W    | R+L         | Chronic, Chronic| Moderate, Moderate | Skin, Skin   | 84                  | Double Spica | 48                         |
| 21   | 8.3                     | M    | W    | L           | Chronic        | Mild          | Skin              | 119                 | 1 1/2 Spica  | 32                         |
| 22   | 10.8                    | F    | NW   | L           | Chronic        | Mild          | Skin              | 84                  | 1 1/2 Spica  | 76                         |
| 23   | 12.1                    | F    | W    | R+L         | Chronic, Chronic| Mild, Moderate | Skin, Skin        | 98                  | Double Spica | 41                         |
| 24   | 9.0                     | F    | N-W  | R           | Chronic        | Mild          | Skin              | 84                  | 1 1/2 Spica  | 75                         |
| 25   | 12.5                    | F    | W    | L           | Acute on Chronic | Mild          | Skin              | 84                  | 1 1/2 Spica  | 23                         |
| 26   | 12.8                    | M    | N-W  | R+L         | Acute, Acute   | Mild, Moderate | Skin, Skin        | 84                  | Double Spica | 71                         |
| 27   | 11.10                   | F    | N-W  | R           | Acute          | Mild          | Skin              | 84                  | 1 1/2 Spica  | 70                         |
| 28   | 13.5                    | M    | N-W  | R+L         | Chronic, Chronic| Mild, Moderate | Skin, Skin        | 84                  | Double Spica | 28                         |
| 29   | 11.5                    | F    | N-W  | R+L         | Chronic, Chronic| Mild, Moderate | Skin, Skin        | 84                  | Double Spica | 78                         |
| 30   | 14.0                    | M    | W    | R           | Chronic        | Mild          | -                 | 84                  | 1 1/2 Spica  | 35                         |
| 31   | 11.6                    | F    | W    | L           | Chronic        | Mild          | -                 | 84                  | 1 1/2 Spica  | 25                         |
| 32   | 10.8                    | F    | W    | L           | Chronic        | Moderate      | -                 | 84                  | 1 1/2 Spica  | 68                         |
| 33   | 14.0                    | M    | W    | L           | Chronic        | Mild          | -                 | 84                  | 1 1/2 Spica  | 122                        |
| 34   | 11.8                    | M    | W    | L           | Acute on Chronic | Severe        | -                 | 80                  | 1 1/2 Spica  | 56                         |
Table 1 Data on the Patients (Continued)

| Case | Age at Diagnosis | Sex | Race | Hip Treated | Classification | Grade of Slip | Type of Traction | Time in cast | Type of cast | Follow-up Analysis |
|------|------------------|-----|------|-------------|----------------|---------------|------------------|--------------|--------------|-------------------|
| 36   | 12               | F   | N-W  | R           | Chronic        | Mild          |                 | 81           | 1 1/2 Spica  | 130               |
| 37   | 9.7              | F   | N-W  | R           | Chronic        | Mild          |                 | 80           | 1 1/2 Spica  | 48                |
| 38   | 11.8             | M   | W    | L           | Acute          | Mild          |                 | 88           | 1 1/2 Spica  | 48                |
| 39   | 12.1             | M   | N-W  | R+L         | Chronic, Chronic | Mild, Mild |                 | 88           | 1 1/2 Spica, Bilateral Short Casts | 46 |
| 40   | 13               | M   | W    | R           | Chronic        | Mild          |                 | 83           | 1 1/2 Spica  | 50                |
| 41   | 11.9             | F   | W    | R+L         | Chronic, Chronic | Mild, Mild |                 | 85           | Double Spica | 81                |
| 42   | 14.5             | M   | W    | L           | Chronic        | Mild          |                 | 84           | 1 1/2 Spica  | 13                |
| 43   | 11.9             | M   | N-W  | L           | Chronic        | Mild          |                 | 84           | 1 1/2 Spica  | 45                |

*M = male and F = female; # W = white and N-W = non-white; ¥ R = right and L = left.

Table 2 Data on the Patients

| Case | Age at Diagnosis | Sex | Race | Hip Treated | Classification | Grade of Slip | Type of Traction | Time in cast | Type of cast | Follow-up Analysis |
|------|------------------|-----|------|-------------|----------------|---------------|------------------|--------------|--------------|-------------------|
| 44   | 13               | M   | W    | R+L         | Chronic, Chronic | Severe, Mild, Skeletal, Skin | 84           | Double Spica | 12                |
| 45   | 12               | M   | W    | L           | Chronic        | Mild          |                 | 84           | 1 1/2 Spica  | 45                |
| 46   | 11.7             | F   | N-W  | L           | Chronic        | Severe        |                 | 88           | 1 1/2 Spica  | 44                |
| 47   | 11.4             | M   | W    | L           | Chronic        | Mild          |                 | 84           | 1 1/2 Spica  | 48                |
| 48   | 12.6             | F   | N-W  | R           | Chronic        | Mild          |                 | 90           | 1 1/2 Spica  | 30                |
| 49   | 12.2             | M   | W    | R+L         | Chronic, Chronic | Severe, Mild, Skeletal, Skin | 93           | 1 1/2 Spica, Bilateral Short Casts | 50 |
| 50   | 11.8             | M   | W    | L           | Chronic        | Mild          |                 | 84           | 1 1/2 Spica  | 36                |
| 51   | 11.3             | F   | W    | R+L         | Chronic, Chronic | Mild, Mild |                 | 84           | Double Spica | 34                |
| 52   | 12               | F   | N-W  | R           | Chronic        | Mild          |                 | 84           | 1 1/2 Spica  | 36                |
| 53   | 12               | F   | W    | R+L         | Chronic, Chronic | Mild, Moderate |                 | 95           | Double Spica | 12                |
| 54   | 14.3             | M   | N-W  | L           | Chronic        | Mild          |                 | 84           | 1 1/2 Spica  | 16                |
| 55   | 11               | M   | N-W  | L           | Chronic        | Mild          |                 | 88           | 1 1/2 Spica  | 64                |
| 56   | 11.3             | F   | W    | L           | Chronic        | Moderate      |                 | 89           | 1 1/2 Spica  | 50                |
| 57   | 12               | F   | W    | R           | Acute on Chronic | Mild          |                 | 84           | 1 1/2 Spica  | 37                |
| 58   | 7.6              | M   | N-W  | R           | Acute          | Mild          |                 | 87           | Bilateral Short Casts | 94 |
| 59   | 12.9             | M   | N-W  | R+L         | Chronic, Chronic | Mild, Mild |                 | 82           | Double Spica | 19                |
| 60   | 11.8             | F   | W    | L           | Acute          | Mild          |                 | 87           | Bilateral Short Casts | 18 |
| 61   | 11.8             | M   | N-W  | L           | Chronic        | Mild          |                 | 106          | Bilateral Short Casts | 52 |
| 62   | 11.7             | M   | W    | R+L         | Chronic, Chronic | Mild, Severe |                 | 94           | Bilateral Short Casts, Bilateral Long Leg Casts | 13 |
| 63   | 13               | M   | N-W  | R           | Chronic        | Mild          |                 | 94           | Bilateral Short Casts | 13 |
| 64   | 11.2             | F   | W    | R           | Chronic        | Mild          |                 | 84           | Bilateral Short Casts | 48 |
| 65   | 11.4             | M   | W    | L           | Chronic        | Mild          |                 | 87           | Bilateral Short Casts | 50 |
| 66   | 13               | M   | N-W  | L           | Acute on Chronic | Severe        |                 | 92           | Bilateral Short Casts | 43 |
| 67   | 9.9              | F   | N-W  | R+L         | Chronic, Chronic | Mild, Mild |                 | 90           | Bilateral Short Casts | 12 |
| 68   | 11.10            | F   | N-W  | R           | Chronic        | Moderate      |                 | 87           | Bilateral Short Casts | 12 |
| 69   | 13.6             | M   | W    | L           | Chronic        | Mild          |                 | 90           | Bilateral Short Casts | 36 |

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growth-plate closure (12 weeks). Follow-up was performed every three months to monitor the growth plate closure (Figure 1).

For patients who developed chondrolysis, the treatment protocol for the hip was as follows: analgesics, skin traction, bed rest, gentle active range-of-motion exercises, hydrotherapeutic/physiotherapeutic program, and the use of crutches (prolonged and nonweightbearing). The patients who presented chondrolysis underwent an observation period which took from 3 (three) to 12 (twelve) months; the criterion to stop the treatment for chondrolysis was opted for when irreversible clinical range of motion and deformation of both the femoral head and acetabulum were detected.

**Results**

The results of the *spica* treatment (69%) and bilateral short/long leg casts (31%) in abduction and internal rotation with anti-rotational bars were evaluated functionally as well as roentgenographically according to Heyman, Herdon [4], Aadalen, Weiner, Hoyt, Herdon and Herdon’s methods and criteria [5]. A 70.5% satisfactory result was obtained in the acute group, 94% in the chronic group (chronic + acute-on-chronic). Regarding the degree of the slipping, a satisfactory result was obtained in 90.5% of hips with a mild slip, 76% of hips with a moderate slip and 73% of hips with a severe slip. It became necessary to reapply a new cast (re-displacement), after the established protocol (12 weeks), in six (5.6%) patients (Cases 25, 27, 63, 64, 74, and 75), who presented a second slip (average: 11 months after cast was discontinued) (Table 3).

In 106 analyzed hips, 12 (11.3%) were detected with chondrolysis, clinically diagnosed by pain, limp, muscle spasms, stiffness, mobility limitations and narrowing of the hip joints’ space, as radiographically determined. Among 44 males, only two (Cases 54 and 82) presented chondrolysis. Among 40 females, eight (Cases 1, 2, 5, 6, 13, 18, 53 and 67) also displayed the same problem (Table 4). Among twelve hips with chondrolysis, four (33% [Cases 2, 5, 6, and 82]) presented transient chondrolysis, joints had widened close to normal, osteopenia had improved and pain and stiffness had decreased during the follow-up period (Figure 2).

Regarding race types, there were 43 white SCFE patients. Only two (Cases 54 and 82) displayed chondrolysis. Among 41 non-white patients, eight (Cases 1, 2, 5, 6, 13, 18, 54 and 67) also presented chondrolysis. Seven of these (Cases 1, 2, 5, 6, 13, 18, and 67) were female patients, and one was a male (Case 54).

### Table 2 Data on the Patients (Continued)

| Case | Age | Sex | Race | Diagnosis | Degree | Duration | Treatment |
|------|-----|-----|------|-----------|--------|----------|-----------|
| 70   | 10.5| M   | W    | Acute    | Mild   | 90       | Bilateral Short Casts 72 |
| 71   | 12.6| M   | W    | Chronic | Moderate| 90       | Bilateral Short Casts 12 |
| 72   | 12.1| F   | W    | R+L     | Chronic| Mild, Mild| 93, 93     |
| 73   | 11.4| M   | W    | R+L     | Chronic| Mild, Mild| 91         |
| 74   | 11.5| M   | W    |        | Chronic| Mild      | 97, 93     |
| 75   | 12.10| F | N-W | L      | Acute  | Severe    | Skeletal   | 90       |
| 76   | 12.8| F   | W    | Chronic| Moderate| 100      | Bilateral Short Casts 38 |
| 77   | 15.8| M   | W    | Chronic| Moderate| 90       | Bilateral Short Casts 54 |
| 78   | 11.8| M   | W    | R+L     | Chronic| Mild, Moderate| 90, 90 |
| 79   | 13.7| M   | N-W  | L      | Chronic| Severe    | Skeletal   | 107      |
| 80   | 15.6| M   | W    | Chronic| Moderate| 90       | Bilateral Short Casts 12 |
| 81   | 12.8| F   | N-W  | L      | Chronic| Mild      | 101        |
| 82   | 13.9| M   | W    | R+L     | Chronic| Moderate, Mild| 90, 90 |
| 83   | 12.7| M   | W    | Acute  | Mild    | 90       | Bilateral Short Casts 25 |
| 84   | 14   | M   | N-W  | L      | Chronic| Mild      | 97         |
| 85   | 14   | F   | W    | No     | Chronic| Severe    | -          | -        |
| 86   | 11.8| F   | N-W  | No     | Chronic| Mild      | -          | -        |

*M = male and F = female;  
#W = white and N-W = non-white;  
¥ R = right and L = left.
In 19 patients (38 hips) with simultaneous involvement displacement, only two patient cases, 18 and 67, developed complications. In 44 hips with the right side affected, only three (Cases 1, 13 and 82) presented chondrolysis; in 62 cases on the left side, five (Cases 2, 5, 6, 53 and 54) presented the same complication.

Regarding the type of plaster cast used and chondrolysis, the following was observed: 1 1/2 spica - four chondrolysis hips, cases, (1, 2, 13 and 54); double short leg casts-three chondrolysis hips, cases (67 [both hips] and 82); double spica - three chondrolysis hips (18 [both hips] and 53); and double long leg casts-one chondrolysis hip (Case 5).

Table 3 Distribution of the results of the six patients who presented a re-displacement (Progression cases after cast discontinued)

| Cases | Age     | Sex   | Race     | Hip   | Physis Stage | Type of cast | Time in Cast |
|-------|---------|-------|----------|-------|--------------|--------------|--------------|
| 25    | 10+07   | Female| Non-White| Right | Open         | 1 1/2 Spica  | 84           |
| 27    | 13+11   | Male  | Non-White| Right | Open         | Double Spica | 84           |
| 63    | 12+01   | Female| White    | Right | Open         | Short Leg Casts | 84         |
| 64    | 12+01   | Female| White    | Right | Open         | Short Leg Casts | 84         |
| 74    | 13+04   | Male  | White    | Left  | Open         | Short Leg Casts | 97          |
| 75    | 13+06   | Female| Non-White| Left  | Open         | Long Leg Casts | 90          |
There were 17 hips with symptoms classified as acute, two (Cases 5 and 13), displaying chondrolysis, only ten hips (Cases 1, 2, 6, 18 [both hips], 54, 67 [both hips], 53 and 82) from 85 pertaining to the chronic group developed chondrolysis.

Seventy-four displacements were observed in the mild-degree group. Seven hips (Cases 1, 2, 6, 18, 54, and 67 [both hips]) presented chondrolysis; in the moderate degree, 5 out of 21 hips (Cases 5, 13, 18, 53 and 82) presented chondrolysis, and none of the nine hips with a severe degree developed it. Avascular necrosis was not detected in none of the hips manipulated, by the Leadbetter maneuver [8] (Figure 3). Two patients with SCFE (Cases 85 and 86) were excluded from the study as these had the epiphyseal line already closed in the first appointment. Both patients had chondrolysis without any previous kind of treatment. One case of pseudoarthrosis (0.9%) with necrosis of the head was detected after a repeated slip. This complication was classified as severe, of the traumatic displacement type, in the patient’s hip (Case 75), due to a prolonged heavy femoral and tibia skeletal traction time employed simultaneously; avascular necrosis also was observed as a complication.

**Statistical Analysis**

One of the objectives of the statistical analysis was to specify whether a significant variation existed in hip mobility measures (in degrees) before or after treatment. The absolute variation (in degrees) between pre- and post-treatment is given by the following formula: Absolute variation of flexion = flexion in post-treatment - flexion in pre-treatment. Statistical analysis was accomplished by Wilcoxon’s marked positions test [10]. According to hip flexion analysis, significant variations (p = 0.0001) were found, i.e., there was an increase of 29.5° on average after treatment. With regard to hip abduction, a significant variation (p = 0.0001) was found, i.e., there was an increase of 12.5°. As for hip internal rotation, there were significant variations (p = 0.0001), i.e., an increase of 11.8°. Concerning hip external rotation, significant variations (p = 0.02) were also observed, i.e., there was an increase of 5.1°.

The other objective regarding statistical analysis was to specify whether there existed a significant variation between age, sex, race, and type of immobilization versus chondrolysis. Statistical analysis was performed by means of Fisher’s accurate test, at 5% level [11]. Chondrolysis was present in 11.3% of the hips tested. There was no significant variation between age and chondrolysis (p = 1.00). Concerning gender analysis, statistically significant variations were observed (p = 0.031). In race analysis, there was also a statistically significant difference (p = 0.037). _No causal association between plaster cast and chondrolysis was observed_ (p = 0.60). Regarding the symptomatology group and the slip degree versus chondrolysis, the p value was not statistically significant in either analysis, respectively p = 0.61 and p = 0.085.

**Discussion**

The cause of articular cartilage necrosis after slipped capital femoral epiphysis still remains obscure [12]. Betz, Steel, Emper, Huss and Clancy found 13.5% of chondrolysis in their trials [7]. Ingram, Clarke, Clark and Marshall mentioned that the incidence of chondrolysis varies from 2% to 55% [6]. Jerre, in a series of 200 slipped femoral epiphyses treated mainly by closed reduction and plaster immobilization, found nine hips (4.5%) with articular cartilage necrosis [13]; in this study, chondrolysis affected 12 hips (11.3%): four presented a temporary form of chondrolysis (7.5%), with eight being permanent. Writings on this subject have shown a predominance of females over males [14,15]; in this series, chondrolysis was also predominant in females over males.
According to published works [2,14,16,17]; chondrolysis in non-white patients (16%- 66%) is more common than in white patients (2.5%). In this study, regarding articular cartilage necrosis, it was ascertained that non-white patients prevailed by a considerable number over the white patients. The manifestation and prevalence of chondrolysis as a complication in females and non-whites are some of the unclarified points in the study as of yet.

Regarding symptomatology, classification in previous studies assigns to chronic group patients the worst IH

Figure 2 Necrosis of the joint cartilage (Waldenström disease) of the right hip after cast period. The functional value of mobility of the affected hip was reached. Reversible clinical range of motion and deformation of both the femoral head and acetabulum were detected. (A and B) Anteroposterior and frog-leg lateral radiographs of the pelvis made before treatment, showing bilateral chronic SCFE, being moderate slip in the right hip and mild in the left. (C) Anteroposterior roentgenogram of both hips after cast treatment with bilateral leg casts in abduction and an internal rotation. We may observe narrowing and irregularity of the right hip joint with demineralization of the surrounding bone = chondrolysis of the right hip. (D and E) Anteroposterior and frog-leg lateral radiographs of the hips showing closure of the growth-plate in the right hip, further demineralization with obliteration of the joint space and irregularity of the head of the femur and acetabulum and also decrease in cartilage thickness. (F and G) Anteroposterior and frog-leg lateral radiographs observing in the right hip some restoration of cartilage, with irregular contour of the femoral head. (H and I) Anteroposterior and frog-leg lateral radiographs observing in the right hip joint, the articular space is now widened compared to the initials X-rays. The femoral head presents mild deformity and limited range-of-motion in the right hip.
prognosis in relation to chondrolysis [6,7,17,18]. In this sample, the record of chondrolysis incidence in this type of group was in accordance with the literature.

Concerning the degree of epiphysis displacement in relation to the femoral neck, in chondrolysis, bad results are proportional to the severity of the slip degree [6,17,18]. In this study, seven patients classified as mild degree presented chondrolysis, five classified as moderate presented the complication, with none of the nine severe cases displaying it. This finding is contrary to the general condition.

Nevertheless, concerning chondrolysis, there was an inexplicable finding with one female patient who was treated for bilateral slipping by 1 1/2 spica cast. While her right hip was normal, the left one deteriorated to

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**Figure 3** Young female patient with severe slip of the left hip, treated by immobilization (anti-rotation plasters) after hip manipulation. The range of motion of the left hip was normal at the final follow-up. (A and B) Anteroposterior radiograph of the pelvis and spot film before treatment, in a nine-year-old girl who had an acute/severe slip SCFE in the left hip. (C and D) Patient under general anesthesia submitted to gentle Leadbetter manipulation. Bilateral toe-to-groin casts had been applied. (E and F) Anteroposterior and Frog-leg lateral radiographs showing the physis beginning the closure process in AP and lateral views. (G and H) Anteroposterior and frog-leg lateral radiographs of the left hip, showing complete closure of the growth-plate.
With all forms of treatment [26]. Chondrolysis can appear spontaneously after the slipping of the femoral epiphysis without any treatment, and may follow either a slight or a severe slip. It may occur after any type of treatment, whether conservative or operative [12].

These results show why some methods are in favor, and others are in disfavor, in the clinic where these patients were treated and where as, in all hospitals the facilities and limitations must be evaluated by every surgeon (Clarence H. Heyman, M D) [27].

Conclusions

After analyzing the nonoperative treatment in slipped capital femoral epiphysis and chondrolysis, we concluded that the employment of the treatment revealed that the method was functional, efficient, valid, and reproducible; it can also be used as an alternative therapeutic procedure regarding to this specific disease.

This manuscript is faced with the fact that the orthopaedic surgeons employ and evaluate a little-adopted treatment technique by musculoskeletal studies in the treatment of SCFE. The success or failure of treatment intervention is determined based on the outcomes [28]. The presented work was evaluated and tested on its contents, methodology and clinical usefulness. Modern medicine is based on evidence, and outcomes have to have their importance proven. The instrument of quality employed (plaster cast method) was assessed not only by the surgeon, but also by the patient, through his descriptions. The patient was always given the option, upon the first appointment, to choose from the conservative or surgical treatment. The nonoperative management of SCFE was accepted by relatives. The interest demonstrated by the patients in method reliability has shown the possibility of analyzing the difference between the patients’ reports, and those from the professionals and their studies, with the possibility of varied outcomes. Evaluation in modern medicine must be based on evidences of the result and on the functional radiographic measurements, in addition to being statistically analyzed and including the patients’ reports. The present work showed an optional method for the treatment of slipped capital femoral epiphysis.

Consent

Written informed consent was obtained from all patients and relevant parents/guardians for publication of this report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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