Acta Orthop. Belg., 2019, **85**, 502-509

ORIGINAL STUDY

How much does saving femoral head cost after acetabular fracture? Comparison between ORIF and THA

Alessandro Aprato, Cristina Ghia, Ferdinando Tosto, Luigi Sabatini, Alessandro Bistolfi, Alessandro Masse

From the Orthopaedic Department, University of Turin, Italy

We performed a prospective study on patients with acetabular fractures treated either with internal fixation either with arthroplasty comparing clinical outcomes, quality of life, economic resources and cost efficacy in the first five years after surgery.
Demographic data, diagnosis, index treatment, costs and subsequent surgeries were recorded. Patients were requested to fulfill Merle d'Aubigné and EQ-5D-5L questionnaires.
Clinical differences between treatments are significant only in discharge period. Comparing respectively group with fixation and arthroplasty, cost efficacy was 5483 and 10838 euros/quality-adjusted-life years, mean global costs 23965 and 16878 € and quality of life gained in five years 2.788 and 3.175. Group of arthroplasty showed better quality of life at discharge and at one year. If choice between fixation and arthroplasty should be based only on cost-efficacy, arthroplasty should be suggested but clinical outcomes suggest to consider fixation because results at five years are not different to arthroplasty.

Keywords : acetabular fracture ; costs efficacy ; open reduction and internal fixation ; quality of life ; total hip arthroplasty

INTRODUCTION

Acetabular fractures are commonly treated with open reduction and internal fixation (F). Several publications showed that age and other factors are associated with low chances of survival *(5,6,22)*. Therefore, in selected groups of patients who present poor prognostic factors, acute total hip arthroplasty (A) should be considered. Literature showed both acute A and F are effective on medium and long terms, but costs and postoperative qualities of life have never been compared. Aim of this study is to compare the two techniques in terms of clinical outcomes, quality of life (QoL), economic resources and cost-efficacy in the first five years after surgery.

PATIENTS AND METHODS

Patients arrived in our center with an acetabular fracture were prospectively enrolled in this study. Criteria of inclusion was age older than 40 years. Patients were invited to choose between ORIF

The authors declare that they have no conflict of interest and the study is an independent study, not supported by any funding.

■ Alessandro Aprato,
■ Cristina Ghia,
■ Ferdinando Tosto,
■ Luigi Sabatini,
■ Alessandro Bistolfi,
■ Alessandro Masse
Orthopaedic department, University of Turin, Italy
Correspondence : Alessandro Aprato, Orthopaedic department, University of Turin, Italy
E-mail: ale_aprato@hotmail.com

and acute THA and they were informed about their chances of hip survival. If calculated chance of survival were higher than 50 percent at 5 years according to Tannast algorithm *(22)*, the surgeons suggested patients to be treated with fixation (F group) otherwise acute arthroplasty was suggested (A group). No patients were lost at follow-up.

General data

Demographic data and diagnosis according to Letournel classification *(10)* were collected for both groups. All fractures were treated by at least two members of the pelvic surgeon team (three surgeons). Data about length of hospitalization in surgical and rehabilitation unit, length of hospitalization in the Intensive Care Unit (ICU), time of surgical theatre occupancy, number and type of implanted surgical devices, number of transfused blood units were collected. If patients underwent a subsequent hip arthroplasty, the additional costs were calculated with the same method and added to the total costs. We analyzed the full fixation (F) group then we split it in two groups for the purpose of this study : patient who underwent a subsequent arthroplasty were assigned to the "post fixation arthroplasty" group (FAA group) while patients who did not required a subsequent arthroplasty were assigned to the "fixation no arthroplasty" (FNA group).

Clinical evaluation

All patients were clinically evaluated with the Merle d'Aubigne *(15)* hip score. It was performed at surgical discharge, at one year, at two years, at three years, at four years and at five years after surgery. Data about patients' clinical condition pre trauma were retrospectively collected.

Quality of life evaluation

Health related quality of life was evaluated by using the EQ-5D-5L questionnaire developed by the EuroQol Group *(4,23)*. It consists of the EQ-5D-5L descriptive system, that comprises 5 dimensions -mobility, self care, usual activities, pain/discomfort, anxiety/depression- and each dimension has 5 levels -no problems, slight problems, moderate problems, severe problems, and extreme problems- and it provides a descriptive profile and a single index value (utility index) for each health status, that can be used in the calculation of quality-adjusted life years (QALYs). This utility index is on a scale of -1 to 1, where 1 represents perfect health, 0 represents death and negative values represent a state perceived as being worse than death *(8)*.

QALY is a measure of health-related quality of life that takes into account both the quantity and the quality of life generated by a therapeutic intervention *(3,24)*. In other words, the amount of time spent in a health state is weighted by the utility score given to that health state. One year of perfect health (utility index of 1) generates one QALY, whereas one year in a health state valued at 0.5 is regarded as being equivalent to half a QALY.

All patients were requested to fulfill the EQ-5D-5L questionnaire *(4,8,23)* regarding their status pre trauma, at surgical discharge, at one year then annually until the end of five years follow-up.

Data about patients' pre trauma were retrospectively collected before surgery. The other data were prospectively collected.

Each individual patient's state of health was converted to a single summary index (utility index) to obtain average value. Average value of QoL in utility index at discharge was calculated. According to previously published studies *(20)* we used this value to calculate QoL gained in every year after surgery, as the difference between the utility index of the year and the utility index of the immediate post-operative period. Then we added up the QoL gained in every year to obtain QALYs gained in five years. Then we calculated the difference between QoL gained by patients undergone THA and patients undergone ORIF in every single year after surgery and between the QALYs gained in five years.

Cost analysis

Cost analysis was performed with the same methods used in a previously published study *(2)*. Costs for hospitalization in the ICU *(21)*, surgical and rehabilitation units *(1)* and for surgical theatre

Table I. — Costs per unit and references

Variables	Cost per unit (in Euros)	Reference
One-day hospitalization in ICU	1,168	(13)
One-day hospitalization in surgical ward	216	(14)
One-day hospitalization in physiotherapy ward	121	(14)
One minute of surgical theatre occupation	20	(15)
Transfusion of one unit of blood	482	(16)
Physiotherapy session	80	(17)
Surgical plate with classic screws configuration	530	Hospital expenses report
Total hip arthroplasty	1,830	Hospital expenses report

ICU=Intensive Care Unit

occupancy *(12)* were retrieved from the literature. Cost assumptions were also derived from the literature to calculate the costs of blood transfusions *(19)* and physiotherapy sessions *(16)*. The costs for plates, screws and hip implants are specific for costs incurred in our institution and were hence retrieved from our hospital expenses reports. Treatment costs were calculated from the cost assumptions presented in Table I. Cost of subsequent total hip replacement procedures was calculated with the same process.

Cost efficacy evaluation

In order to obtain the cost per QALY, we calculated average cost both for F and A groups, then we divided average cost by the QALY gained in five years according to the methodology of previously published studies *(9,17)*.

Statistical analysis

All data were analyzed with standard descriptive statistics. Univariable analysis was performed to compare the group A with the other three groups (F, FNA and FAA) with regard to age, Merle d'Aubignè *(15)* score, EQ-5D-5L *(4,8,23)* score, gained quality of life and costs. This was done with the Chi-squared test or the Fisher's exact test for categorical outcomes, and the Student's t-test or Mann-Whitney test for continuous outcomes. The Kolmogorov-Smirnov test was used to determine whether data were normally distributed. P-values lower than 0.05 were considered statistically significant. All analyses were performed using Stata version 12 (Stata Corporation, College Station, Texas, USA).

RESULTS

Inclusion criteria were met by 147 patients but 83 were younger than 40 years and therefore excluded. Twelve patients (group A) presented a calculated survival changes lower than 50 percent at five years and all of them accepted to be treated with an arthroplasty ; the remaining 52 patients chose an open reduction and internal fixation (group F). Subsequent arthroplasty (FAA group) has been performed in 11 patients (about one fifth of F group). Average time from fixation to subsequent arthroplasty was 16.6 months (SD 6.3).

General data

Mean age was 52.4 years (SD 10.1) for the F group and 65.3 years (SD 10.8) for the A group, this difference was statistically significant (p value< 0.001). Mean ages respectively for FAA and FNA group were 57.5 years (SD 10.7) and 51.0 years (SD 9.5). This difference was not statistically significant (p=0.064).

Clinical evaluation

Merle D'Aubigne *(15)* score pre trauma was twelve point for every patient. Comparisons of

Table II. — Comparisons of clinical outcomes between A and F group and between A, FNA and FAA groups are shown

	Merle D'Aubignè scores (points)					
	Mean (SD)					
	at discharge	1 year	2 years	3 years	4 years	5 years
A group	3.25 (0.87)	11.58 (0.67)	11.67 (0.49)	11.67 (0.49)	11.67 (0.49)	11.67 (0.49)
F group	2.29 (1.21)	10.10 (2.84)	11.08 (1.25)	11.16 (1.17)	11.12 (1.18)	11.059 (1.19)
	at discharge	1 year	2 years	3 years	4 years	5 years
A group	3.25 (0.87)	11.58 (0.67)	11.67 (0.49)	11.67 (0.49)	11.67 (0.49)	11.67 (0.49)
FNA group	2.60 (0.93)	10.63 (2.10)	11.18 (1.13)	11.18 (1.13)	11.13 (1.14)	11.05 (1.15)
FAA group	1.18 (1.47)	8.18 (4.26)	10.73 (1.62)	11.09 (1.38)	11.09 (1.38)	11.09 (1.38)

Table III. — Results of postoperative quality of life evaluation are shown

	EQ-5D-5L utily index					
	Mean (SD)					
	at discharge	1 year	2 years	3 years	4 years	5 years
A group	0.465 (0.102)	0.925 (0.091)	0.933 (0.076)	0.933 (0.076)	0.993 (0.076)	0.993 (0.076)
F group	0.257 (0.230)	0.744 (0.288)	0.876 (0.132)	0.886 (0.122)	0.884 (0.119)	0.881 (0.118)
	at discharge	1 year	2 years	3 years	4 years	5 years
A group	0.465 (0.102)	0.925 (0.091)	0.933 (0.076)	0.933 (0.076)	0.993 (0.076)	0.993 (0.076)
FNA group	0.293 (0.225)	0.797 (0.223)	0.879 (0.136)	0.882 (0.130)	0.879 (0.127)	0.875 (0.126)
FAA group	0.124 (0.206)	0.551 (0.411)	0.864 (0.121)	0.900 (0.090)	0.900 (0.090)	0.900 (0.090)

Table IV. — Results of postoperative quality of life evaluation are shown

	QoL gained					
	Mean (SD)					
	1 year	2 years	3 years	4 years	5 years	TOT QALYs
A group	0.628 (0.091)	0.637 (0.076)	0.637 (0.076)	0.637 (0.076)	0.637 (0.076)	3.175 (0.391)
F group	0.448 (0.228)	0.579 (0.132)	0.590 (0.122)	0.587 (0.119)	0.584 (0.118)	2.788 (0.696)
	1 year	2 years	3 years	4 years	5 years	TOT QALYs
A group	0.628 (0.091)	0.637 (0.076)	0.637 (0.076)	0.637 (0.076)	0.637 (0.076)	3.175 (0.391)
FNA group	0.501 (0.223)	0.583 (0.136)	0.586 (0.130)	0.583 (0.127)	0.579 (0.126)	2.831 (0.710)
FAA group	0.255 (0.411)	0.567 (0.121)	0.604 (0.090)	0.604 (0.090)	0.604 (0.090)	2.633 (0.650)

clinical outcomes between A and F group and between A, FNA and FAA groups are shown in table II.

Results at discharge were significantly different between group A and F (p=0.012). No significant differences were found between group F and A in all the other post-operative clinical scores (p values were respectively 0.079 at one year, 0.075 at two years, 0.147 at three years, 0.120 at four year and 0.089 at five years). Significant difference were found between group A and FNA at discharge clinical score (p=0.036) while no significant differences were shown at one, two, three, four and five years (respectively p=0.127, 0.151, 0.151, 0.116 and 0.079). Significant differences were found between group A and FAA at discharge (p<0.001) and at one

year (p<0.001) while no significant differences were shown at two, three, four and five years (respectively p=0.069, 0.188, 0.188 and 0.188).

Quality of life evaluation

Pre trauma quality of life was rated 11.67 points (SD 0.49) and 11.06 (SD 1.19) respectively in groups A and F with no significant difference (p=0.89) between those groups. Results of postoperative quality of life evaluation are shown in table III-IV.

Results at discharge and at 1 year were significantly different between group A and F (respectively p=0.003 and 0.037). No significant differences were found between group F and A in all the scores (p values were respectively 0.153 at two years, 0.205 at three years, 0.178 at four year and 0.134 at five years). Significant difference were found between group A and FNA at discharge and at one year (p=0.014 and 0.060) while no significant differences were shown at two, three, four and five years (respectively p=0.196, 0.202, 0.171 and 0.120). Significant differences were found between group A and FAA at discharge (p=0.001) and at one year (p=0.006) while no significant differences were shown at two, three, four and five years (respectively p=0.111, 0.350, 0.350 and 0.350).

Gained quality of life was significantly different between group A and F at one and two years (respectively p=0.001 and 0.001). No significant differences were found between group F and A at three, four and five years (p values were respectively 0.253, 0.234 and 0.337). Significant differences were found between group A and FNA at one year (p=0.034) while no significant differences were shown at two, three, four and five years (respectively p=0.145, 0.2035 0.131 and 0.231). Significant differences were found between group A and FAA at one years (p=0.001) while no significant differences were shown at two, three, four and five years (respectively p=0.089, 0.231, 0.231 and 0.231).

Costs evaluation

Costs for each group are shown in table V. Mean preoperative costs for A group were not statistically different from F, FNA and FAA groups (respectively p= 0.216, 0.142 and 0.978). No significant differences in surgical cost were found between group A and group F. Surgical costs for group A were significantly higher than group FNA (p=0.001) and significantly lower than FAA (p=0.01). Costs for hospitalization in surgical unit and cost for physiotherapy were significantly lower for group A if compared to than group F (p= 0.045 and 0.032), group FNA (p=0.027 and 0.041) and FAA (p=0.028 and p=0.046). Costs for hospitalization in physiotherapy unit were not significantly different between group A and the other three groups (A vs F p= 0.608, A vs FNA p=0.614 and A vs FAA p=0.716). Total costs for group A were significantly lower than group F (p=0.045), group FNA (p=0.0.38) and group FAA (p=0.008).

Table V. — Costs for each group are shown

	preoperative cost	**surgery cost**	**surgical hospitalization cost**	**physio hospitalization cost**	**physio cost**	**TOTAL COST**
A group	1,836 (907)	6,770 (1,329)	2,178 (963)	3,227 (5,424)	2,866 (3,433)	16,878 (5,959)
F group	2,296 (1,192)	5,981 (3,176)	4,370 (5,000)	4,095 (5,211)	7,133 (12,294)	23,965 (18,599)
A group	1,836 (907)	6,770 (1,329)	2,178 (963)	3,227 (5,424)	2,867 (3,433)	16,878 (5,959)
FNA group	2,419 (1,257)	4,491 (1,336)	3,910 (4,381)	4,102 (5,195)	6,720 (6,958)	21,652 (11,586)
FAA group	1,846 (810)	11,401 (1,514)	6,048 (6,796)	4,070 (5,525)	8,635 (23,742)	32,376 (33,270)

Cost efficacy evaluation

Cost efficacy resulted respectively 5,483euros/QALY (SD 2,247) for group A and 10,838 euros/QALY (SD 14,108) for group F. Groups FNA and FAA showed respectively 9,957 euros/QALY (SD 13,522) and 14,042 euros/QALY (SD 16,306).

DISCUSSION

To our knowledge, no study with medium-term follow-up has previously compared clinical outcomes and economic burden of acetabular fractures treated with primary arthroplasty and with open reduction and internal fixation. Aim of this study is to compare the two techniques in terms of clinical outcomes, quality of life, economic resources and cost efficacy in the first five years after surgery.

Using 50% at five years as cut-off rate of hip survival in Tannast's algorithm *(22)*, we found that 79% of the native hips could be preserved successfully at a follow-up of five years. A secondary total hip arthroplasty was necessary in 21%, this rate is comparable with literature data (*6,7)* if young patients are excluded.

According the Merle d'Aubignè *(15)* scores, differences between the two treatments are only in the discharge period. No other significant clinical differences were found the first five years of follow-up. This conclusion is enforced by literature results for those treatments : in both cases fixation *(6,7)* and arthroplasty *(14,18)* published results are similar to the ones obtained in this study.

Patients treated with a direct arthroplasty have a better quality of life at discharge and at one year after surgery than patient who received a fixation. On the other a hand, the quality of life is not significantly different from the second to the fifth year.

The absence of a significant difference either in clinical score either in quality of life from two to five years of follow-up supports the choice of fixation for acetabular fractures.

Significant differences were found only between direct and secondary arthroplasty groups in the first year, this is not surprising because in the secondary arthroplasty were obviously enrolled all the patients with a poor outcome. On the other hand, our results showed no difference in clinical score between those groups after patients who required a subsequent THA were definitively treated. Also in the quality of life evaluation, significant differences were found between direct and secondary arthroplasty groups only in the first year, those groups showed again similar results after the secondary arthroplasty has performed in patients who required it.

From a clinical point of view, our results confirm that a fixation should be considered in most of the patients because results at five years may be similar to primary arthroplasty. Furthermore in case of subsequent arthroplasty necessity, results will not be different from those achieved with a direct arthroplasty. On the other hand, patient should be informed that a fixation will give him less quality of life and less function in the first two years.

From an economic point of view, a direct arthroplasty is less expensive than a fixation for acetabular fracture. Mean global cost for fixation group was about 24000 € while total cost for arthroplasty group was about 17,000 €. Furthermore treatment of direct arthroplasty group was cheaper than the group healed with only fixation (about 21,000 €) and represented almost half of the cost in patients treated with fixation and a subsequent arthroplasty (mean costs about 32,000 €). Differences of those costs were mostly due to surgical, hospitalization and home based physiotherapy costs.

Cost efficacy resulted almost double in fixation group (about 11,000 €/QALY) than in the arthroplasty group (about 5,500 €/QALY). Furthermore in patients who required a subsequent arthroplasty cost efficacy resulted even higher (about 14,000 €/QALY).

If the choice between fixation and arthroplasty should be based only on the cost-efficacy at five years, an arthroplasty should be suggested. Studies with longer follow-up will be required to confirm or dispute this statement ; in fact the predictable costs for subsequent revision arthroplasty may severely affect this economic choice in a longer follow-up.

Limitation

This study has some limitations. We did not evaluate the radiographic follow-up data of

the patients. Criteria of exclusion (age lower than 40 years) has been chosen according to literature *(11,13,14)* and cut-off rate (50% chances of survivorship at five years) has been arbitrarily chosen by the pelvic team but changing those cutoff may deeply influence our results.

Furthermore the worst patients have been assigned to the arthroplasty group and the best allocation criteria would be a randomization, this may have negatively influenced the post-operative quality of life and the clinical outcome of this group.

Another limitations are the relatively small number of patients in the arthroplasty group, the disparity of the demographic, radiographic, and operative parameters of the two groups (A and F).

Furthermore costs calculations have been based on literature data, calculating the real costs in a national public service would be too complicated. Eventually patient filled the Merle d'Aubignè *(15)* questionnaire and the EQ-5D-5L *(4,8,23)* scores every year in the same sheet, often patient tended to rate their status similar to year before to shorten the tests time. All those limitations may have reduced the reliability of our conclusions.

We think a randomize trial with ten years of follow would be necessary to support or deny our findings. According to our point of view, on the long run, saving femoral head after acetabular fracture may probably be the best choice from clinical and economic points of view.

In conclusion we found that a primary arthroplasty in acetabular fracture with high risk of failure is the less expensive and the most cost-effective treatment after the first five years of follow-up. On the other hands, our clinical results confirm that a fixation should be considered in most of the patients because results at five years may be similar to primary THA but also because in case of subsequent arthroplasty necessity results will not be different from those achieved with a direct arthroplasty. Only in the first one or two years a direct arthroplasty would give the patient more quality of life and hip function.

Ethics and registration

The present study was approved by the local ethical committee and was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Acknowledgement

The authors thank Alexander Joeris (AO Clinical Investigation and Documentation) for the help in preparing the manuscript. The corresponding author was supported by the AO foundation via an AO Trauma fellowship at AOCID.

REFERENCES

1. **Adam T, Evans DB, Murray CJ.** Econometric estimation of country-specific hospital costs. *Cost Eff Resour Alloc.* 2003 ; 1 : 3.
2. **Aprato A, Joeris A, Tosto F, Kalampoki V, Stucchi A, Massè A.** Direct and indirect costs of surgically treated pelvic fractures. *Arch Orthop Trauma Surg*. 2016.
3. **Araújo CD, Veiga DF,** *et al.* Health economics and health preference concepts to orthopedics practitioners. *Acta Ortop Bras.* 2014 ; 22 : 102-5.
4. **Brooks R.** EuroQol : the current state of play. *Health Policy.* 1996 37 : 53-72.
5. **Butterwick D, Papp S, Gofton W, Liew A, Beaulé PE.** Acetabular fractures in the elderly : evaluation and management. *J Bone Joint Surg Am*. 2015 ; 97 : 758-68
6. **Daurka JS, Pastides PS, Lewis A, Rickman M, Bircher MD.** Acetabular fractures in patients aged > 55 years : a systematic review of the literature. *Bone Joint J.* 2014 ; 96-B : 157-63.
7. **Giannoudis PV, Grotz MR, Papakostidis C,** *et al.* Operative treatment of displaced fractures of the acetabulum. A meta-analysis. *J Bone Joint Surg Br*. 2005 ; 87 : 2-9.
8. **Janssen MF, Pickard AS, Golicki D,** *et al.* Measurement properties of the EQ-5D-5L compared to the EQ-5D-3L across eight patient groups : a multi-country study. *Qual Life Res.* 2013 ; 22 : 1717-1727.
9. **Jenkins PJ, Clement ND,** *et al.* Predicting the cost-effectiveness of total hip and knee replacement. *Bone Joint J*. 2013 ; 95-B : 115-21.
10. **Judet R, Judet J, Letournel E.** Fractures of the acetabulum : Classification and surgical approaches for open reduction. Preliminary report. *J Bone Joint Surg Am*. 1964 ; 46 : 1615-46.
11. **Liebergall M, Mosheiff R, Low J, Goldvirt M, Matan Y, Segal D.** Acetabular fractures. Clinical outcome of surgical treatment. *Clin Orthop Relat Res*. 1999 ; 366 205-16.
12. **Macario A.** What does one minute of operating room time cost? *J Clin Anesth*. 2010 ; 22) : 233-236.
13. **Matta JM.** Fractures of the acetabulum : accuracy of reduction and clinical results in patients managed operatively within three weeks after the injury. *J Bone Joint Surg Am*. 1996 ; 78 :1632-45.

14. **Mears DC, Velyvis JH, Chang CP.** Displaced acetabular fractures managed operatively : indicators of outcome. *Clin Orthop Relat Res*. 2003 ; 407 : 173-86.
15. **Ovre S, Sandvik L,** *et al.* Comparison of distribution, agreement and correlation between the original and modified Merle d'Aubigne-Postel Score and the Harris Hip Score after acetabular fracture treatment. *Acta Orthop*. 2005 ; 76 : 796-802.
16. **Piscitelli P, Iolascon G, Argentiero A, Chitano G,** *et al.* Incidence and costs of hip fractures vs strokes and acute myocardial infarction in Italy : comparative analysis based on national hospitalization records. *Clin interv aging*. 2012 ; 7 : 575-583.
17. **Räsänen P, Paavolainen P, Sintonen H, et al.** Effectiveness of hip or knee replacement surgery in terms of quality-adjusted life years and costs. *Acta Orthop*. 2007 ; 78 : 108-15.
18. **Rickman M, Young J , Bircher M, Pearce R, Hamilton M.** The management of complex acetabular fractures in the elderly with fracture fixation and primary total hip replacement. *Eur J Trauma Emerg Surg*. 2012 ; 38 : 511-516.
19. **Santini V, Truschi F, Bertelli A, Lazzaro C.** Cost of red blood cell transfusion : an activity-based cost description. *Drugs and Cell Therapies in Hematology*. 2013 ; 2 : 157-167.
20. **Sassi F.** Calculating QALYs, comparing QALY and DALY calculations. *Health Policy Plan.* 2006 ; 21 : 402-408.
21. **Tan SS, Bakker J, Hoogendoorn ME, Kapila A, Martin J, et al.** Direct cost analysis of intensive care unit stay in four European countries : applying a standardized costing methodology. *Value health*. 2012 ; 15 : 81-86.
22. **Tannast M, Najibi S, Matta JM.** Two to twenty-year survivorship of the hip in 810 patients with operatively treated acetabular fractures. *J Bone Joint Surg Am*. 2012 ; 94 : 1559-67.
23. **The EuroQol Group.** EuroQol-a new facility for the measurement of health-related quality of life. *Health Policy*. 1990 ; 16 : 199-208.
24. **Vainiola T, Roine RP, et al.** Effect of health-related quality-of-life instrument and quality-adjusted life year calculation method on the number of life years gained in the critical care setting. *Value Health*. 2011 ; 14 : 1130-4.