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Original Article / Оригинални рад

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Treatment of slipped capital femoral epiphysis – a comparative study during twelve years period

Лечење склизнућа главице бутне кости – упоредна студија у периоду од дванаест година

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Лечење склизнућа главице бутне кости – упоредна студија у периоду од дванаест година

SUMMARY

Introduction/Objective The purpose of this study was to compare two methods of treatment and to evaluate the advantages in final outcome of transcervical fixation of femoral head using one cannulated screw in treatment of slipped capital femoral epiphysis (SCFE).

Methods This study included 65 pediatric patients (35 boys and 30 girls), aged 6-16 years (average 11.86), during twelve years period (from 2000-2012). We compare the slipping degree before and after treatment (Southwick angle), range of motion (ROM) before and after treatment and complication occurrence between two groups of children. The first group of children (26 patients) undewent closed reduction and cast immobilisation (Group I). The other group (39 patients) was treated with transcervical fixation using one cannulated screw (Group II).

Results Comparing preoperative and postoperative Southwick angle, we found much better improvement in Group II, but without statistical significance between two groups of patients (p=0.09). Observing the range of motion (ROM) of the hips before and after tretament, we found improvement in both groups of patients, especially in patients treated using transcervical fixation with cannulated screw (Group II). In complication occurrence patients in Group II had less complication occurrence comparing to Group I (p=0.02) .

Conclusion The transcervical fixation using one cannulated screw has better clinical outcome and less complications rate in relation to closed reduction and cast imobilisation in treatment of SCFE.

Keywords: transcervical fixation; cannulated screw; closed reduction

САЖЕТАК

Увод/Циљ Циљ ове студије је поређење две методе лечења и процена предности резултата лечења трансцервикалном фиксацијом главе бутне кости употребом једног канулираног завртња у лечењу склизнућа главе бутне кости (СГБК).

Методологија У студију је укључено 65 педијатријских пацијената (35 дечака и 30 девојчица), узраста од 6 до 16 година (просечна вредност 11.86), током 12- годишњег периода (од 2000. до 2012. година). Упоређивали смо степен склизнућа пре и након спроведеног лечења (Саутвиков угао), обим покрета пре и након спроведеног лечења и учесталост компликација између две групе пацијената. Прва група (26 болесника) је лечена затвореном репозицијом и имобилизацијом гипсаним завојем (Група I), а друга група (39 болесника) је била лечена перкутаном фиксацијом једним канулираним завртњем (Група II).

Резултати На основу поређења преоперативних и постоперативних вредности Саутвиковог угла, пацијенти групе II су имали бољи радиографски резултат у односу на пацијенте из групе I, али без статистички значајне разлике (p=0.09). Посматрајући обим покрета кукова пре и после интервенције, забележено је значајно побољшање у обе групе болесника, посебно у пацијената лечених трансцервикалном фиксацијом једним канулираним завртњем (Група II). Посматрајући учесталост компликација болесници Групе II су имали мањи број компликација (p=0.02) у односу на пацијенте Групе I.

Закључак Метода трансцервикалне фиксације главе бутне кости је дала бољи клинички резултат и мањи број компликација у односу на методу ортопедске репозиције и имобилизације гипсаним завојем у лечењу болесника са СГБК.

Кључне речи: трансцервикална фиксација; канулирани завртањ; затворена репозиција

INTRODUCTION

Slipped capital femoral epiphysis (SCFE) is the most common hip disorder in adolescence, especially in obese adolescents. It occurs 0.2-10 per 100 000 children [1]. Also, it could be connected to endocrinological disorders, especially hypothyrodism and hyperparathyroidism [2, 3]. Etiology of SCFE is still unknown, but it is obviously that mechanical, endocrinological and genetic factors

during adolescent period cause SCFE [4-11]. It has been classified according to symptom duration, to weight ability and to radiographic degree of slip. Approximately, in 20-25% SCFE could be bilateral [12, 13].

Complications of SCFE could be early and late. Early complications are rare, contrary to late complications. Avascular necrosis (AVN) and chondrolysis are the most serious and most common late complications of SCFE. AVN is related to insufficient blood supply of the femoral neck and head after proximal femoral epiphysis slips [4]. Epiphyseal slip severity correlate directly to late complications occurrence [4,7,13].

Various procedures have been described in treatment of SCFE: closed reduction and cast imobilisation, minimal invasive surgery and percutaneous fixation or femoral osteotomies and osteosynthesis.

Prophylactic stabilization of contralateral hip is still controversial [14-16].

The aim of this study was to compare two methods of treatment of SCFE and to evaluate the advantages of transcervical fixation of femoral head using one cannulated screw in final outcome.

METHODS

This retrospective study included 65 pediatric patients (35 boys and 30 girls), aged 6-16 years (average 11.86), during twelve years period (from 2000-2012). Observation period was in range of 6 months to 12 years (average 6.83 years). We compared the slipping degree angle before and after treatment (Southwick angle), range of motion of the hip before and after treatment and complications occurrence between two groups of children [15,16]. The first group of children underwent closed reduction and cast immobilisation (Group I). Group I included 26 patients (12 boys and 14 girls). The other group (Group II) was treated with percutaneous pinning using one cannulated screw. This Group included 39 patients (23 boys and 16 girls). We observed various types of SCFE: according to slip duration, to slipping degrees and according to slip instability. According to SCFE types, in our study acute slips (less than 3 weeks duration) were presented in 6/26 (23.08%) in Group I, and in Group II were presented in 11/39 (28.21%) patients. According to weight ability, in both groups dominated stable slips, in Group I in 20/26 (76.92%) and in Group II in 33/30 (81.54%) patients. Stable slips include slips where patients could walk (with or without crutches), contrary to unstable ones where patients have severe pain that walkin is not possible, even with crutches. Five patients had an endocrinologycal contribution in SCFE, 3/26 (11.54%) in Group I, and 2/39 (5.13%) in Group II. Bilateral involvement was found in 7/65 patients (10.77%).

We observed radiologycal and clinical outcome in patients with SCFE. The Southwick angle is the radiologycal parameter in SCFE we observed. It is measured bilaterally in anteroposterior (AP) and “frog leg“ view, by drawing line perpendicular to epiphyseal line (connect point at anterior and posterior tip of epiphysis) and femoral shaft angle. The final result of the slip is obtain by subtraction from the angle of unaffected side and it is expressed in angle degrees. The clinical outcome we observed were range of motion of the hip before and after the treatment: flexion, abduction, external and internal rotation. For evaluation we used gonimeter and results are expressed in angle degrees. Also, we evaluate the complication occurrence in observed patients. It could be early (pain, infection, malfixation) or late (avascular necrosis, hondrolysis, reslip) complications.

The exclusion criteria in this study were metabolic and blood vessels diseases, patients on chemo or radio therapy and patients with bone dysplasia or bone tumors of proximal femur.

Reference data was selected according to hystory data, clinical findings and radiography of hips in anterioposterior and “frog leg” position.

Treatment procedure and postoperative treatment

Both groups were initially treated with percutaneous traction during period of two weeks. The traction were applied progressively in abduction and internal rotation (with 10% of patient total weight on each leg). After percutaneous traction period the Group I was treated with closed reduction and cast imobilisation using maneuver according to Whitman, which means fixed position of contralateral hip in maximal abduction (about 70 degrees) and progressive increase of abduction (about 60 degrees) and internal rotation (about 20 degrees) of affected hip and imobilisation in hip-spica cast [2,4]. The cast was removed after 6 weeks followed by physical therapy (kinesiotherapy), with progressive weight bearing (up to full weight bearing three months after cast removal).

The other group of patients (Group II) was treated using transcervical fixation with one cannulated screw. The patient was in supinated position with leg in slight extension, abduction and internal rotation. Under the C-arm fluoroscopy control, two Kirschner wires (K-wires) were inserted starting from base of the neck to epiphysis of proximal femur. The K-wires were used as "guides" for cannulated screw. Before cannulated screw insertion we did a small 2 cm skin incision and drilling over the K-wires. After cannulated screw was inserted, the K-wires were extracted and fluoroscopy control was done in AP and "frog leg" position. Average cannulated screw diameter was 4.0 or 4.5 mm (according to pateint's age). The physical therapy started two days after the surgery, with progressive weight bearing.

Radiography was done after treatment (for Group I before cast removal), three months after the treatment, and in 6-month period up to two years after treatment. After two years radiographic control was done annualy.

Statistical interpretation

In statistical interpretation we used descriptive and analytic methods of statistical analysis. For estimation of statistical difference between evaluated groups we used Pearson χ^2 test, Fisher exact test, Wilcoxon rank sum test with continuity correction and Mann Whitney U test. Statistical significance was set at $p \leq 0.05$.

RESULTS

This retrospective observed 65 pediatric patients, divided in two groups, depending on the method of treatement: closed reduction and cast imobilisation (Group I) or transcervical fixation using one cannulated screw (Group II). We found statistical significant differences between Group I and Group II concerning the age and body weight ($p<0.05$) of participants, as table 1 indicates.

Symptom-duration period (SDP) for Group I was average 61.77 days (range 2-180) and for Group II 50.72 days (range 3-180). We found no statistical signifficance in SDP between two groups of patients ($p=0.316$). Also, we found no statistical signifficance in side affection ($p=0.0655$).

For both groups of patients acute and stable slips dominated, but we found no statistical signifficance between observated groups, as it is presented in table 2 and 3. Endocrinologycal disorders in contribution of SCFE presented no statistical signifficance betwee two groups of patients ($p=0.3815$).

Observing preoperative and postoperative Southwick angle we found better improvement in Group II, but we found no statistical significance between two groups of patients, as table 4 presents.

In statistical analizies of ROM in affected hips before and after the treatment, we found improvement in both groups of patients, but no statistical significance was found between two groups of patients, as it is presented in table 5.

Observing the complications occurence, we found significant differences in complication occurrence and severity between two groups of patients ($p=0.022$). It is presented in table 6. In Group I we found avascular necrosis (AVN) of femoral head and neck in 4/26 patients (15.38%), and in

Group II we found no AVN, but we found reslip in one patient (2.5%). It is presented in table 7. In our study we found no chondrolysis in complication occurrence.

DISCUSSION

The goal in treatment of SCFE is early diagnosis and early treatment. We combined preoperative tractions with two methods of treatment: closed reduction and cast imobilisation and transcervical fixation using the cannulated screw.

Betz and co-workers observed the complication occurrence (AVN and chondrolysis) in patients treated with preoperative extension, closed reduction and cast imobilisation. Study included 32 patients (37 SCFE) during 11 years period. They concluded that 19% of patients had chondrolysis, 3% reslipping of capital femoral epiphysis, and no AVN reccurence [17]. Also, Hurley and coworkers compared reslipping occurence between patients treated with closed reduction (CR) and cast imobilisation and patients treated with femoral osteotomy. They concluded that 7% of patients treated with CR and cast imobilisation had reslipping versus 36% of reslipping in patients treated with femoral osteotomy [18]. Our study included 26 patients treated with CR and cast imobilisation. The complication occurrence in our study was 15.38% (4/26 patients), presented as AVN. All of our patients affected with AVN had an unstable form with slipping over 30 degrees. According to our observations we recommend an agressive approach of unstable and severe forms of SCFE.

One of the largest comparative studies concerning treatment of SCFE was published by Kitano and coworkers [19]. They observed 222 patients (average age 11.8 years) with average follow-up of 11.2 years. Preoperative slip-value (according to Southwick angle) measured using X-ray films in anteroposterior and "frog like" position was average 38.8 degrees. They compared the treatment outcome of SCFE between patients treated with closed reduction and cast imobilisation (65 patients) and patients treated with percutaneous transcervical fixation using one cannulated screw (157 patients). Both groups of patients were treated preoperatively with percutaneous traction in two weeks period. According to Southwick, the most slips (43%) were below 30 degrees, 42% of all slips were between 31-60 degrees and 15% of slips were over 61 degrees. The treatment results were compared acccording to Oxford score, postoperative slips and AVN occurrence. Finally, study confirmed that unstable and acute forms of SCFE had a high risk for AVN occurrence (unstable forms 30%, acute forms 26%). Patients treated with transcervical fixation using one cannulated screw had AVN occurrence of 6%. Comparing results of this study to results of our study, our patients had a lower preoperative slip-value (23.85 degrees for patients treated with CR and cast imobilisation and 23.87 for patients treated with transcervical fixation using one cannulated screw). Also, in our study

occurrence of the mildest forms of SCFE was much higher. We found 76.92% with Southwick angle below 30 degrees, comparing to 43% in Katano and coworkers study. Weight ability forms of SCFE was simillar, in our study 81.54% compared to 84.2% in Katano and coworkers study. AVN occurrence in our study was 15.38% for patients treated with CR and cast imobilisation, what is similar to Kitano`s results. Concerning clinical outcome (expressed in physical findings as ROM) before and after treatment, we found signifficant improval in ROM in both groups of patients. We prefere preoperative treatment using percutaneous traction as an important factor in clinical outcome. According to our results and results of Katano et al. study, treatment of SCFE with percutaneous traction, CR and cast imobilisation have unfavourable outcome in slipps of over 30 degrees, in acute and unstable forms of slipping. Treatment of SCFE using percutaneous transcervical stabilisation using one cannulated screw provide a good outcome and stability in slipps below 35 degrees. In severe slips, transcervical fixation using cannulated screw isn't as stable and becomes more vulnerable to complication occurrence.

Prophylactic stabilisation of contralateral hip is still controversial. We use it only in treatment of SCFE in endocriologycal diseases in children younger than 10 years.

CONCLUSION

According to our study of 65 patients with SCFE, the transcervical fixation using one cannulated screw has multiple advantages in relation to closed reduction and cast imobilisation. The major effect of this method of treatment is better clinical and radiologycal outcome. Also, this method of treatment decreases the complication occurrence.

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Table 1. Patient analysis according to gender, age and body weight depending of the method of treatment

Parameter	**Group I****	**Group II*****	**Test**
Gender male female	 12 (46.15%) 14 (53.85%)	 23 (58.97%) 16 (41.03%)	Pearson χ^2 test χ^2_1=1.0317.; p=0.3097
Age (years) Average (SD*) Mediana (range)	 10.74 (4.27) 11 (4-18)	 11.87 (4.49) 12 (3-18)	Wilcoxon rank sum test with continuity correction W=358 ; p= 0.0431
Body mass (kg) Average (SD*) Mediana (range)	 52.85 (13.94) 54 (17-78)	 66.56 (16.89) 65 (34-100)	Wilcoxon rank sum test with continuity correction W=277 ; p= 0.0021

*Standard Deviation
**Patients treated with closed reduction and casting (Whitman method)
***Patients treated using percutaneous pinning using one cannulated screw

Table 2. Type of SCFE related to method of treatment

Type of SCFE	Group I*	Group II**	Total	Pearson χ^2 test
Acute SCFE	6 (23.08%)	11 (28.21%)	17 (26.15%)	p= 0.64488
Chronic SCFE	20 (76.92%)	28 (71.79%)	48 (73.85%)	
Total	26 (100%)	39 (100%)	65 (100%)	

* Patients treated with closed reduction and casting (Whitman method)`

** Patients treated using percutaneous pinning using one cannulated screw

Table 3. Presentation of weight ability (stable vs. unstable) in SCFE depending of the method of treatment

Weight ability in SCFE(stable/unstable)	**Group I***	**Group II****	**Total**	**Pearson χ^2 test**
Stable SCFE	20 (76.92%)	33 (84.62%)	53 (81.54%)	p= 0.43358
Unstable SCFE	6 (23.08%)	6 (15.38%)	12 (18.46%)	
Total	26 (100%)	39 (100%)	65 (100%)	

* Patients treated with closed reduction and casting (Whitman method)`

** Patients treated using percutaneous pinning using one cannulated screw

Table 4. Southwick angle distinction (before and after treatment) depending of method of treatment

Treatment method	**Average (SD)* distinction**	**Mediana ***	**Range***	**Wilcox rang sum test with continuity correction**
Group I**	13.08 (7.63)	10	5-30	W=629 p=0.09974
Group II***	11.31 (12.4)	10	5-50	

*expessed in angle degrees
**Patients treated with closed reduction and casting (Whitman method)
***Patients treated using percutaneous pinning using one cannulated screw

Table 5. Range of motion (ROM) analysis before and after treatment of SCFE, depending of the method of treatment

Treatment method	Movement type	Before physiotherapy MV±SD*	After physiotherapy MV±SD*	Mann Whitney U test (p value)
Group I**	External rotation	38.46±5.62	39.23±4.84	0.696
	Internal rotation	23.46±4.85	32.69±3.80	<0.001
	Flexion	106.73±11.91	114.23±6.43	0.036
	Abduction	29.81±7.00	40.77±3.66	<0.001
Group II***	External rotation	37.69±6.57	41.28±4.25	0.018
	Internal rotation	23.33±3.31	37.56±3.01	<0.001
	Flexion	107.82±11.91	118.59±2.80	<0.001
	Abduction	28.72±5.82	42.69±2.53	<0.001

*Mean Value ± Standard Deviation (expressed in angle degrees)
* Patients treated with closed reduction and casting (Whitman method)`
** Patients treated using percutaneous pinning using one cannulated screw

Table 6. Complications ratio depending of method of treatment

Complications	**Group I***	**Group II****	**Total**	**Fisher Exact Test**
No complication	22 (84.62%)	38 (97.44%)	60 (92.31%)	p = 0.02208
With complication	4 (15.38%)	1 (2.56%)	5 (7.69%)	
Total	26 (100%)	39 (100%)	65 (100%)	

*Patients treated with closed reduction and casting (Whitman method)`

**Patients treated using percutaneous pinning using one cannulated screw

Table 7. Complication analysis depending of method of treatment

Complication type	Group I* (%)	Group II** (%)	Total (%)	Fisher exact test
No compl.	22 (84.62%)	38 (97.44%)	60 (92.31%)	p=0.2208
Acute compl.	0 (0%)	1 (2.56%)	1 (1.54%)	
AVN***	4 (15.38%)	0 (0%)	4 (6.15%)	
Total	26 (100%)	39 (100%)	65 (100%)	

* Patients treated with closed reduction and casting (Whitman method)`
**Patients treated using percutaneous pinning using one cannulated screw
***Avascular necrosis occurrence

Figure 1. Anteroposterior (AP) view of SCFE (right hip affected) before treatment

Figure 2. "Frog leg" view of SCFE (right hip affected) before treatment

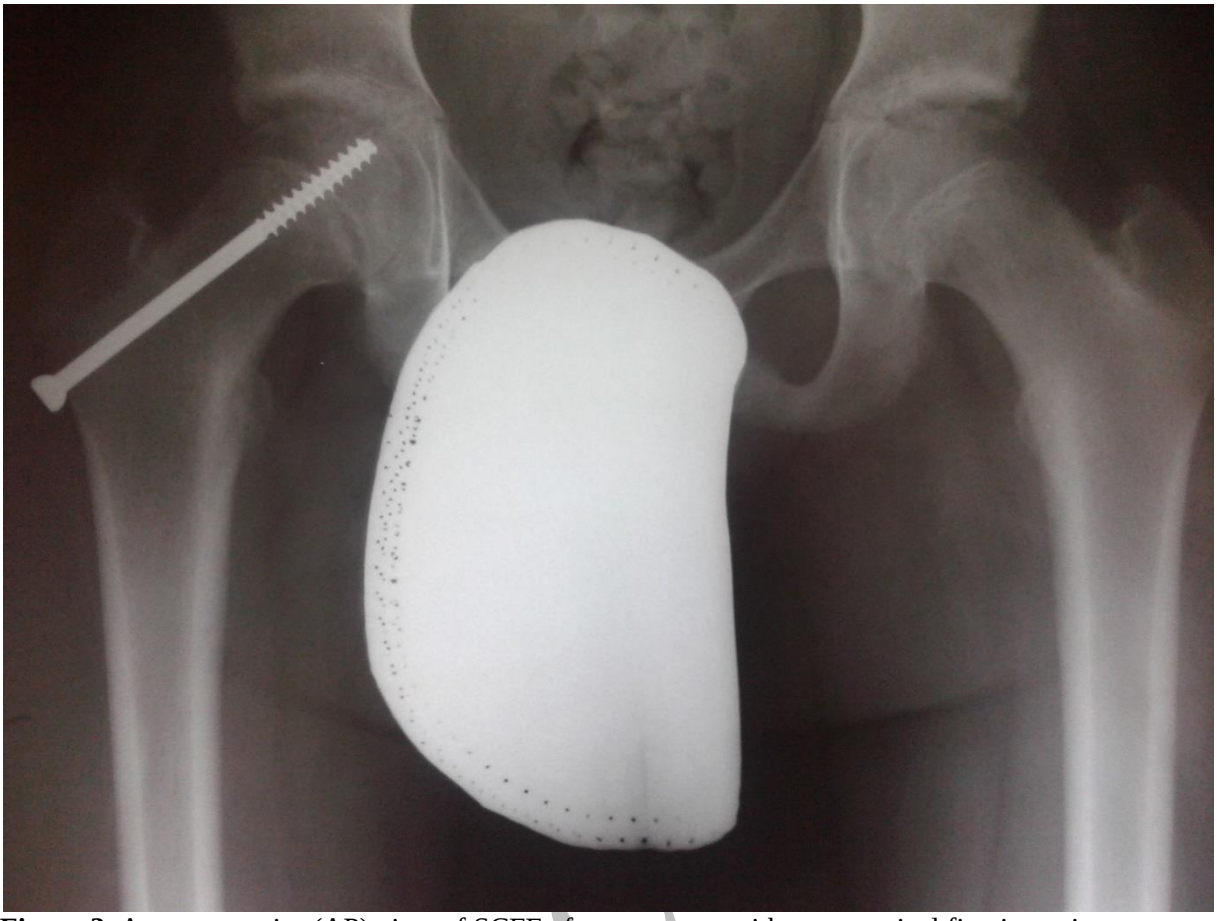

Figure 3. Anteroposterior (AP) view of SCFE after treatment with transcervical fixation using one cannulated screw (4.0 mm diameter)

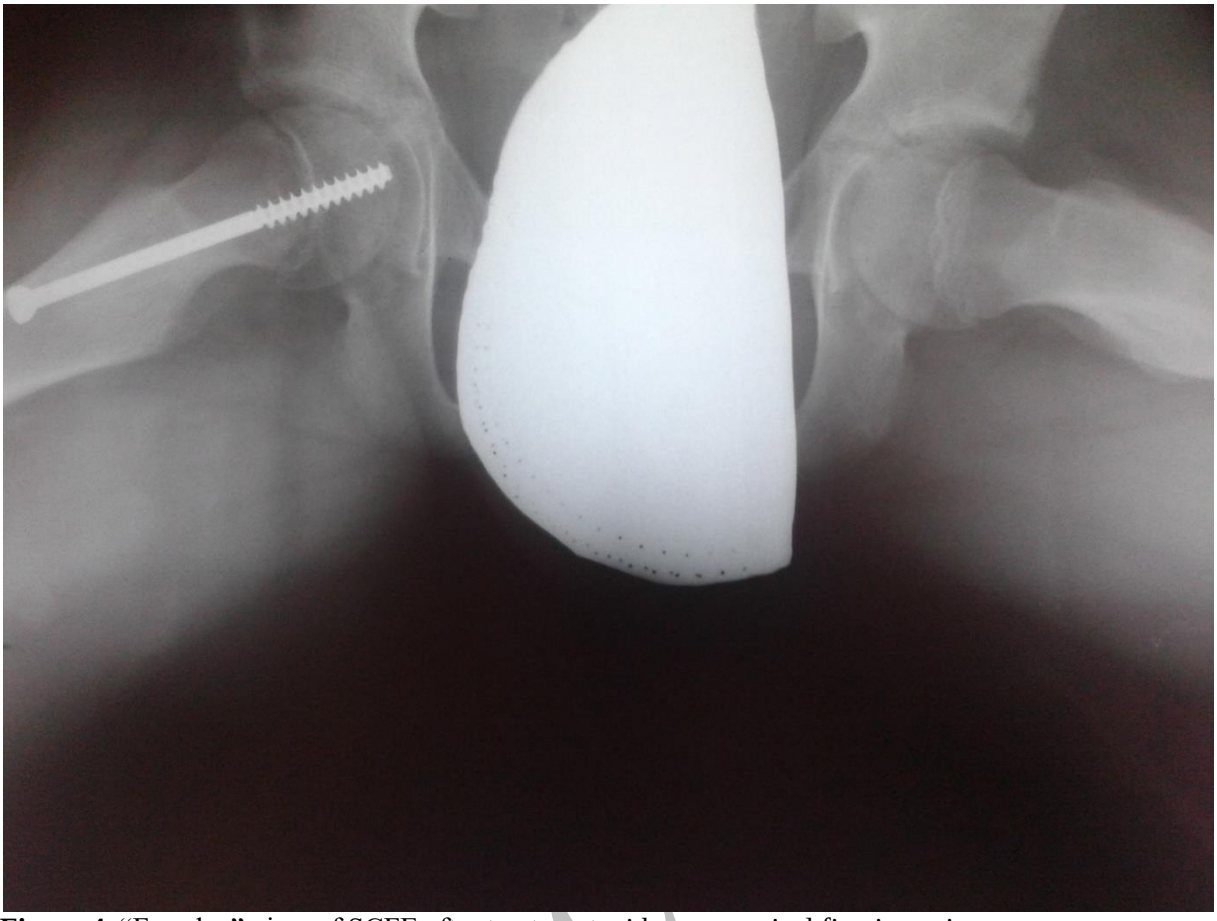

Figure 4. "Frog leg" view of SCFE after treatment with transcervical fixation using one cannulated screw (4.0 mm diameter)

