

Valgus Slipped Capital Femoral Epiphysis (SCFE) Managed by Plaster Cast Immobilization Treatment: Seven Case Reports and Review of The Literature

Pedro Carlos de M. S. Pinheiro* & Vanessa dos Santos Madeira Côrtes Salvio

Department of Orthopedic Surgery, Jesus Children's Hospital, Rio de Janeiro, RJ, Brazil

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***Corresponding author:** Dr. Pedro Carlos M. Sarmento Pinheiro, Department of Orthopedic Surgery, Jesus Children's Hospital, Rio de Janeiro, RJ, Brazil, Tel: 55.21.2255-4685; E-mail: pecacho@infolink.com.br

Abstract

Background: This report provides detailed information with illustrative examples of more than seven patients (eight hips) with one specific rare condition valgus of SCFE. The purpose of this study was to describe and comment on the complete analysis of seven cases of valgus SCFE.

Patients and Methods: The research was performed based on the study of the following variables: clinical patient history, symptomatology and physical findings. Admission for anteroposterior (AP) view and Lauenstein [1] frog-leg position for lateral radiograph view of both hips (validated instrument) was performed. A retrospective review maintained data base of patients diagnosed with valgus SCFE was conducted. Patients with radiographically valgus SCFE were identified, confirmed and in the analysis, included. Medical records for clinical features, treatment, and outcomes, were reviewed.

Results: Seven patients from the database were identified: the patient average age at diagnosis was ten years and six months old, within follow up time of thirty six months. All valgus SCFE patients with localized disease with conservative treatment using cast immobilization were managed. Two hips showed evidences of chondrolysis; however just one patient presented juvenile rheumatoid arthritis (JRA) disease diagnosed.

Conclusions: The hip joint in our series treated by plaster cast immobilization method to control the progressive valgus displacement of the epiphysis was effective and capable of being justified, and functional. Chondrolysis and its link as a complication were described. This research is justified by the importance and attention that the entity deserves.

Keywords: SCFE; Coxa Valga; Plaster Cast Immobilization.

Literature Review

Slipped Capital Femoral Epiphysis (SCFE)

SCFE is a painful hip disorder which most commonly occurs in prepubescence and early adolescence, period that boys and girls may present the proximal capital femoral epiphysis from the metaphysis of the growth plate breaks away.[2,3] The etiology of SCFE is multifactorial.

Valgus Slipped Capital Femoral Epiphysis

Valgus SCFE is a very rare entity, defined as a lateral and superior displacement of the proximal capital femoral epiphysis relative to the metaphysis.[3]

History of Slipped Capital Femoral Epiphysis

The first description of a separation of the proximal capital femoral epiphysis has been credited to Ambroise Paré (1572)[4]. He admitted the feasibility of confounding the separation of the capital femoral epiphysis with luxation in a hip dislocated.

XXI. De La Fracture Du Col Du Fémur

Quelquefois, il se fait une fracture près de la jointure de la hanche, au col du fémur: J'ai vu ce cas chez une dame qui m'avait appelé pour la panser. Voyant que sa jambe était plus courte que l'autre, avec une éminence faite par le trochanter extérieurement, au-dessus de la jointure de l'ischion, j'estimai d'abord que c'était la tête de l'os et qu'il y avait luxation et non fracture. Je tirai alors et poussai l'os, ce me semblait-il en sa boîte, étant donné que les deux jambes étaient égales de longueur et d'aspect et je la pansai ensuite comme s'il s'agissait d'une luxation. Deux jours après, je revins voir la malade qui se plaignait alors d'une extrême douleur. Je trouvai sa jambe courte et son pied tourné en dedans. Je défis toutes les bandes et vis la même éminence qu'auparavant. Je m'efforçai à nouveau de réduire l'os en sa boîte. Cependant, je m'aperçus qu'il crépitait et sus alors qu'il y avait fracture et non luxation. De même, l'épiphyse de la tête de cet os se sépare quelquefois et le chirurgien est trompé, estimant qu'il y a luxation et non disjonction. Donc, je réduisis l'os, appliquai des attelles sur les compresses et fis une ligature à deux têtes, la croissant par-dessus la jointure et autour du corps en croix de Saint-André. Le reste de la cure se fit comme nous l'avons déjà indiqué plus haut.

Ambroise Paré [4], Sabatier, M. Mémoire Sur la Fracture du Col du Fémur The first investigation description about the word spica in old French was published.[5].

“On fait le fpica avec une bande longue de quatre ou cinq aunes roulée à um chef le globe paffe plufieurs fois fous la cuiffe malade pour le faire revenir fur le grand trochanter, & leconduire enfuite autour du corps Celui dont plus nombre des Auteurs recommande l’ufage eft le fpica...

Walther Müller introduced, in March 2, 1926, from the Surgical University Clinic of Marburg, descriptions, illustrations, interpretations, comments, and observations of the Coxa valga forms (lateral and upward displacement of the epiphysis against the femoral neck).[6] There is no explanation for the formation of the Coxa valga adolescentium. The displacement of the femoral head on the metaphysis in the literature is little discussed. This process of lateral displacement of the epiphysis on the femoral neck, in fact, represents the key to the explanation of most forms of the Coxa valga. The genesis was not yet clarified at all. Müller report epiphyseal Coxa valga in patients with coexisting

acetabular dysplasia. In several parameters the articles from world literature, the authors did not report the subject matter from the demographic data of valgus SCFE.

The authors, in 2017, presented seven more patients with valgus SCFE (eight hips). A female patient had the right hip treated by spica cast immobilization. The other female patient (left hip) had bilateral long casts (with cross bar-struts) employed. A male patient (both hips) and a female patient (left hip) had the hips treated by short casts in abduction with antirotational bars. A male patient (left hip) and two female patients (both left hips) had the hips with bilateral short casts in abduction and internal rotation of about 30° with cross bar-struts applied.

Detailed information from the literature investigated, baseline demographic characteristics of included 69 patients with 89 valgus SCFEs on (Table 1) are reported.

Table 1: Relevant Demographic Data on 89 Valgus SCFEs in 69 Patients of 27 articles from the Orthopedic Literature

Year	Author	Patient	Sex	Age at Diagnosis (Yrs.)	Race	Hip R/L	Weight (kg)	Stability	IR	ER	ABD	FLEX	Type	Grade	Treatment	Complications
1926	Müller ⁶	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1930	Scheuermann ⁷	One	F	14	--	R	--	--	--	--	--	--	--	--	Confinement to bed for 2 months	--
1946	Finch and Roberts ⁸	Two	F F	14 13	N-W N-W	R+L R+L	-- --	--	-- / 10° -- / --	15° / -- -- / --	-- / -- -- / --	-- / -- --	Ch / Ch Ch / --	-- / -- -- / --	Bilateral long-leg casts in IR / abduction of 30° Adhesive traction for 8 weeks + right hip spica for six weeks	A vascular necrosis --
1949	Howorth ⁹	Three	--	--	--	3	--	--	--	--	--	--	--	--	--	--
1950	Jerre ¹⁰	Four	--	--	--	7	--	--	--	--	--	--	--	3 slight 4 marked	Different forms of treatment	5 arthrosis deformans
1957	Meyer et al ¹¹	Two	F --	13 --	W --	L --	-- --	--	-- --	-- --	-- --	-- --	Ch --	-- --	Manipulation and well-leg traction Non weight bearing on crutches	Some limitation of IR Some limitation of IR
1965	Fahey and O'Brien ¹²	One	F	11.8	W	R	--	--	--	--	--	--	AcCh	--	Gentle traction + fixation with 2 threaded pins	Sclerotic changes+ regression
1965	Wilson et al ¹³	Two	F --	12 --	-- --	L --	-- --	--	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
1970	Schott and Vianna ¹⁴	One	F	12	--	L	--	--	--	--	--	--	Ac	--	in situ three left Steinmann' pins	Chondrolysis + hip joint restored
1972	Krishan and Shelton ¹⁵	One	F	11	N-W	R+L	--	--	30° / 30°	45° / 45°	-- / --	70° / 90°	Ch / Ch	-- / --	in situ three Knowles' pins of the right hip in situ three Knowles' pins of the left hip	-- / -- -- / --
1972	Mihran O. Tachdjian ¹⁶	Two	F M	-- 13	-- N-W	R+L R	-- --	--	-- --	-- --	-- --	-- --	-- --	RI / LII --	in situ two Knowles' pins of the left hip. Two threaded pins + spica cast + crutches + varization osteotomy	-- / -- Two threaded pins out of the neck + pins removed
1978	Skinner and Berkheimer ¹⁷	One	M	12	N-W	R	--	--	--	--	--	60°	Ch	--	in situ three Knowles' pins of the right hip	--
1979	Rothermel ¹⁸	One	M	15	W	R	--	--	--	--	--	10°	Ch	--	in situ four Knowles' pins of the right hip	--
1984	Carlioz et al ¹⁹	Two	F F	14 13	-- --	L R	-- --	--	-- --	-- --	-- --	-- --	Ch Ch	-- --	in situ left screw fixation in situ right screw fixation	-- --

1989	Scher et al ²⁰	One	F	14	--	R+L	56	--	--	--	--	100° / 90°	AcCh AcCh	--	Imhauser-Weber osteotomies	L femoral head segmental avascular necrosis
1996	Segal et al ²¹	Two	F F	9.9 10.11	W N-W	R R	36 91	1 Stable 1 Stable	-- 0°	-- 30°	-- 30°	-- 40°	Ac Ch	III III	in situ right cannulated screw fixation in situ right cannulated screw fixation	-- --
2003	Rajan et al ²²	One	F	10	--	R	--	1 Stable	reduced	--	reduced	reduced	Ch	--	An adductor tenotomy + varus osteotomy+ Richards' screw and hip spica	--
2004	Docquier et al ²³	One	F	13.6	--	R+L	26	2 Stables	--	--	--	--	Ch / Ch	--	<i>in situ</i> R + L screw fixation	--
2005	Yngve et al ²⁴	Seven	3 M 4 F	15 y (m.age) 13.5 y (m.age)	6 NW 1W	10	40 obese and 3 non-obese	--	--	--	--	--	--	--	Percutaneous screw fixation Percutaneous screw fixation	-- --
2006	Loder et al ³	Four	F M M F	9 14 14 9 / 10	N-W N-W N-W N-W	R+L R+L R L+R	70 62 96 74 / 94	2 Stables 2 Stables 1 Stable 2 Stables	5° / 0° 45° / 45° 0° 5° / 5°	45° / 45° 45° / 45° -- 75° / 75°	20° / 20° -- / -- 30° 90° -- / --	70° / 70° 120° / 120° 120° 90° -- / --	Ch / Ch Ch / Ch Ch Ch / Ch	1 / 1 1 / 1 1 1 / 1	Screw fixation / Screw fixation / Screw fixation / Screw fixation / Screw fixation /	-- -- -- -- --
2007	Shea et al ²⁵	Two	F F	11 13	-- --	R+L R+L	Both below 45th percentile for age	-- --	-- --	-- --	-- --	-- --	-- --	I I	Bilateral Percutaneous screw placement Bilateral Percutaneous screw placement	-- --
2010	Mata and Ovejero ²⁶	One	F	13.7	--	L	--	1 Stable	- 40°	--	--	--	Ac	--	<i>in situ</i> percutaneous screw fixation	--
2010	Shank et al ²⁷	Twelve	5 M 7 F	11.6 ± 3.1	6W? 5NW?	5 R 3 L 4 R+L	67.7 ± 20.2	10 Stables? 1 Unstable?	-- --	-- --	-- --	-- --	-- --	-- --	14 <i>in situ</i> screw fixation 2 surgical subcapital hip osteotomies	1 Chondrolysis 1 segmental osteonecrosis 3 wound dehiscence
2011	Renganathan et al ²⁸	One	F	22	--	R	--	1 Stable	limitation	30°	limitation	limitation	Ch	--	Traction for period of 6 weeks	--
2011	Venkatadass et al ²⁹	Two	M F	10 13	-- --	R+L L	-- --	1 Stable 1 Unstable	-- --	-- --	-- --	-- --	Ch / Ch Ac	-- --	<i>in situ</i> bilateral screw fixation <i>in situ</i> left two screws fixation	--
2013	Koczewski ³⁰	Eleven	5 M 6 F	11.1 ± 1.6	--	5 R 6 L	--	10 Stables 1 Unstable	--	--	--	--	1 Ac 7 Ch 3 AcCh	--	Treated surgically	--
2017	Kotoura et al ³¹	One	M	17	--	R	63	1 Unstable	10°	60°	45°	90°	Ch	--	<i>in situ</i> right single screw fixation	--

F indicates, female; M, male; R, right; L, left; W, white; NW, non-white; weight; IR, internal rotation; ER, external rotation; ABD, abduction; FL, flexion; AC, acute; Ch, chronic; AcCh, acute on chronic, Y, year; m.age, mean age.

Materials and Methods

As usual, through Brazil Platform institutional review board, the Research Project of study entitled: Valgus slipped capital femoral epiphysis have been managed by plaster cast immobilization treatment: seven case reports and review of the literature has been analyzed validated and approved. The study with PCEA (Presentation Certificate of Ethical Appreciation) number 73819017.0.0000.5279 on November 28, 2017, was registered. The typology (type of study) of the design in this sample, a retrospective cohort study of an individualizing, observational (nonrandomized) longitudinal characteristics has been employed. The independent variable (a form of treatment) was cast treatment. In this research the dependent variable was chondrolysis. A total of 131 patients in 166 hip joint affected of SCFEs from 1999 until 2012 at the authors' own department, were treated. The first 84 patients (106 hips) with SCFE, by one

of the authors, have already been published [32]. It was found in the total series 7 patients (eight hips) with one specific condition – valgus SCFE, using plaster cast immobilization as the method of treatment chosen.

To qualify this study, valgus hip SCFE and painful condition in the hip had been the characteristic deformity. Radiographs (type of imaging) remains the gold standards used as validated instruments (important tools) to improve medical care in daily clinical practice and by modifying treatment protocols were the basis of the results. The outcome instruments, focused on biological and physiological factors in orthopedic research were considered. The valgus SCFE patient's sex, race, weight, hip treated, age at diagnosis, time in a cast and the type of cast were recorded. The methods used were based on symptomatology, and categorized as acute (symptoms for < 3 weeks), chronic (symptoms for ≥ 3 weeks), and acute-on-chronic (chronic

symptoms, complaints initially and the subsequent exacerbation of acute symptoms); according to Fahey and O'Brien criteria were evaluated. Slip degrees were documented by the standard method of thirds and classified as mild (<33%), moderate (33% to 50%), or severe (>50%), according to Wilson, Jacobs, Schecter, MacEwen and Ramsey, who use the three grades (<30%) (30%-50%), (>50%) of slip percentage [12,13,33]. The hips were evaluated systematically roentgenographically as well as functionally, according to Heyman and Herdon's criteria, and were also categorized as satisfactory and unsatisfactory by means of Aadalen, Weiner, Hoyt, Herdon and Herdon's criteria [34,35]. Methods to analyze the joint cartilage and detect chondrolysis were utilized based on Ingram, Clarke, Clark and Marshall's criteria [36]. Chondrolysis leads to deformity, pain, and limp, limitation of motion in the hip and narrowing of the joint space affected according to radiographies criterion if the joint space measured 3mm or less, then chondrolysis was present. The type of SCFE as stable or unstable was classified [37]. A stable SCFE is defined when the patient is able to ambulate, with or without crutches. An unstable SCFE is classified when the patient, with or without crutches cannot ambulate. The lack of intersection between a line draw parallel to the superior edge of the femoral neck (Klein's Line) and the epiphysis confirms a slip [38]. In valgus SCFE, the Klein line will always be normal [3]. For an opportune diagnosis The Klein's line, therefore, the Lauenstein frog-leg position for the lateral radiograph view of both hips are absolutely necessary [1]. Weight category was based on 2000 CDC Growth Charts for the United States: Methods and Development [39]. The method of treatment of the valgus SCFE, in this project the immobilization in a spica cast and bilateral long/ short leg casts in abduction internal rotation with antirotational bars has been applied. The protocol period for immobilizing the patient's hip for twelve weeks, was established.

Statistic Methodology

The descriptive analysis in the form of tables and the observed data were expressed by frequency (n) and percentage (%) for categorical data (qualitative) and for the medium and interval Interquartile range (1° quartile - 3° quartile) for numeric data, was presented.

The inferential analysis for comparison between the two SCFE (classic and valgus) subgroups by the Fisher accurate test in the categorical data and by the Mann-Whitney U test (non parametric) in the numeric data was composed. The association among the characteristics of the hips affected by chondrolysis complication by the qui-square (χ^2) test or by the Fisher accurate test was analyzed.

The non parametric method, because the variables did not present normal distribution (Gaussian distribution), due to the rejection of the normality hypothesis according to the Shapiro-Wilk test was used. The determination criterion of the significance was at 5% level was adopted. The statistical analysis by the statistical software SAS® System, version 6.04 (SAS Institute, Inc., Cary, North Carolina) was processed.

Results

Between 1999 and 2012, 131 patients (166 hips) were treated by conservative method, from the author's own department. Among this group, 7 patients (8 hips) were defined as having a valgus SCFE characteristic deformity with painful hip.

Summary of clinical and characteristics parameters of valgus SCFE (author's own series) in table 2 is described. Proximal Femoral angular measurements in patients with valgus SCFE in table 3 is observed.

Table 2: Data on 7 patients (8 hips) of Valgus SCFE (author's own series)

Case	Age at Diagnosis (Yrs)	Sex*	Race#	Hip Treated¥	Weight kg	Classification Fahey and O'Brien[33]	Grade Of Slip Wilson. Jacobs.	Stability Loder et al[39]	Time in Cast (Days)	Type of cast	Complications	Functional evaluation criteria of Heyman/ Herdon[36] and Aadalen[37]	Follow up analysis (months)
1	11.7	F	N-W	R	49	Acute	Mild	Stable	116	1 ½ Hip Spica	JRA Chondrolysis	Unsatisfactory	77
2	11.8	F	W	L	28	Acute	Mild	Unstable	93	Bilateral Long Casts	_____	Satisfactory	21
3	11.4	M	W	R L	65	Chronic Chronic	Mild Mild	Stable Stable	91	Bilateral Short Casts	_____	Satisfactory Satisfactory	58
4	9.1	F	N-W	R	60	Acute	Mild	Stable	94	Bilateral Short Casts	_____	Satisfactory	28
5	11.4	M	N-W	L	50	Chronic	Mild	Stable	90	Bilateral Short Casts	_____	Satisfactory	26
6	10.3	F	N-W	L	36	Chronic	Mild	Stable	93	Bilateral Short Casts	Chondrolysis	Unsatisfactory	29
7	10.7	F	N-W	L	50	Chronic	Mild	Stable	90	Bilateral Short Casts	_____	Satisfactory	15

F indicates female; M, male; R, right; L, left; JRA, Juvenile rheumatoid arthritis

Table 3: Range of motion before cast/at latest follow-up (degrees) of Valgus SCFE (author's own series)

Case	Flexion		Abduction		Adduction		Internal Rotation		External Rotation		Comments
	Before	Latest	Before	Latest	Before	Latest	Before	Latest	Before	Latest	
1	(R) 30°	0°	20°	0°	10°	0°	10°	0°	20°	0°	Juvenile rheumatoid arthritis Right hip(chondrolysis)
2	(L) 90°	90°	60°	45°	30°	30°	20°	15°	90°	80°	Idiopathic Valgus SCFE
3	(R) 75°	120°	45°	45°	20°	30°	10°	20°	60°	60°	Bilateral Idiopathic
	(L) 80°	120°	45°	45°	20°	30°	15°	20°	60°	60°	Valgus SCFE
4	(R) 90°	90°	35°	60°	30°	30°	15°	15°	80°	60°	Endocrine Dysfunction
5	(L) 90°	90°	45°	40°	20°	20°	15°	15°	45°	45°	Idiopathic Valgus SCFE
6	(L) 60°	30°	40°	10°	20°	15°	0°	0°	30°	0°	Left hip-Chondrolysis
7	(L)100°	90°	45°	45°	20°	20°	20°	20°	60°	45°	Idiopathic Valgus SCFE

R indicates right; L, left; JRA, Juvenile rheumatoid arthritis

First Work Objective

The present variables association between the classic and valgus SCFE were characterized in patients sample.(Table 4)

Second work objective

The patient's hip joint of the sample and the chondrolysis as complications, were characterize and reported. The classic/valgus SCFEs hip joint characteristics and complication (chondrolysis) were observed.(Table 5)

Table 4: Clinical characteristics of the patient's sample with classic and valgus SCFE and descriptive level (p value) of the statistical test (author's own institution)

Variable	category	Total (n = 131)	Classic SCFE (n = 124)	Valgus SCFE (n = 7)	p value
Clínical Characteristics					
Age (years)					
median (Q1 - Q3)		12 (11 - 13)	12 (11 - 13)	11 (10 - 11)	0,049
Age-group - n (%)	< 12 years	68 51,9	61 49,2	7 100	0.009
	≥ 12 years	63 48,1	63 50,8	0 0	
Sex- n (%)	male	71 54,2	69 55,6	2 28,6	0.16
	female	60 45,8	55 44,4	5 71,4	
Race - n (%)	white	64 48,9	62 50,0	2 28,6	0.24
	non-white	67 51,1	62 50,0	5 71,4	
Wheight (kg)					
median (Q1 - Q3)		62 (49 - 72)	62 (50 - 74)	49 (36 - 60)	0,019
Obese - n (%)	yes	86 65,6	84 67,7	2 2,9	0.046
	no	45 34,4	40 32,3	5 97,1	
Patient side involvement- n (%)	right	42 32,1	40 32,3	2 28,6	0.99
	left	54 41,2	51 41,1	3 42,9	
	bilateral	35 26,7	33 26,6	2 28,6	
Treatment and follow-up					
Cast type- n (%)	spica	58 44,3	57 46,0	1 14,3	0,18
	short cast	72 55,0	66 53,2	6 85,7	
	crutches	1 0,8	1 0,8	0 0,0	
Time in cast (weeks)					
median (Q1 - Q3)		13 (12 - 13)	13 (12 - 13)	13 (12 - 14)	0,35

Follow up (months)				
median (Q1 - Q3)	34 (13 - 57)	35 (13 - 57)	25 (12 - 70)	0,92
The categorical data by frequency (n), percentage (%), compared by the Fisher's accurate test; and the numeric data by the median (1° quartile - 3° quartile) were compared by the Mann-Whitney U test				
Comments:				
The subgroup with valgus SCFE have presented: age in years (p=0,049), age group ≥ 12 years (p=0,009), weight (p=0,019) and obesity (p=0,0046) significantly <u>smaller</u> than the subgroup with classic SCFE. The other clinical characteristics of the patients, between the two SCFE subgroups did not present significant differences at 5% level. Also the treatment characteristics and follow-up did not present significant differences at 5% level, between the two SCFE subgroups.				
Obs: The interquartile interval (IIQ) have 50% of the observations between the limits which corresponds to 1° quartile (Q1) and 3° (Q3). This interval as a measure dispersion which follows the median (as the standard deviation follows the medium) it was obtained.				

Table 5: The above table shows characteristic and complications of the hip joint patient's with classic and valgus SCFE of the 166 hip joint affected

Variable		category	Total (n = 166)		SCFE				p value
					Classic (n = 158)		Valgus (n = 8)		
Hip Joint Characteristics									
Hip Side	- n (%)	right	77	46,4	74	46,8	3	37,5	0,44
		left	89	53,6	84	53,2	5	62,5	
Symptomatology	- n (%)	acute	26	15,7	23	14,6	3	37,5	0,17
		cronic	131	78,9	126	79,7	5	62,5	
		acute-on cronic	9	5,4	9	5,7	0	0,0	
Stability	- n (%)	stable	151	91,0	143	90,5	8	100,0	0,46
		unstable	15	9,0	15	9,5	0	0,0	
Slip degrees	- n (%)	mild	119	71,7	111	70,2	8	100,0	0,74
		moderate	28	16,9	28	17,8	0	0,0	
		severe	19	11,4	19	12,0	0	0,0	
Complication	- n (%)	right chondrolysis	8	4,8	7	4,4	1	12,5	0,19
		left chondrolysis	9	5,4	8	5,1	1	12,5	
		no complication	149	89,8	143	90,5	6	75,0	
The categorical data by the frequency (n), percentage (%) were compared by the Fisher's accurate test									

Comments

The characteristics and complications (chondrolysis) of the affected hip joint between the two SCFE classic and valgus subgroups did not present significant difference, at 5% level. Chondrolysis classic/valgus subgroups, great proportion between female (76.9%) and non-white race (84.6%) in comparison with patients without chondrolysis (42.4%) and (47.5%) respectively was verified.

Results of the patients with valgus slipped capital femoral epiphysis (SCFE) by plaster cast immobilization treatment were performed. (Cases 1, 2, 3, 4, 5, 6, 7)

Distribution of the seven cases with valgus SCFE. Radiographs and pictures of the patients during follow-up treatment, Cases 1,2,3,4,5,6,7 was demonstrated.(Figures 1-7)

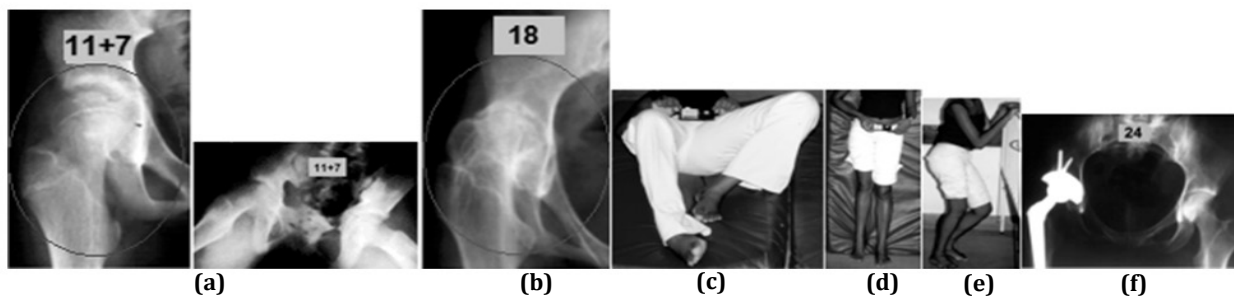


Figure 1: Anteroposterior and frog-leg lateral radiographs of a girl aged 11-year-7 month-old, with a painful valgus right SCFE (a). More detailed view on anteroposterior of the right hip joint at 18-year-old, was demonstrated narrowing and irregularity with demineralization of the surrounding bone and obliteration of the joint space (chondrolysis) (b). Patient lying down with and irreversible clinical range of motion, flexion contraction, loss of strength and stiffness of the right hip joint was presented (c). Patient in orthostatic position showing right limb-length discrepancy (d). A crouching impossibility (Get-up and Go-test) movement of the right hip joint is demonstrated (e). A radiograph of the pelvis showing the right hip after total hip surgery in another center was performed (f). Obs.: Patient had poly-articular rheumatoid (Still's) disease during treatment of the valgus SCFE diagnosed.

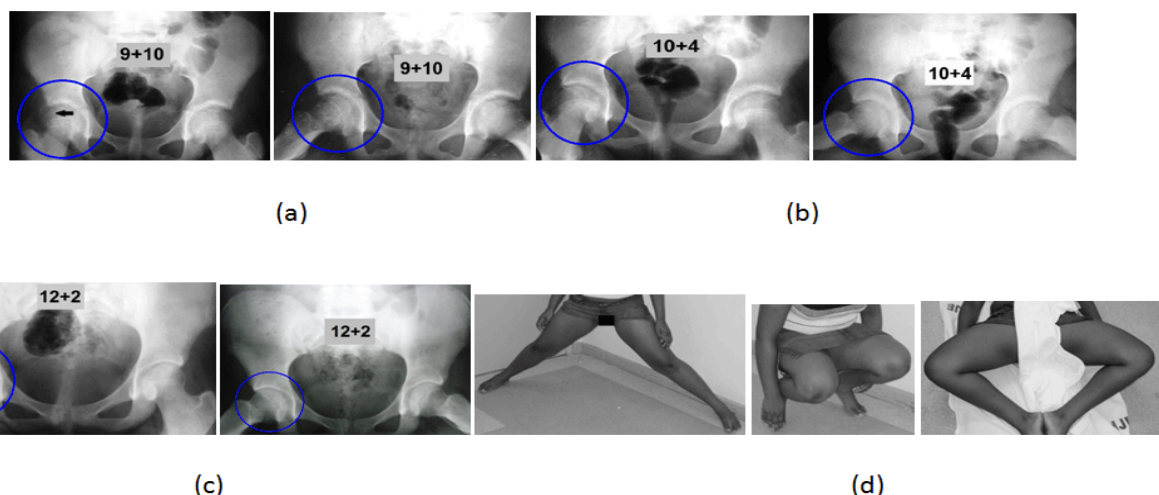


Figure 2: Anteroposterior and frog-leg lateral radiographs of a girl aged 9-year-10-month-old, with an open physal and a painful mild valgus right SCFE is showed. The femoral capital epiphysis is eccentric (a). Anteroposterior and frog-leg lateral radiographs at 10-year-4-month-old was taken. The physal orientation is more horizontal (b). Last radiographs taken at 12-year-2-month-old, in anteroposterior and frog-leg lateral views; the epiphyseal line had closed (c). Patient in orthostatic / lying down abduction and crouch anteroposterior positions is presented (d).

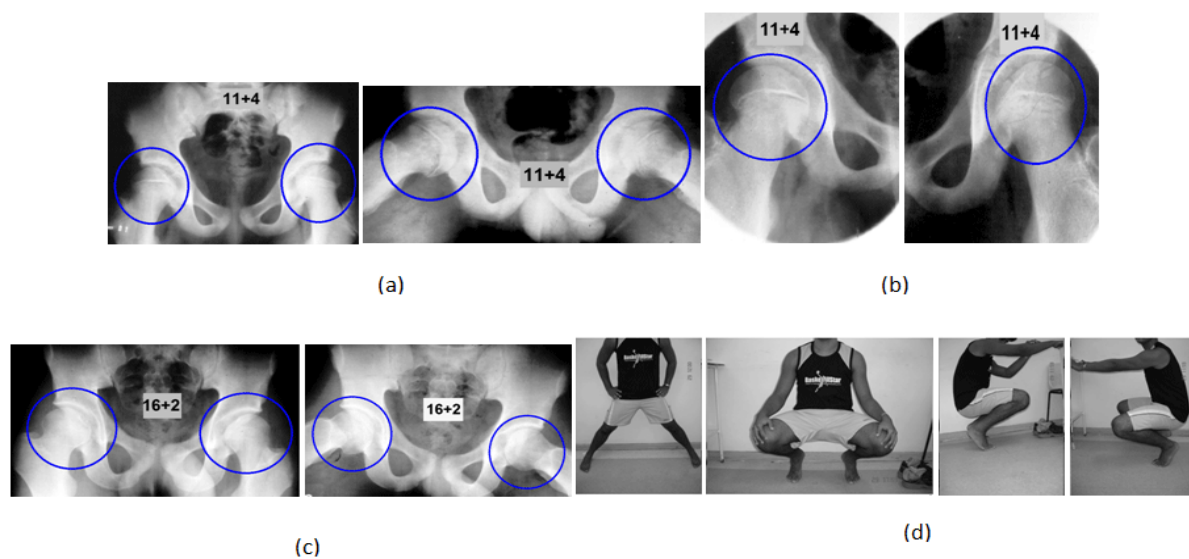


Figure 3: Anteroposterior and frog-leg lateral radiographs of a boy aged 11-year-4-month-old, with bilateral horizontal epiphyseal plate and painful mild bilateral valgus SCFE **(a)**. More detailed view on the anteroposterior radiograph showing slipping an open bilateral physis of both proximal valgus capital femoral epiphyses showing a laterally displaced capital epiphyses of the head of the femur **(b)**. Radiographs taken at 16-year-2-month-old, in anteroposterior and frog-leg lateral radiographs, observing both proximal epiphyseal lines closed **(c)**. Patient in orthostatic abduction and anteroposterior / lateral crouch position **(d)**.

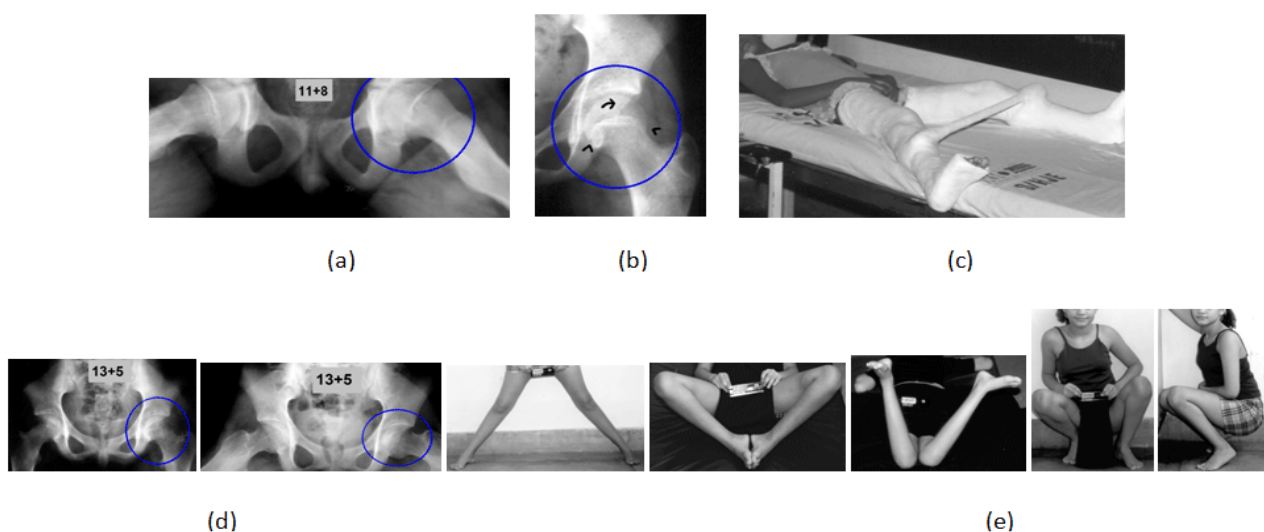


Figure 4: Anteroposterior and frog-leg lateral radiographs of a girl who hesitated to stand up, aged 11-years-8 month, with an open physis of valgus left SCFE **(a)**. A more detailed view showing valgus slipping of the left hip **(b)**. A double long leg (toe-to-groin) casts with antirational bars (cross bar-struts) as a rule of treatment which maintain the extremities in abduction and internal rotation of about 300 degrees have been applied **(c)**. Radiographs taken at 13-year-old- 5 month-old, in anteroposterior and frog-leg lateral radiographs, the epiphyseal line had physical fusion **(d)**. Patient in orthostatic and lying down abduction positions; in ventral decubitus with some limitation of the internal rotation of the left hip joint and excellent anteroposterior and lateral crouching positions at the end of the treatment **(e)**.

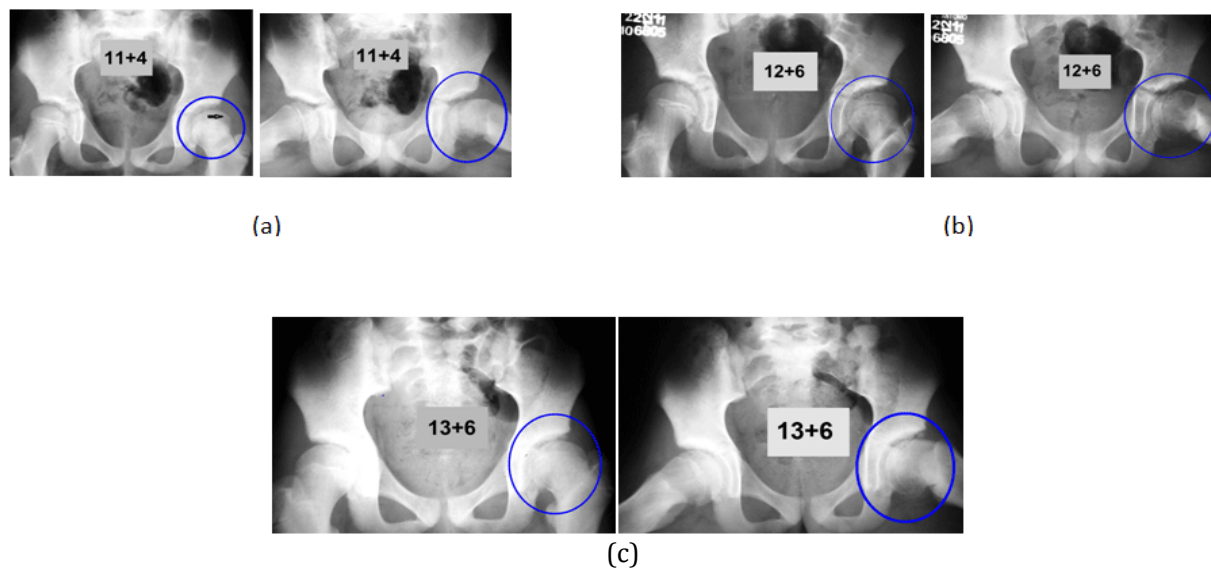


Figure 5: Anteroposterior and frog-leg lateral radiographs of a boy aged 11-year-4-month-old, with a painful and open physis on a mild left valgus SCFE (a). The orientation of the growth plate is more horizontal in anteroposterior views. Radiograph control in anteroposterior and frog-pelvis aged 12year-6-month-old (b). Last radiograph aged 13-years-6 month, in anteroposterior and frog-leg lateral radiographs, showing left proximal capital femoral epiphyseal line complete closed (c).

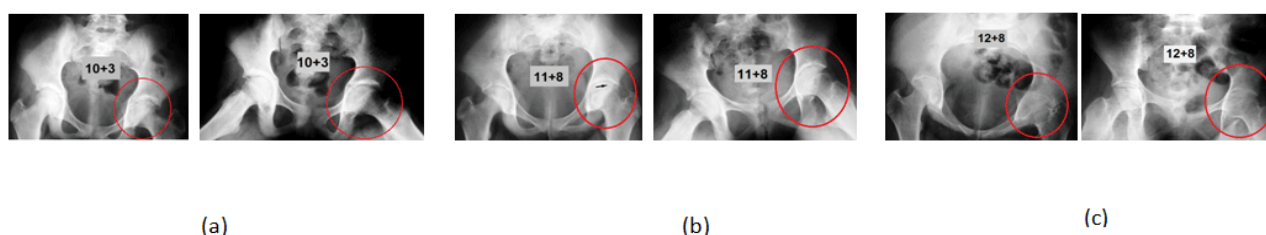


Figure 6: Anteroposterior and frog-leg lateral radiographs of a girl aged 10-years-3-month-old, with a painful and open physis of the left valgus SCFE, physis more horizontally can be observed (a). Radiographs at the age of 11-year-8-month-old (b) and a 12year-8-month-old views taken narrowing of the left hip joint space (chondrolysis of the left hip/necrosis of the joint cartilage – Waldenström50 disease) , was demonstrated (c).

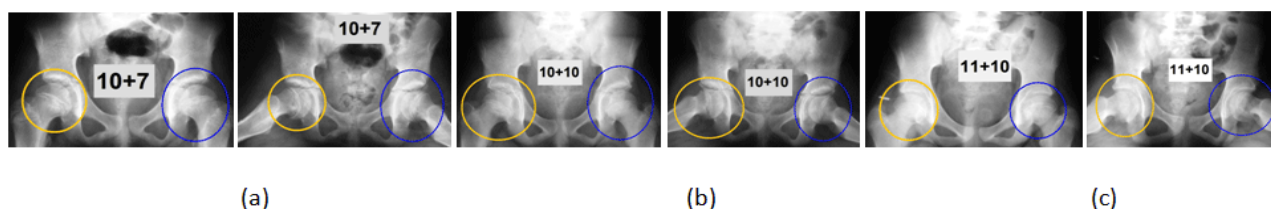


Figure 7: Anteroposterior and frog-leg lateral radiographs of a girl with an open physis aged 10-year-7month-old, showing a painful varus right and valgus of left SCFE with the left hip physis appear more horizontally (a). Radiographs taken at 10-year-10 month-old (b) and 11-year-10 month-old, showing both left physis in anteroposterior and frog-pelvis almost completely closed(c).

Case Comments

Chondrolysis as complication were detected in two cases (1 and 6) in 8 analyzed hip joint. Chondrolysis is defined as pain, muscle spasms, stiffness, mobility limitation, narrowing of the hip joints as well as radiographic measurements. The results of chondrolysis incidence in relation to sex, race, side, symptomatology, concerning to slip degrees were documented.

One patient with juvenile rheumatoid arthritis (Case 1) and the other patient with endocrine dysfunction (Case 2) as atypical valgus SCFEs were observed. The other five patients with absence of diseases as idiopathic valgus SCFE were documented. The type of cast, only in one patient (Case 1) hip spica was used, and in the other six patients have been employed (Cases 3 until 7), long/short leg cast with anti-rotational bars with lower limbs in abduction and internal rotation about 30°. Avascular necrosis in none of the hips with cast treatment was detected. On radiograph taken in patients with valgus SCFE, the Klein's line in all hips, an increase of intersection between a line draw parallel to the superior edge of the femoral neck was observed [39]. The case 1 of our valgus SCFE list, the right hip (non-white female patient), showed periarticular osteoporosis, joint space narrowing and coxa valga deformity compatible with chondrolysis. Another chondrolysis complication result treated with bilateral short cast in non-white female patient (Case 6) was reported.

Valgus SCFE Treatment Literature

Concerning treatment of SCFE Sir Reginald Watson-Jones, said: the treatment of displacements of the upper femoral epiphysis is not a very happy chapter in the history of orthopedic surgery [40]. The treatment of the SCFE has been the matter of much contestation and debate. The principal treatment's objective of SCFE is to identify the condition, avoiding progressive displacement and accomplish the most adequate management. The first essential to treatment is early diagnosis [13]. To obtain a good prognosis of the treatment is necessary: an early clinical patient history, a good physical finding and good radiographs in anteroposterior and frog-leg lateral (Lauenstein 1) position. The purpose of treatment is to avoid sequential displacement with the safest and the most effective technique proposing to arrest the growth plate. The author's literature treatment of valgus SCFE is above reported. Scheuermann 7 patient confinement to bed was prescribed. Finch and Roberts bilateral long-leg casts in internal rotation with cross bar strut and in another patient, traction plus spica cast for six weeks was used [8]. Meyer et al manipulation and well-leg traction was employed. Shelton three Knowles' pins were used [11,15]. Mihran O. Tachdjian pins in situ and varization osteotomies with spica cast were reported [16]. Skinner and Berkheimer three Knowles pins were used [17]. Rothermel four Knowles' pins were applied [18]. Carliz et al started to use screw fixation, as the classical percutaneous technique [19]. Scher et al had bilateral modified Imhauser-Weber osteotomies carried out [20]. Segal et al in situ screw fixation was employed [21]. Rajan et al an adductor tenotomy following varus osteotomy plus Richards' screw and spica cast for 6 weeks was utilized. Docquier et al, Yngue et al, Loder et al, Shea

et al, Mata and Ovejero fixation with screws were used [22-26,3]. Shank et al screws and two surgical osteotomies were employed [27]. Renganathan et al had patients treated by traction. Venkatadass et al Koczewski, Kotoura et al screw fixation were used. In recent years, the treatment of valgus SCFE, using screw pin fixation has been usually surgical [3, 19, 21-31]. In some cases of severe displacement, authors have found difficulties of placing in situ screws, due to potential danger to the neurovascular structures in patients with more valgus slip and they recommend a limited open anteromedial approach for fixation of valgus SCFE [3,21,24-27,29,31].

The routine methodology in current report on conservative principle with the use of spica cast immobilization in accordance with Betz et al protocol and bilateral short/long leg casts in abduction, slight internal rotation (30°) with antirotational bars based on Kite; Wright, et al and King works was used [41-44]. Cast immobilization for 12 weeks, in accordance with the casting protocol was carried out. No weight-bearing during the "casting period" was permitted. One case of Waldenström's disease associated with poly-articular rheumatoid with the use of spica cast immobilization was observed. Moule and Golding the appearance of hip changes in a patient with poly-articular rheumatoid disease (Still's disease) associated with coxa valga have been described [45,46]. The manifestation and prevalence of chondrolysis as complication in female and non-white patients are some of the unclarified points in the literature [32]. Wright et al and King presented 52 cases with the use of bilateral short-leg cast immobilization as a form of treatment for SCFE without chondrolysis [43,44]. Regarding the frequency of development of chondrolysis in non-white patients with the diagnosis of SCFE, we think that cast immobilization, at least, is not the major factor in the development of this complication [47]. Pinheiro [32] used cast treatment for SCFE (106 hip joints) and had 11.3% of chondrolysis as complication [32]. Betz et al 41 with spica-cast immobilization in 37 hips had five hips (13.5%) with chondrolysis. Ingram et al the incidence of chondrolysis varies from 2% to 55%. It may occur after any type of treatment, whether conservative or operative [48,49]. In summary, the cause of chondrolysis after SCFE still remains obscure and their genesis either not yet clarified at all [49].

Note: Skinner and Berkheimer [17] in his article observed a patient with a right valgus slip with contralateral varus, probably the first case in the orthopedic literature [17]. Venkatadass et al also have shown varus of the right (1 year ago) and valgus of the left the hip treated with two 6.5mm partially threaded cancellous screws in both hips (second case) [29]. Kotoura et al presented the third case with right valgus SCFE and left typical varus SCFE [31]. In our sample we had a patient (Case 7) with a varus of the right and valgus SCFE of the left hip. Presumably the fourth varus + valgus patient in the literature published.

Discussion

SCFE is a painful adolescent hip disorder in which the capital femoral epiphysis is dislocated around the metaphysis of the proximal femur [2,3]. In the majority of SCFE cases, the capital

femoral epiphysis posterior and medial in relation to the femoral neck is displaced. When the displacement is lateral (rare condition) we use the term valgus SCFE [3]. The first article to describe the lateral displacement of the epiphysis against the femoral neck to Müller has been credited [6]. The lateral displacement of the femoral head in the literature is less discussed and only 27 articles as valgus SCFE have been published. About 69 patients with 89 valgus SCFE in the pertinent review of the literature from 1926 until 2017 have been collected. The epidemiology, occurrence and demographics of valgus SCFE patients by the following authors are described. Loder et al, 4 patients (4.7%) with 7 valgus SCFEs (3.8%) from 105 children with 141 idiopathic SCFEs until 2006, have been published [3]. Howorth in his series of 243 cases of SCFE has reported three hips with valgus deformity [9]. Jerre in his series of 153 re-examined patients (183 hip joints) has found four patients (2.6%) seven hip joints (3.8%), with valgus SCFE [10]. Wilson et al in their series of 240 patients (300 hips) two patients (0.83%) with valgus SCFE and two hips (0.66%) were collected [13]. Carliz et al in his series of 80 patients two (2.5%) were valgus SCFE. Shank et al has observed 12 valgus SCFEs (16 hips) among 258 patients (4.7%). Koczewski a total of 115 patients 11 (9.6%) were valgus SCFE [19,27,30]. In this work, 7 patients (5.3%), 8 hips (4.8%) with valgus SCFEs among 131 patients (166 hip joints) with SCFE were observed.

The clinical characteristic scope of valgus SCFE has permitted new relations and discoveries and for this reason each main topic will be separately discussed.

Age

Concerning the average age of patients at diagnosis presentation (years) of the literature with valgus SCFE was 12 years [7,8,11-31]. In this work the author's average of 11 years was similar to the literature. The medium age at diagnosis of patients with valgus SCFE was 2.3 years lower than the classic SCFE Loder et al, and Shank et al [3,27].

Gender

Loder and Skopelja mentioned: in a review of 4343 children with classic varus SCFE, 64.3% were boys and 35.7% girls. The reviews of the valgus SCFE literature, investigations in a relationship about sex, 40 (66.6%) were female and 20 (33.3%) males [50,7,8,11-31]. Loder et al 50%, Yngue et al 57%, Shank et al 58.3%. Koczewski, 55% also the same predominance in girls was found. In this sample, 5 females (71.4%) and 2 males (28.6%) were similar to the valgus female SCFEs literature (76%) [3,24,27,30]. The possible explanation of the higher female predominance in valgus SCFE may be increasing femoral anteversion in females [51]. Anteverted femoral neck with a horizontal physis predisposes to a valgus SCFE [22].

Racial

Articles on the racial frequency of valgus SCFE literature, describe 21 (65.0%) non-white and 11 (34.4%) white patients [3,7,8,11-31]. In this series 2 (28.6%) white and 5 (71.4%) non-white children, valgus SCFE were in accordance with valgus SCFE literature.

Body Weight

Obesity is a predisposing factor of SCFE [50]. Previous studies confirm a very high percentage (72%) of these patients to be substantially overweight (maturation factors [52]). The article abstracted from valgus SCFE literature some comments about body weight was found: Loder et al [3] noted the average weight was (69.1±17.2kg); Segal in the first case the weight 36kg (above the 75th percentile for her age) and the second weighed 91kg (above the 95th percentile for age); Docquier et al reported patient weight was 26kg (P3 = 34kg); Yngue et al collected 4 obese patients who have presented the 95th percentile weight for obesity; Shea et al in both case body weights belowered the 45th percentile for age, neither of these patients were obese; Shank et al noted (67.7±20.2kg) [21,23-25,27]. In the present work among 7 valgus SCFE, 2 children (2.9%) were considered obese (48.2±17.5kg) and 5 (97.1%) non obese. The results were based on the graphics for obesity [39]. In this report, obesity was not a risk factor for development of the disease.

Side of Involvement

The authors that have mentioned side of involvement from valgus SCFE literature were: 41.5% right, 28.3% left and 30.2% bilateral involvements [3,7,11-31]. In the present series the prevalence of the left side was 62.5%, right 37.5% and 1 bilateral 12.5% had side of involvement identified. This report confirmed that previous studies are in accordance with the literature.

Symptom Duration

Concerning symptomatology of valgus SCFE literature, a chronic category was the prevalence data [3,8,11,12,14, 15,17-26,28-31]. In this sample chronic presentation category (62,5%) was widely found, in accordance with the valgus SCFE literature.

Stability

Concerning the concept of stability the average of the valgus SCFE literature, 10% were instable and 90% stables [3, 21,-23, 26-31]. According to stability type, Loder et al had 7 stable valgus SCFEs, Segal et al had 2 stable hips, Rajan et al 1, Docquier et al 1, Yngue et al 7, Mata and Ovejero 1, Shank et al 10 stables and 1 unstable [3,21-24,26]. Renganathan et al 1 stable, Venkatadass et al 1 stable and 1 unstable, Koczewski 10 stables and 1 unstable, Kotoura et al 1 unstable valgus SCFE [28-31]. In this article all stable valgus patients SCFEs were observed.

Slip Severity

The slip severity of the valgus SCFE, Loder et al 3 (7 hips / grade I), Jerre (3 slight and 4 marked), Tachdjian (1 hip grade I and 1 grade II), Segal et al (1 hip / grade III), Rajan et al (1 hip / grade III), Shea and Kotoura et al (1 hip / grade II) from author's literature were reported [3,10,16,21,22,25,31]. Among this study all 8 (100%) slip severity were grade I.

Conclusions

Evaluation in modern medicine must be based on evidences of the results and on the functional radiographic measurements. This article has shown an optional method, using cast treatment

for patients with a very rare entity known as valgus SCFE. The authors have presented a disease with radiographic aspects of the unusual entity. The plaster cast immobilization as a form of conservative treatment has been employed. Differences between groups of continuous data statically were analyzed. The dependent variables (Chondrolysis) as complication by the authors in our owns series of valgus and classic SCFE were cited. We want to call attention to the orthopedic surgeons and rheumatologists for patients with valgus SCFE with associated of JRA and the possibility of having chondrolysis as a complication[50].

In conclusion, we judged that cast treatment for SCFE's (classic/valgus) was productive, functional, competent and it can be used for services with the difficulties of using a safe surgical procedure with appropriate fluoroscopy (X- ray machine) and cannulated screws for slipping fixation as a method of treatment.

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Ethical Approval

The procedures in this study involving human participants was in accordance with the ethical standards of the Institutional Jesus Children Hospital Rio de Janeiro, Brazil, and with the 1964 declaration of Helsinki (DoH) and its later amendments/clarifications have been performed. This study with CAAE (Presentation Certificate for Ethical Appreciation) number 73819017.0.0000.5279 of November 28, 2017 was registered.

Consent

Written informed consent from parents/guardians for publication of this report and accompanying images was obtained. Written consent on the patient's chart registration number # 814330 # 25127 # 47008 # 81788 # 106805 # 80826 # 49174, Departments of Orthopedic, and Radiologic Services of Jesus Children's Hospital, Rio de Janeiro, Brazil is available.

Disclosure

None of the authors received payments or services, either directly or indirectly, i.e., via his or her institution of any aspect of this work. None of the authors, or their intuition(s), have had any financial relationship, prior to submission of this work, with any entity in the biomedical arena that could be perceived to influence or have the potential to influence what is written in this article. Also, no author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work.

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