Minimal access surgeries for posterior pelvic injuries and sacral fractures: A systematic review and meta-analysis

Alaa Rafat Ramzy Abdalla,MBBCH; Ahmed Mohamed Sallam,MD and Abdelfattah M.F. Saoud,MD

Orthopaedic Surgery Department, Faculty of Medicine, Ain Shams University
* Corresponding author: Alaa Rafat Ramzy Abdalla
Address: Elkosia-Assiut,
E-mail: alaarafatramzy3@gmail.com
Mob:01222857316

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Abstract

Background
Percutaneous fixation of pelvic injuries was first described by Routt in 1993 and minimal invasive ilioilial screws for sacral fractures was also first described by Saoud A.M.F and Reda M.A. 2011.

Material and methods
We searched databases: Medline/PubMed, Cochrane library from 1998 to 2018 for the studies that deal with posterior pelvic and sacral fractures using p.c iliosacral or ilioilial screws and after application of our inclusion and exclusion criteria we identified Nine studies . Data from these studies were extracted and Statistical analysed using MedCalc© version 18.9.1 (MedCalc© Software, Ostend, Belgium).

Results
Our selected studies included 327 patients who were treated by minimal invasive iliosacral and ilioilial screws for posterior pelvic ring injuries and/or sacral fractures. Our extracted data were about clinical and radiological outcome of this method of treatment and it's complications including hardware failure, neurovascular injuries, non union, infection and need for re-operation . Our results were as follow: The rate to achieve satisfactory reduction(displacement less than 10 ml) is 92.6% , The rate to achieve excellent and good functional scores (according to Majeed score and Pohleman score) is 90%, Rate of hard ware failure and screws miss-displacement is 3.3 %, Rate of neurovascular complication is 2.8%, Rate of superficial infection is 3.5%, Rate of re-operation is 3.4%, Rate of non union is 0.0%.

Conclusion
From this study we concluded that percutaneous screw fixation for posterior pelvic and sacral fractures is a sound method of fixation and has low complication rate with good long term functional outcome.

Keywords
Iliosacral and ilioilial screws, Management of posterior pelvic fractures, Complications follow p.c. iliosacral and ilioilial screws.

Introduction

Unstable pelvic fractures are the most serious orthopedic injury, however controversy exists in the recommended treatment and outcome. [1,2] Anatomic reduction and stabilization is an important factor that determine the outcome of these fractures. [1,3]

Open reduction and internal fixation of pelvic ring disruptions usually disrupts the pelvic hematoma and lead to additional hemorrhage so it is usually delayed.

Closed reduction and percutaneous fixation of unstable posterior pelvic and sacral fracture can be used for early stabilization and provide stable internal fixation without causing disruption of pelvic hematoma and avoid large surgical exposure and major complications associated with these surgeries. [2,4] And that what we will survey and discuss in our study.

Aim of the work

In this study we will survey the effectiveness of minimal access surgeries including percutaneous ilioilial & iliosacral screws regarding operative time, infection rate, bleeding, other complication rate & biomechanical stability over traditional open methods in management of posterior pelvic and sacral fractures.

Material and Methods

A -Criteria for considering studies for this review

- Types of included studies

We used randomized controlled trials that evaluate the long term results & complications of MIS for posterior pelvic and sacral fractures.

- Types of participants

Only studies on human subjects underwent surgical intervention using percutaneous ilioilial, iliosacral screws for posterior pelvic and sacral fractures.

- Types of interventions

Surgical treatment of sacral & posterior pelvic fractures using percutaneous iliosacral, ilioilial screws.

- Types of outcome measures

The following Outcomes collected and data extracted from individual studies; blood loss, blood transfusion, duration of surgery, functional outcomes, complications (hardware failure, and non-union, superficial wound infection), and reoperation.

B- Search strategy for identification of studies

We searched databases: Medline/PubMed, Cochrane library, using the variety of Medical Subject Headings (MESH) and the following free text words: Iliosacral &ilioilial screws, complications of p.c. iliosacral and ilioilial screws, posterior pelvic fracture management. We conducted additional searches of current contents, best evidence and examination of cited reference sources.

C-Methods of the review

1- Locating and selecting studies

Abstracts of articles identified using the above search strategy reviewed, and articles that look like to fulfill the inclusion criteria reviewed in a full, when there is a doubt, a second reviewer will assess the article and consensus will be reached. We exclude non RCT, case report studies, studies discuss other modalities of treatment, review articles.

2- Data extraction

Data independently extracted from the included studies .

3- Statistical considerations

Statistical analysis was done using MedCalc© version 18.9.1 (MedCalc© Software, Ostend, Belgium).

Testing for heterogeneity

Studies included in meta-analysis were tested for heterogeneity of the estimates using the following tests:

1. Cochran Q chi square test: A statistically significant test (p-value <0.1) denoted heterogeneity among the studies.
2. I-square (I^2) index which is interpreted as follows;
   - § I^2 = 0% to 40%: unimportant heterogeneity
   - § I^2 = 30% to 60%: moderate heterogeneity
   - § I^2 = 50% to 90%: substantial heterogeneity
   - § I^2 = 75% to 100%: considerable heterogeneity

Examination of publication bias

Publication bias was assessed by examination of funnel plots of the estimated effect size on the horizontal axis versus a measure of study size (standard error for the effect size) on the vertical axis. In the presence of bias, the plots are asymmetrical.

Pooling of estimates

Incidence of events was presented as proportions with their 95% confidence limits (95% CI). Estimates from included studies were pooled using the DerSimonian laird random-effects method (REM) and the Mantel-Haenszel fixed-effects method (FEM). Because of the presence of significant heterogeneity, the random-effect estimates were considered.

Results

We searched 28 studies, 9 of them are excluded based on title review. Other 10 are excluded based on full text assessed for eligibility leaving 9 studies that met the inclusion criteria as shown in (figure 1).

Inclusion criteria:

1- Studies that are written in English.
2- Studies involving human subject only.
3- Randomized controlled trials (RCT).

Exclusion criteria:

1- Studies written in languages other than English
2- Studies not involving human subject.
3- Non RCT, cross sectional studies or one arm study not providing numerical data.
4- The duplicated article by the same author.
5- Review articles.
6- Studies discuss other modalities of treatment.
7- Studies discuss pathological fractures or specific type of fractures as U shape sacral fractures

Results of our meta-analysis are shown in tables 1 to 7.

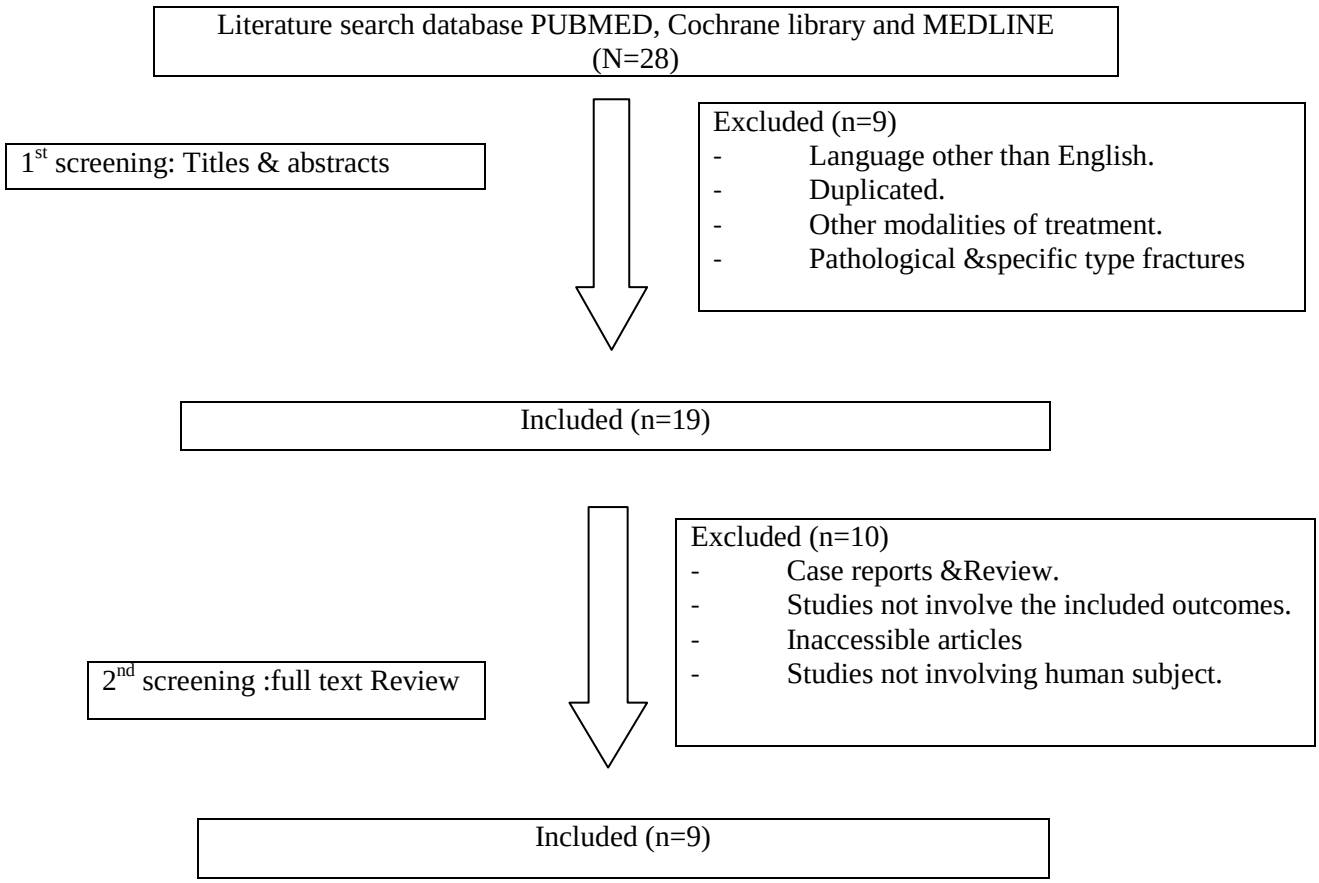

Figure 1: Details the study selection flow.

Table 1: Meta-analysis for the rate of satisfactory reduction

Study	N	Event rate (%)	95% CI	Weight (%)	
				Fixed	Random
Bousbaa 2017	5	100	47.818 to 100.000	2.15	6.39
Choy 2012	32	78.125	60.027 to 90.723	11.83	14.74
El-Desouky 2016	20	80	56.339 to 94.267	7.53	12.64
Lindsay 2016	53	100	93.277 to 100.000	19.35	16.61
Naudé 2014	41	97.561	87.145 to 99.938	15.05	15.71
Saoud 2018	50	90	78.186 to 96.672	18.28	16.42
Schweitzer 2008	71	97.183	90.192 to 99.657	25.81	17.49
Total (fixed effects)	272	93.873	90.383 to 96.385	100	100
Total (random effects)	272	92.59	85.032 to 97.643	100	100
Test for heterogeneity					
Q	22.9453				
DF	6				
Significance level	P = 0.0008				
I^2 (inconsistency)	73.85%				
95% CI for I^2	44.07 to 87.78				

N = number, 95% CI = 95% confidence interval, Q = Cochran Q, DF = degree of freedom.

Table 2: Meta-analysis for the rate of achieving excellent / good functional score

Study	N	Event rate (%)	95% CI	Weight (%)	
				Fixed	Random
Ayvas 2011	20	100.000	83.157 to 100.000	8.75	11.73
Bousbaa 2017	5	80.000	28.358 to 99.495	2.50	4.48
Choy 2012	32	81.250	63.561 to 92.792	13.75	15.35
El-Desouky 2016	20	85.000	62.107 to 96.793	8.75	11.73
Elzohairy 2016	35	85.714	69.743 to 95.194	15.00	16.07
Saoud 2018	50	96.000	86.286 to 99.512	21.25	18.96
Schweitzer 2008	71	91.549	82.508 to 96.835	30.00	21.68
Total (fixed effects)	233	90.023	85.513 to 93.506	100.00	100.00
Total (random effects)	233	89.586	83.404 to 94.461	100.00	100.00
Test for heterogeneity					
Q	11.0163				
DF	6				
Significance level	P = 0.0879				
I^2 (inconsistency)	45.54%				
95% CI for I^2	0.00 to 77.06				

N = number, 95% CI = 95% confidence interval, Q = Cochran Q, DF = degree of freedom.

Table 3: Meta-analysis for the rate of hardware failure & misplacement of screws

Study	N	Event rate (%)	95% CI	Weight (%)	
				Fixed	Random
Ayvas 2011	20	0.000	0.000 to 11.944	11.76	14.40
Bousbaa2017	5	0.000	0.000 to 52.182	2.35	5.29
Choy 2012	32	0.000	0.000 to 10.888	12.94	14.99
El-Desouky 2016	20	0.000	0.000 to 16.843	8.24	12.15
Naudé 2014	41	7.317	1.535 to 19.925	16.47	16.42
Saoud 2018	50	0.000	0.000 to 7.112	20.00	17.51
Schweitzer 2008	71	11.268	4.992 to 21.000	28.24	19.24
Total (fixed effects)	248	3.842	1.841 to 6.993	100.00	100.00
Total (random effects)	248	3.154	0.563 to 7.741	100.00	100.00
Test for heterogeneity					
Q	15.1444				
DF	6				
Significance level	P = 0.0192				
I^2 (inconsistency)	60.38%				
95% CI for I^2	9.16 to 82.72				

N = number, 95% CI = 95% confidence interval, Q = Cochran Q, DF = degree of freedom.

Table 4: Meta-analysis for the rate of neurovascular complications

Study	N	Event rate (%)	95% CI	Weight (%)	
				Fixed	Random
Ayvas 2011	20	0.000	0.000 to 16.843	8.43	8.68
Bousbaa 2017	5	0.000	0.000 to 52.182	2.41	2.52
El-Desouky 2016	20	5.000	0.127 to 24.873	8.43	8.68
Elzohairy 2016	35	0.000	0.000 to 10.003	14.46	14.63
Naudé 2014	41	2.439	0.0617 to 12.855	16.87	16.96
Saoud 2018	50	0.000	0.000 to 7.112	20.48	20.39
Scweitzer 2008	71	5.634	1.556 to 13.801	28.92	28.15
Total (fixed effects)	242	2.793	1.126 to 5.682	100.00	100.00
Total (random effects)	242	2.776	1.070 to 5.247	100.00	100.00
Test for heterogeneity					
Q	6.2292				
DF	6				
Significance level	P = 0.3980				
I^2 (inconsistency)	3.68%				
95% CI for I^2	0.00 to 72.35				

N = number, 95% CI = 95% confidence interval, Q = Cochran Q, DF = degree of freedom.

Table 5: Meta-analysis for the rate of non-union

Study	N	Event rate (%)	95% CI	Weight (%)	
				Fixed	Random
Bousba 2017	5	0.000	0.000 to 52.182	5.41	5.41
Choy 2012	32	0.000	0.000 to 10.888	29.73	29.73
Schweitzer 2008	71	0.000	0.000 to 5.063	64.86	64.86
Total (fixed effects)	108	0.572	0.00227 to 4.350	100.00	100.00
Total (random effects)	108	0.572	0.0300 to 2.819	100.00	100.00
Test for heterogeneity					
Q	0.5326				
DF	2				
Significance level	P = 0.7662				
I^2 (inconsistency)	0.00%				
95% CI for I^2	0.00 to 87.40				

N = number, 95% CI = 95% confidence interval, Q = Cochran Q, DF = degree of freedom.

Table 6: Meta-analysis for the rate of reoperation

Study	N	Event rate (%)	95% CI	Weight (%)	
				Fixed	Random
Ayvaz 2011	20	0.000	0.000 to 16.843	9.33	13.45
Bousbaa 2017	5	0.000	0.000 to 52.182	2.67	5.34
Choy 2012	32	0.000	0.000 to 10.888	14.67	17.28
Naudé 2014	41	7.317	1.535 to 19.925	18.67	19.34
Saoud 2018	50	0.000	0.000 to 7.112	22.67	20.95
Schweitzer 2008	71	8.451	3.165 to 17.492	32.00	23.65
Total (fixed effects)	219	3.821	1.724 to 7.228	100.00	100.00
Total (random effects)	219	3.364	0.702 to 7.905	100.00	100.00
Test for heterogeneity					
Q	10.3787				
DF	5				
Significance level	P = 0.0652				
I^2 (inconsistency)	51.82%				
95% CI for I^2	0.00 to 80.80				

N = number, 95% CI = 95% confidence interval, Q = Cochran Q, DF = degree of freedom.

Table 7: Meta-analysis for the rate of superficial infection

Study	N	Event rate (%)	95% CI	Weight (%)	
				Fixed	Random
Bousbaa 2017	5	0.000	0.000 to 52.182	2.74	3.85
Choy 2012	32	0.000	0.000 to 10.888	15.07	16.62
El-Desouky 2016	20	0.000	0.000 to 16.843	9.59	11.69
Elzohairy 2016	35	2.857	0.0723 to 14.917	16.44	17.71
Saoud 2018	50	10.000	3.328 to 21.814	23.29	22.46
Schweitzer 2008	71	1.408	0.0357 to 7.599	32.88	27.66
Total (fixed effects)	213	3.478	1.476 to 6.844	100.00	100.00
Total (random effects)	213	3.419	1.098 to 6.961	100.00	100.00
Test for heterogeneity					
Q	6.8419				
DF	5				
Significance level	P = 0.2327				
I^2 (inconsistency)	26.92%				
95% CI for I^2	0.00 to 69.66				

N = number, 95% CI = 95% confidence interval, Q = Cochran Q, DF = degree of freedom.

Table 8: Majeed score [5]

Pain-30 points		**Standing -36 points**	
-Intense, continuous at rest	0-5	**A waking aid(12)**	
-Intense with activity	10	-Bedridden or almost	0-2
-Tolerable, but limits activity	15	-Wheelchair	4
-With moderate activity, abolished by rest	20	-Two crutches	6
-Mild, intermittent, normal activity	25	-Two sticks	8
-Slight, occasional or no pain	30	-One stick	10
Work-20 points		-No sticks	12
-No regular work	0-4	**B Gait unaided (12)**	
-Light work	8	-Cannot walk or almost	0-2
-Change of job	12	-Shuffling small steps	4
-Same job, reduced performance	16	-Gross limp	6
-Same job, same performance	20	-Moderate limp	8
Sitting-10 points		-Slight limp	10
-Painful	0-4	-Normal	12
-Painful if prolonged or awkward	6	**C walking distance(12)**	
-Uncomfortable	8	-Bedridden or few meters	0-2
-Free	10	-Very limited time and distance	4
Sexual intercourse-4 points		- Limited with sticks, difficult without prolonged standing possible	6
-Painful	0-1	-One hour with a stick limited without	8
-Painful if prolonged or awkward	2	-One hour without sticks slight pain or limp	10
-Uncomfortable	3	-Normal for age and general condition	12
-Free	4		

Discussion

In this study we surveyed the effectiveness (clinical and radiological outcomes) and the rate of occurrence of complications (blood loss & related transfusion, infection, neurovascular complication, hardware failure and screws miss-displacement, revision rate and rate of non-union) we also surveyed the operative time we noticed:

1- The rate to achieve satisfactory reduction (dis-

placement less than 10 ml) is 92.6%.
2- The rate to achieve excellent and good functional scores according to Majeed score [5] and Pohleman score [6] is 90%. (Tables 8, 9, 10 and 11)

Table 9: Clinical grade based on a score out of 100 points for working and 80 points for non-working patients [5]

Working before injury	Not working before injury	Grade
>85	>70	**Excellent**
70to84	55to69	**Good**
55to69	45to54	**Fair**
<55	**<45**	**Poor**

Table 10: The pelvic outcome score (Pohlemann et al)(7 points maximum) [6]

Points	Radiological result (maximal 3 points)
3	Anatomical posterior healing, anterior displacement pubic symphysis< 5 mm and/or maximal displacement pubic rami < 10 mm.
2	Maximal posterior displacement 5 mm and/or maximal anterior displacement, pubic symphysis 6-10 mm, and/or pubic rami 10-15 mm.
1	Posterior displacement > 5 mm and/or maximal anterior displacement pubic symphysis >10 mm and/or maximal displacement pubic rami >15 mm.

Table 11: The pelvic outcome score (Pohlemann et al) (7 points maximum) [6]

Points	Clinical result (maximal 4 points)
4	No pain, no neurological deficiencies, no urological deficiencies, no functional deficiencies.
3	Pain after extensive exercise, no analgesics, slight functional deficiency (occasional limping), slight sensory deficiencies, subjectively not disturbing
2	Always pain after exercise, analgesics, occasionally notable functional deficiency (limping and cane), motor nerve deficiencies with no functional handicaps and/or sensory deficiencies without loss of the protective sensibility, disturbances in micturation without residual urine and/or erectile dysfunction or sexual dysfunction, subjectively not disturbing.
1	Permanent pain at rest, frequent use of analgesics, regular use of canes, crutches, wheelchair; disabling motor nerve deficiencies (e.g. foot drop) and/or sensory deficiencies with loss of the protective sensibility, deficiencies in micturation with residual urine and/or subjectively disturbing erectile dysfunction or sexual dysfunction. Bowel incontinence.

Results

Excellent 7 points of pohleman score
Good 6 points of pohleman score
Fair 5 points of pohleman score
Poor 4 points or less of pohleman score

Also we surveyed the rate of occurrence of complications related to this method of treatment and we noticed that:
1- The rate of hard ware failure and screws miss-displacement is 3.2 %
This include loose screws and miss-displacement of screws either causing complication or not.
2- The rate of neurovascular complication is 2.8%
Some cases spontaneously recovered and the others need revision surgeries or screw removal.
3- Rate of superficial infection is 3.5%
These cases did not need operative debridement
4- Rate of re-operation is 3.4%
Either for one screw removal and/or reinsertion or for loss of reduction
5- Rate of non union is 0%
Non union had not been detected in any of these studies.

Also we surveyed:
1- The operative time and we see that the main operative time is 37.76 minutes in Saoud 2018 study which include 50 patient and 17 minutes in El-desouky 2016 study which include 20 patient
2- The mean blood loss and we see that the main blood loss is 42.8 cc in Saoud 2018 study which include 50 patient and is 150 cc in Elzohairy study which include 35 patient.
3- The mean blood transfusion and we see that the average blood transfusion in Elzohairy study which include 35 patient is 1 unit.

Conclusion

From our review and analysis of nine studies we conclude that percutaneous screw fixation for posterior pelvic and sacral fractures can be urgently performed as it takes a short time and it does not cause massive blood loss or transfusion also it is a sound method of fixation and has low complication rate with good long term functional outcome.

References

1. **Goldstein A, Phillips T, Sclafani SJ, Scalea T, Duncan A, Goldstein J, Panetta T, Shaftan G.** Early open reduction and internal fixation of the disrupted pelvic ring. J Trauma 1986; 26:325-33.
2. **Ebraheim NA, Rusin JJ, Coombs RJ, Jackson WT, Holiday B.** Percutaneous computed-tomography-stabilization of pelvic fractures: preliminary report. J Orthop Trauma 1987; 1:197-204.
3. **Latenser BA, Gentilello LM, Tarver AA, Thalgott JS, Batdorf JW.** Improved outcome with early fixation of skeletally unstable pelvic fractures. J Trauma 1991; 31:28-31.
4. **Routt ML, Kregor PJ, Simonian PT, Mayo KA.** Early results of percutaneous iliosacral screws placed with the patient in the supine position. J Orthop Trauma 1995; 9:207-14.
5. **Majeed SA.** Grading the outcome of pelvic fractures. J Bone Joint Surg [Br] 1989; 71B:304-306.
6. **Pohlemann T, Gänsslen A, Schellwald O, Culemann U, Tscherne H.** Outcome after pelvic ring injuries. Injury 1996; 27:B31-8.
7. **Saoud A.M.F, Reda M.A:** The Internal Fixator:A Novel Technique for Stabilization of Transforaminal Sacral Fracture as a part of Pelvic Ring Disruption,World Spinal Column Journal, 2011; 2:1.
8. **Saoud A.M.F, Sallam A.M.:** Minimal Access Fixation of Longitudinal Sacral Fractures: The Posterior Internal Fixator with a Minimum of Three Years of Follow-Up, World Neurosurgery-:2018; e1-e6.
9. **El-desouky I. I., Mohamed M. M., Kandil A. E.:** Percutaneous iliosacral screw fixation in vertically unstable pelvic injuries, a refined conventional method, Acta Orthopædica Belgica, 2016; Vol. 82 - 1 .
10. **Elzohairy M.M., Salama A.M.,** Open reduction internal fixation versus percutaneous iliosacral Screw fixation for unstable posterior pelvic ring disruptions, Orthopaedics and Traumatology: Surgery and Research :2016;103:223-227.
11. **Ayvaz M.,** Long-term outcome and quality of life of patients with unstable pelvic fractures treated by closed reduction and percutaneous fixation, Ulus Travma Acil Cerrahi Derg Cilt.2011; 17: 3.
12. **Schweitzer D, Zylberberg A, Co´rdova M, Gonzalez J.** Closed reduction and iliosacral percutaneous fixation of unstable pelvic ring fractures. Injury Int J Care Injured 2008; 39: 869-74.
13. **Lindsay A., Tornetta P, Amna Diwan, Templeman D.** Is Closed Reduction and Percutaneous Fixation of Unstable Posterior Ring Injuries as Accurate as Open Reduction and Internal Fixation?, J Orthop Trauma 2016 ; 30: 1.
14. **Naudé PH., Roche S., Nortje M., Maqungo S.,** The safety and efficacy of percutaneous sacroiliac joint screw fixation, SA Orthopaedic Journal Summer 2014; 13: 4.
15. **Bousbaa H., Ouahidi M., Louaste J, Bennani M., Cherrad T., Jezzari H., Kasmaoui E., Rachid K. Amhajji L.,** Percutaneous iliosacral screw fixation in unstable pelvic fractures, Pan African Medical Journal. 2017; 27:244.
16. **Choy W.S., Kim K.J., Lee S.K., Park H.J.,** Anterior Pelvic Plating and Sacroiliac Joint Fixation in Unstable Pelvic Ring Injuries, Yonsei Med J.2012; 53:2.