ORIGINAL ARTICLE

Acta Orthop Traumatol Turc 2015;49(4):345–353
doi: 10.3944/AOTT.2015.14.0451

Operative vs. nonoperative treatment for comminuted proximal humeral fractures in elderly patients: a current meta-analysis

Jin-Qi SONG[1], Xue-Feng DENG[1], Yi-Min WANG[2], Xue-Bing WANG[1], Xue LI[3], Bin YU[3]

[1]Shenzhen Longhua New District Hospital, Department of Orthopaedics and Traumatology, Guangzhou, China
[2]Gongdong Medical College Affiliated Futian Hospital, Department of Orthopaedics and Traumatology, Guangzhou, China
[3]Southern Medical University, Nanfang Hospital, Department of Orthopaedics and Traumatology, Guangzhou, China

Objective: The aim of this study was to compare the effect of operative vs. nonoperative treatment for comminuted proximal humeral fractures in elderly patients regarding clinical results, complications, and additional surgeries.

Methods: Six electronic databases (Medline, Embase, Clinical, Ovid, Biosos, and Cochrane Central Register of Controlled Trials) were systematically searched to identify randomized controlled trials (RCTs). Eligible RCTs published between 1960–2012 comparing operative vs. nonoperative treatment of comminuted proximal humeral fractures were included. Trial quality was assessed using the modified Jadad scale. Data from included studies were pooled with the use of fixed-effects and random-effects models with mean difference and risk ratios for continuous and dichotomous variables, respectively. Sensitivity analysis was performed to account for bias in patient selection.

Results: Six studies matched the selection criteria, reporting on 287 patients. One hundred fourty-four patients (50.17%) were managed nonoperatively, 20 patients (6.97%) underwent tension band fixation, 55 patients (19.16%) were treated with locked plate, and 68 patients (23.69%) underwent hemiarthroplasty. Mean follow-up ranged from 12–50 months. Results showed no significant difference in post-treatment Constant scores and DASH scores, but conservative treatment showed superior results compared to operative treatment using EQ-5D™. Compared with operative treatment, nonoperative treatment led to significantly fewer complications and additional surgeries. Findings from subgroup analyses remained consistent with these outcomes when compared to nonoperative treatment with tension band fixation, locked plate fixation, and hemiarthroplasty.

Conclusion: Compared with operative treatment for closed comminuted proximal humeral fractures in elderly patients, conservative treatment can effectively reduce the risk of additional surgeries and complications. However, there is no statistical difference between operative and nonoperative treatment in terms of clinical outcomes.

Keywords: Hemiarthroplasty; locked plate; meta-analysis; nonoperative; operative; proximal humeral fracture.

Jin-Qi Song, Xue-Feng-Deng, and Yi-Min Wang contributed equally to this study.

Correspondence: Bin Yu, MD. Southern Medical University, Nanfang Hospital, Department of Orthopaedics and Traumatology, Guangzhou, China.
Tel: +86 – 020 – 61641746 e-mail: orthop@sohu.com

Submitted: December 15, 2014 **Accepted:** January 5, 2015

Available online at
www.aott.org.tr
doi: 10.3944/AOTT.2015.14.0451
QR (Quick Response) Code

Proximal humeral fractures represent approximately 6% of all adult fractures[1] and are the 3rd most common fracture seen in elderly patients after fractures in the hip and distal radius.[2] Additionally, in terms of fractures in the upper extremities of the elderly, this fracture has the 2nd highest incidence.[3] High incidence of this fracture has been reported in many countries. Proximal humeral fractures are common and have severe short- and long-term functional consequences for patients. Epidemiological studies indicate that the age-specific incidence of this fracture has increased in recent years, and the number of fractures may nearly double in women aged 80 or older within the next 20 years.[4,5]

Classification of proximal humeral fractures presents challenges. Neer classification is the most frequently used classification for proximal humeral fractures.[6,7] This classification is based on the 4 anatomical segments of the proximal humerus (i.e., the humeral head, shaft, and greater and lesser tubercles) and whether these segments are fractured and displaced. Three- and 4-part proximal humeral fractures account for approximately 13% of all proximal humeral fractures,[8] and they are considered to be the most difficult to treat.

Non-displaced 2-part fractures are the most common, and there is general consensus that prognosis is good following conservative treatment. The management of comminuted fractures, however, remains controversial.[9–12]

Surgical stabilization of displaced proximal humeral fractures is challenging, especially in elderly patients. Surgical treatment includes open reduction and internal fixation (ORIF) with Kirschner wires, cerclages, intramedullary devices, and screws; an angular stable plate or minimally open procedure using Kirschner wires and screws, external fixation, sutures and tension band presents an additional option. Hemiarthroplasty and reversed prosthesis as well as nonoperative conservative treatment have also been advocated.[13–16]

However, controversy still exists with regard to the optimal treatment for proximal humeral fracture. A number of clinical studies comparing conservative treatment with various surgical treatments have been undertaken. These studies include randomized controlled trials (RCTs), observational studies, and systematic reviews.[17] These issues were addressed by conducting an up-to-date meta-analysis of RCTs published through December 2012.

The purpose of our meta-analysis was to determine the advantages and disadvantages of operative vs. nonoperative treatment of comminuted proximal humeral fractures in elderly patients by comparing their clinical outcomes, complication rate, and additional surgery rate reported in all available related RCTs.

Materials and methods

RCTs meeting the following criteria were included: 1) comparison of conservative to operative approaches in patients treated for 3- and 4-part proximal humeral fractures; 2) inclusion of at least 1 of the outcome measures such as complication, clinical results, radiological outcomes, and Disabilities of the Arm, Shoulder and Hand (DASH) score; 3) documentation of the specific operative technique and protocol for conservative management; 4) intervention initiated within 14 days post-injury and written informed consent; 5) age of patients greater than 50 years; and 6) when 2 studies were reported by the same institution and/or authors, the 1 of higher quality was included in the analysis, unless the study outcomes were mutually exclusive or measured at different time intervals.

Trials were excluded if patients met the following conditions: 1) failure to fulfill the inclusion criteria; 2) fracture of the contralateral side or other fracture in need of treatment; 3) open fracture; 4) ongoing radiotherapy or chemotherapy; 5) metabolic disease affecting the bone; 6) medication affecting the bone.

Databases searched included MEDLINE, EMBASE, CLINICAL, Ovid, BIOSOS, and Cochrane Central Register of Controlled Trials, covering from 1960–December 2012. Publication language was limited to English. The key words used for search were listed as follows: proximal humeral fracture, operation, non-operation, surgery, conservative treatment, randomized controlled trials, and randomization.

Two authors independently screened titles and abstracts of all articles obtained. All relevant articles were then retrieved and read to determine eligibility. If any disagreement regarding eligibility existed, the corresponding author was consulted for final determination.

Two authors participated in the extraction of the relevant data that met the initial inclusion criteria independently. Disagreement was resolved by discussion, and the corresponding author was consulted if necessary.

Methodological assessment was conducted by 2 reviewers independently using the modified Jadad scale,[18] an 8-item scale designed to assess randomization, blinding, withdrawals and dropouts, inclusion and exclusion criteria, adverse effects, and statistical analysis (Table 1).

The following summary data was sought from each study for meta-analysis: 1) functional outcomes such

Table 1. Modified Jadad Scale with 8 items.

Items assessed	Response	Score
Was the study described as randomized?	Yes	+1
	No	0
Was the method of randomization appropriate?	Yes	+1
	No	-1
	Not described	0
Was the study described as blinded?*	Yes	+1
	No	0
Was the method of blinding appropriate?	Yes	+1
	No	-1
	Not described	0
Was there a description of withdrawals and dropouts?	Yes	+1
	No	0
Was there a clear description of the inclusion/exclusion criteria?	Yes	+1
	No	0
Was the method used to assess adverse effects described?	Yes	+1
	No	0
Was the method of statistical analysis described?	Yes	+1
	No	0

*Double-blind RCT obtain score of 1; single-blind RCT obtains 0.5 score.

as Constant score, DASH score, etc.); 2) postoperative complications such as avascular necrosis (AVN), nonunion, infection, etc.; 3) additional surgery rate; 4) health-related quality of life (HRQoL) (EQ-5D™); and 4) operative procedure outcome (tension band fixation, locked plate, hemiarthroplasty) for subgroup meta-analyses.

A fixed-effects model was used for meta-analysis unless there was significant heterogeneity between studies, in which case the random-effects model of DerSimonian and Laird was used. Trial heterogeneity was estimated using the I2 statistic, complying with Quality of Reporting of Meta-Analyses (QUOROM) guidelines.[19,20] Subgroup analyses were carried out according to the different operative procedure with nonoperative treatment. Meta-analysis was performed with RevMan5.0.25 software (Cochrane Collaboration, Oxford, UK) for outcome measures; a p value of <0.05 was considered statistically significant.

Sensitivity analysis was used to assess the robustness

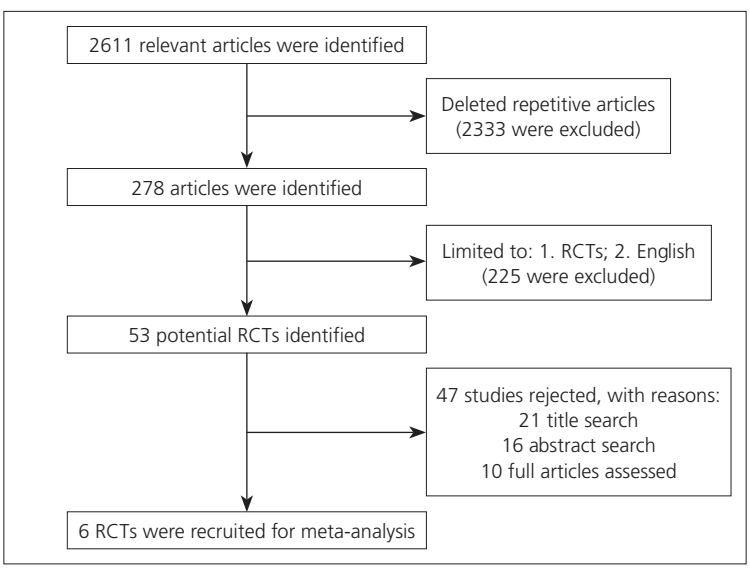

Fig. 1. Flow chart of eligibility selection.

Table 2. General information of RCTs included.

Source (year)	Cases (O/N)	Sex ratio (M/F)	Mean age (O/N) (year)	Follow-up (month)	Jadad scores
Boons HW. 2012[22]	25/25	3/47	76.4/79.9	12	5
Zyto K. 1997[23]	20/20	5/35	73/75	50	3
Olerud P. 2011 a[24]	30/30	112/48	72.9/74.9	24	4
Olerud P. 2011 b[25]	27/28	8/47	75.8/77.5	24	4
Fjalestad T. 2012[26]	25/25	6/44	72.2/73.1	12	5
Stableforth PG. 1984[27]	16/16	7/25	65.6/70.1	50	3

of results, uncertainty of decisions, and assumptions regarding data and methods used.[21] A secondary sensitivity analysis, which compared the outcomes from only high Jadad score RCTs (≥4 points) with those from all RCTs included, was designed to ensure low Jadad score RCTs (<4 points) did not result in a bias impact on the primary analysis.

Results

The literature retrieving strategy and results is shown in Figure 1. There were 2.611 potentially relevant papers. By screening the title and reading the abstract and complete article, 6 published studies with a total of 287 patients met all inclusion criteria and proved eligible for this investigation.[22–27] Table 2 provides a summary of

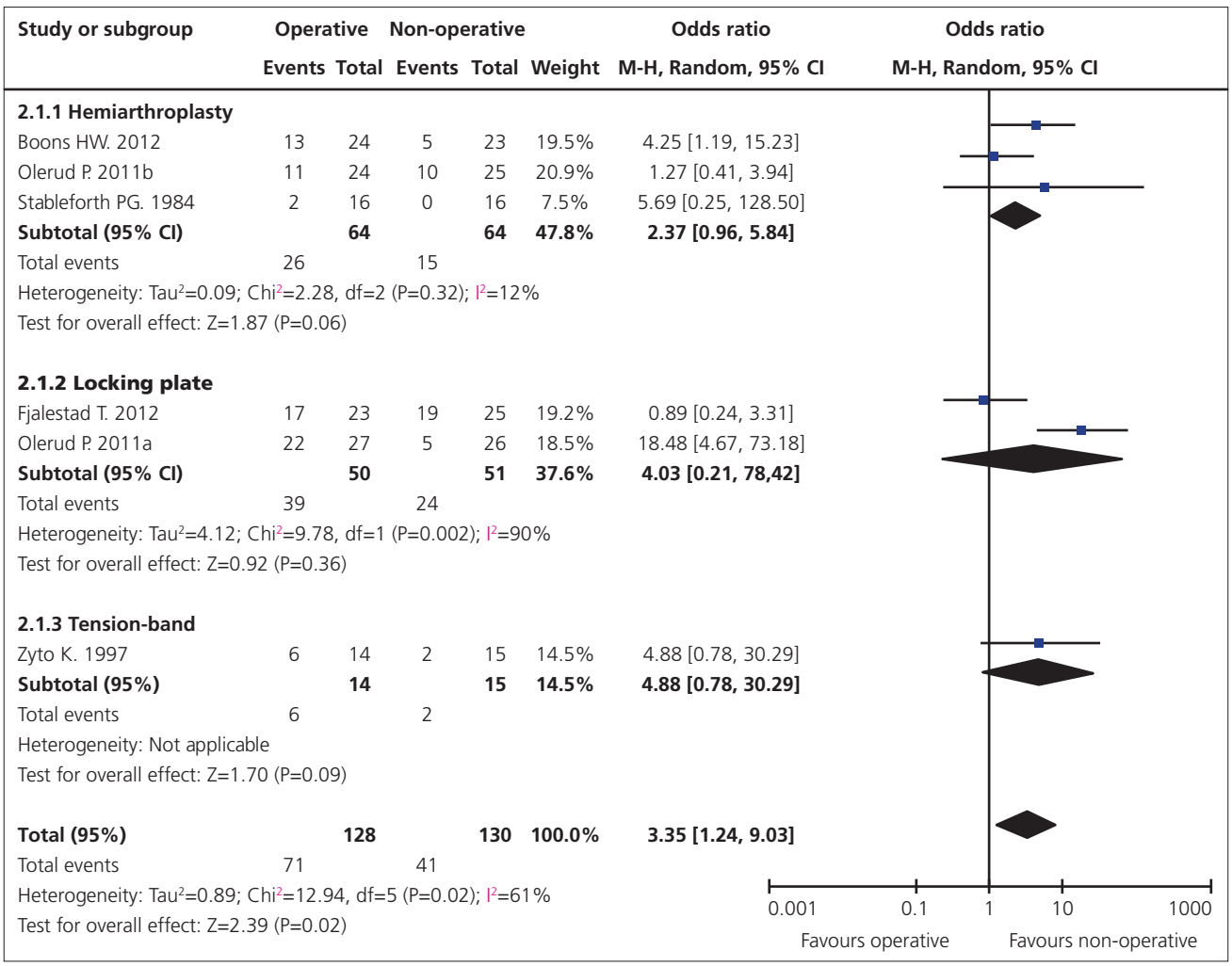

Fig. 2. Incidence of complications after operative and nonoperative treatments. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Table 3. Sensitivity analysis.

Outcome	All eligible RCTs included					Only high score RCTs included				
	No	Patients	I^2	RR (95% CI)	p	No	Patients	I^2	RR (95% CI)	p
Constat score	5	226	0%	1.02 (–3.68, 5.71)	0.67	4	197	0%	2.00 (–3.06, 7.07)	0.44
Complication	6	258	61%	3.35 (1.24, 9.03)	0.02	4	197	76%	3.00 (0.82, 10.92)	0.10
Additional surgery	6	258	0%	3.97 (1.30, 12.10)	0.02	4	197	0%	4.19 (1.17, 14.94)	0.03

the studies, including author, year of publication, patient age range, sample size, follow-up period, and Jadad scores.

Total scores of the RCTs shown in Table 2 indicate that most studies achieved high quality according to the current rating system. Four designs scored over 4. In almost all studies, the main problem reflected was the nonuse of blinding method, which may lead to a certain degree of detection bias.

The 6 eligible studies included a total of 112 patients providing information on complications at the end of follow-up. Results are presented in Figure 2. The pooled results show reduced risk of complications with nonoperative treatment in comparison with operative treatment, which was statistically significant (95% CI 1.24–9.03, p=0.02). Nonetheless, as with the subgroup analysis, there was no significant difference when comparing nonoperative treatment with hemiarthroplasty

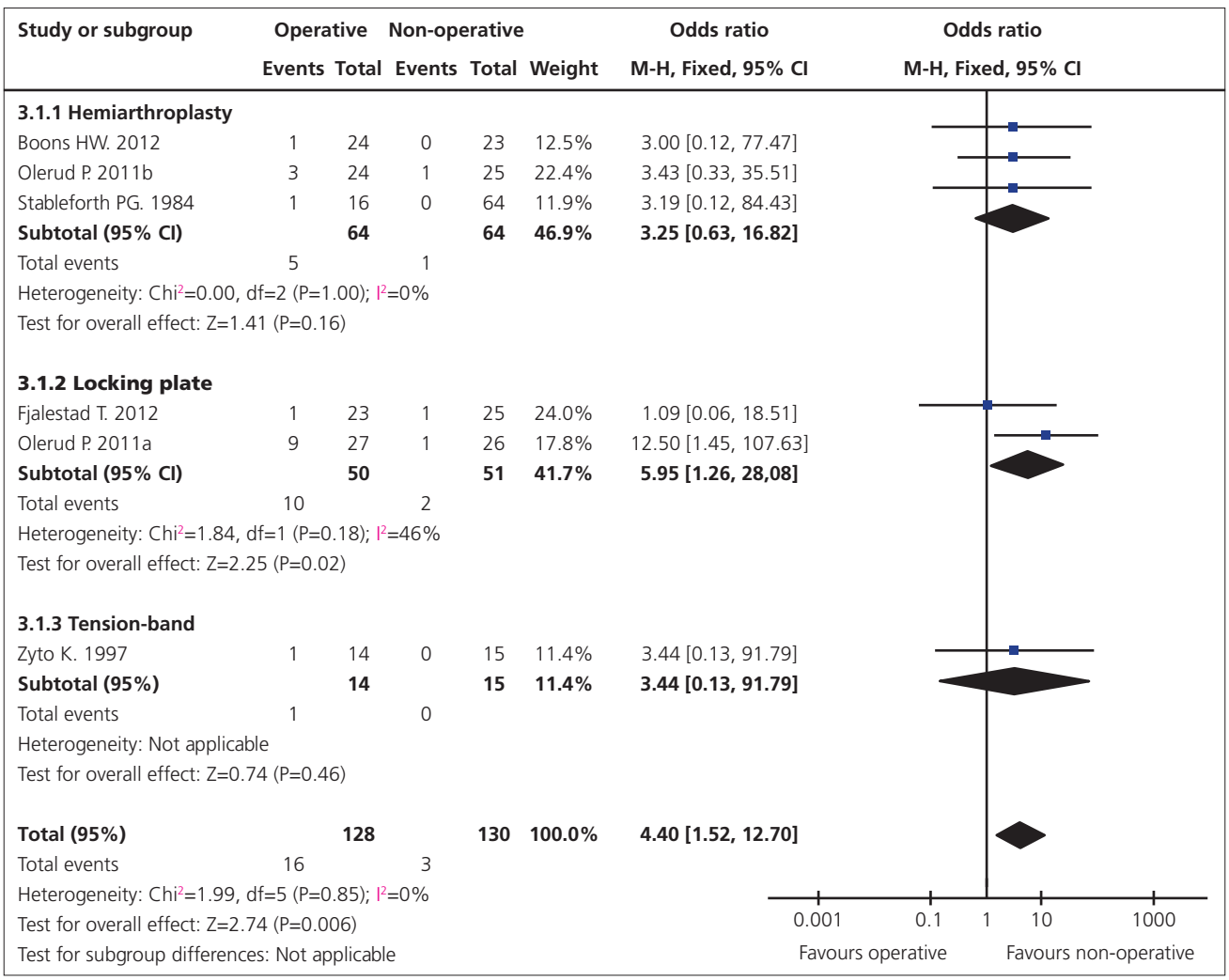

Fig. 3. Incidence of additional surgeries after operative and nonoperative treatments. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

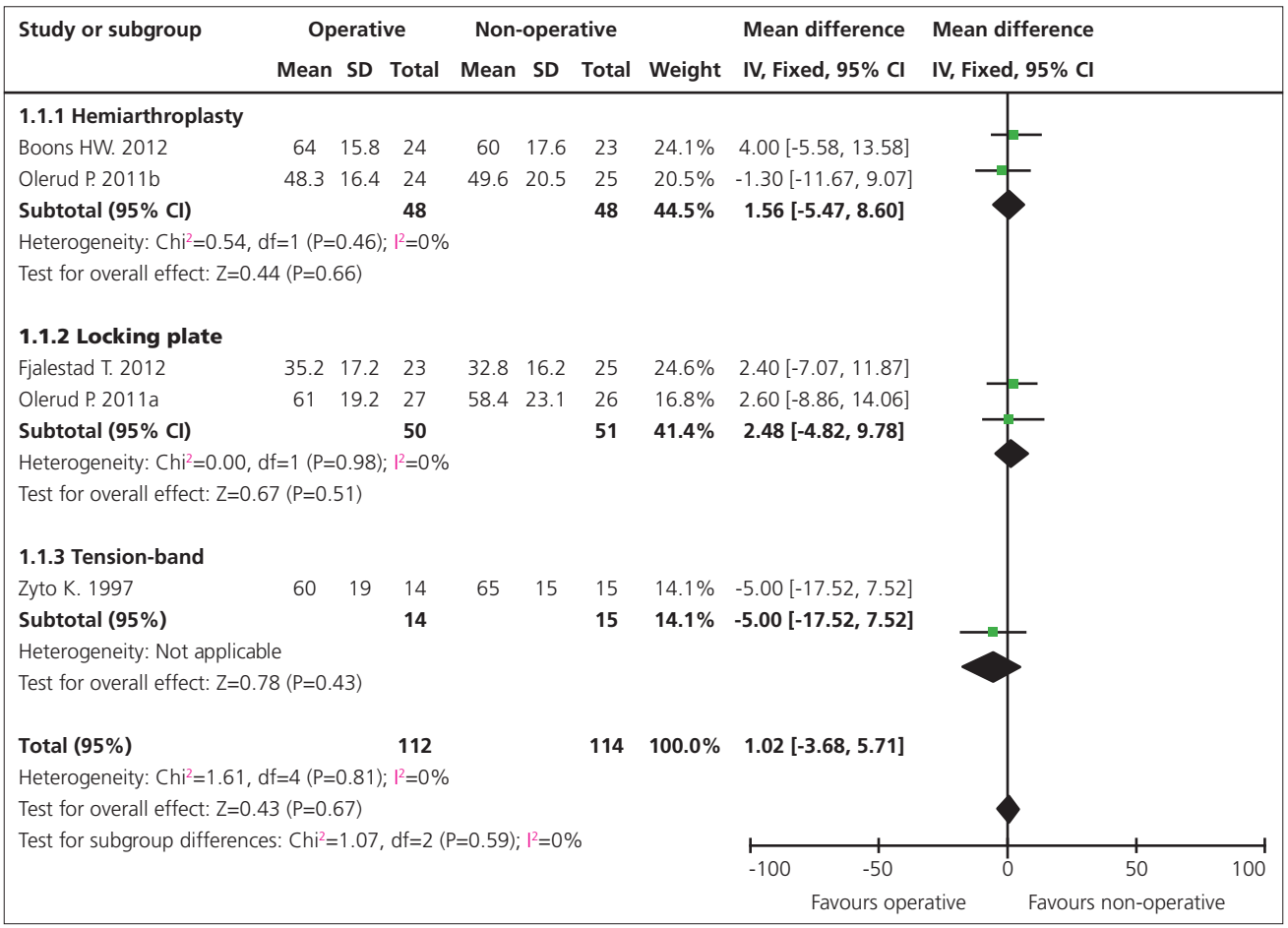

Fig. 4. Constant score of operative and nonoperative groups. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

(95% CI 0.96–5.84, p=0.06), locking plate (95% CI 0.21–78.42, p=0.36), and tension band (p=0.09), respectively.

Figure 3 shows additional surgery outcomes comparing operative treatment with nonoperative treatment. Meta-analysis demonstrated a statistically significant reduced risk of additional surgery (95% CI 1.52–12.70, p=0.006) with nonoperative treatment in comparison with operative treatment. A similar result was found when comparing nonoperative treatment with locking plate (95% CI 1.26–28.08, p=0.02) as a subgroup analysis. However, no significant difference was discovered when comparing nonoperative treatment with hemiarthroplasty (95% CI 0.63–16.82, p=0.16) and tension band treatment (p=0.46).

Figures 4, 5, and 6 show forest plots of Constant score, DASH score, and EQ-5D™. With respect to Constant score, meta-analysis shows no significant difference comparing nonoperative treatment with hemiarthroplasty (95% CI –5.47–8.60, p=0.66), locking plate (95% CI –4.82–9.78, p=0.51), tension band (p=0.43), and total operative treatment (95% CI –3.68–5.71, p=0.67), respectively. Regarding DASH score, no significant difference was found between operative and nonoperative treatment. Despite this finding, EQ-5D™ showed the nonoperative treatment group to be superior (95% CI 0.05–0.24, p=0.004). There was limited data to perform a subanalysis with DASH and EQ-5D™ scores, as only 2 articles provided DASH and and EQ-5D™ scores.

Sensitivity analysis revealed that when low-quality studies (Jadad score ≤3) were excluded, the summary OR, 95% CIs, and p values for complications and additional surgery (as these were outcomes most studies included in the meta-analysis) remained similar to the results prior to the exclusion of the substandard studies, as presented in Table 3. This finding indicates that low score RCTs in the present study had no bias impact on the results of our above meta-analyses.

Discussion

A comminuted displaced proximal humeral fracture in elderly patients has a substantial negative influence on

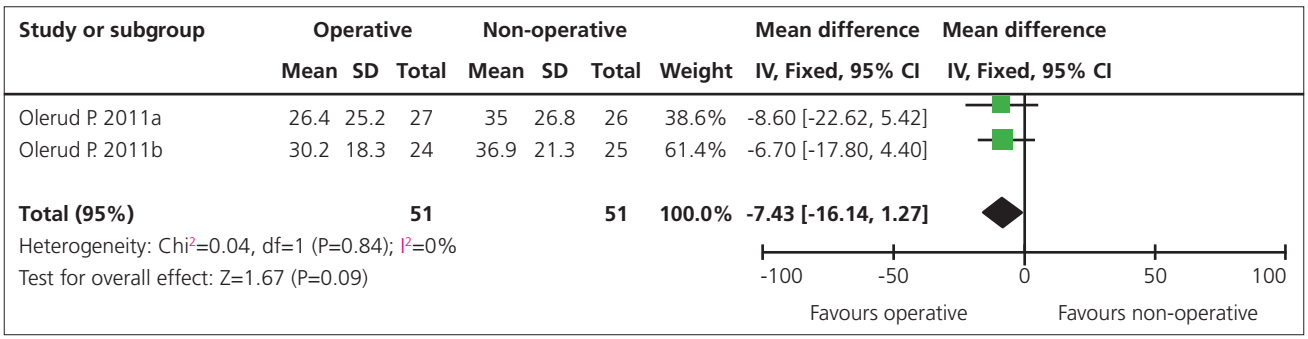

Fig. 5. DASH score of operative and nonoperative groups. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

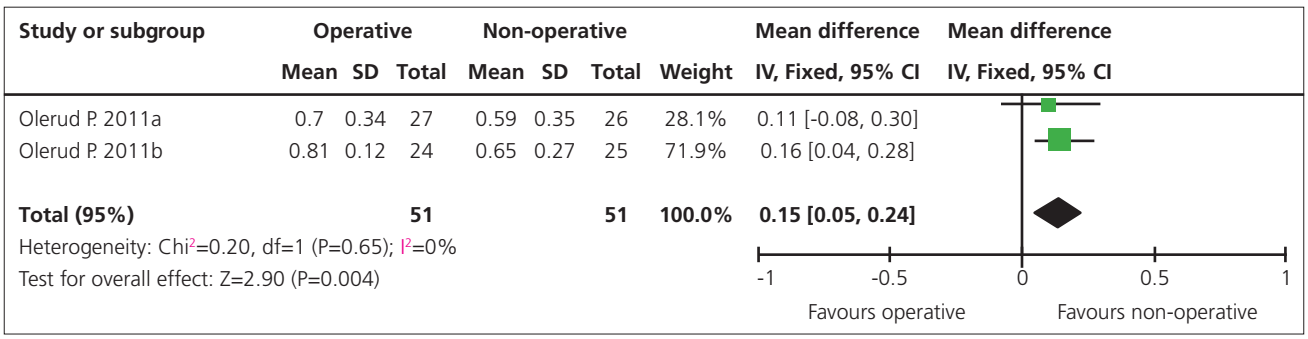

Fig. 6. EQ-5D™ of operative and nonoperative groups. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

the patients' quality of life, and there is need for further studies in this particular field in order to determine optimal treatment.[24,28] Resulting from the paucity of high-quality studies in the literature, treatment for comminuted proximal humeral fracture in the elderly continues to be disputed.[9] In our meta-analysis, 6 eligible RCTs were included according to explicit inclusion criteria, yielding results with greater validity.

Including data from the most recent RCTs, the results of the present meta-analyses have confirmed that in proximal humeral fracture treatment there is no difference in outcomes between fractures managed surgically or conservatively. This is in accordance with the conclusion proposed by Misra.[29] Additionally, our meta-analyses found that compared with operative treatment, nonoperative treatment can reduce complications and additional surgical rate.

Constant score is the most frequently used functional score as an outcome measure in studies of proximal humeral fractures.[30] In our meta-analysis, 5 of 6 RCTs used Constant score for functional result. We used a fixed-effects model in our meta-analysis. There was no significant heterogeneity between studies (I2<50%), as shown in Figure 4. There was no statistical significance between nonoperative treatment and operative treatment. This stands in contrast to a systematic review that included 33 studies encompassing 1,096 patients with 3- or 4-part proximal humeral fractures that used CMS as the outcome measure.[31] In that review, mean CMS was 66.5 in the nonoperative group and 55.5 in the arthroplasty group. However, the authors stated this difference could be attributed to selection bias, unreliable classification of the fractures, and interobserver differences in the assessment of CMS. Subgroup analyses showed the same result when comparing nonoperative treatment with hemiarthroplasty, locking plate, and tension band fixation, respectively. Beyond our present meta-analysis, many other current related studies indicate that nonoperative approach can lead to satisfactory outcomes with a high rate of healing in many proximal humeral fracture patients.[32]

The DASH[33] questionnaire is a region-specific outcome instrument developed to measure upper extremity disability and symptoms. In our review, the results of DASH scores are consistent with that of Constant scores. However, there are only 2 articles which have used this outcome. This scarcity reflects the problems which can arise when using data from disparate systems for functional scoring, as well as the wide variation in study size and length of follow-up. In light of this current situation, there is a pressing need for high-quality RCTs.

The EQ-5D™ was used to rate HRQoL.[34] In our meta-analyses, EQ-5D™ scores of the nonoperative group was superior to that of the operative group. This finding

is inconsistent with the results of Constant scores. One possible explanation for this discrepancy may be that the EQ-5D™ is self-reported and is, therefore, more sensitive to subjectively experienced differences in outcome.[35] Another possible reason is that the 2 articles which adopted EQ-5D™ and DASH scores were reported by the same institute, potentially producing bias. Following this line of reasoning, the EQ-5D™ and DASH scores may not have been taken into account when drawing conclusions.

With regard to complications, the nonoperative treatment group showed superior results. The explanation for this statistical difference is that the operative procedure creates more complications, such as incision infection and screw penetration. However, because increasing age is a risk factor of proximal humeral fracture, and many elderly people have osteopenia, plates and screws provide poor fixation for fractures of the upper humerus.[36] Additionally, nonoperative treatment does not critically impair blood supply to the humeral head, which could induce AVN, a high incidence complication of proximal humeral fractures. Despite this, when performing subgroup analyses, there was no significant difference between nonoperative and operative treatment, possibly resulting from the limited data resources.

The same situation appeared in the analysis of additional surgery rate. A difference did emerge in the subgroup analyses; when compared with locking plate treatment patients, the nonoperative group experienced a lower additional surgery rate, to the point of significant difference. These results could be attributed to the fact that those who were treated for proximal humeral fractures were mostly elderly patients with osteoporosis, and plates and screws provide poor fixation for fractures of the upper humerus with osteopenia.

The lack of adequate RCTs and a consistent functional assessment system are the main weaknesses of current studies on proximal humeral fractures. Further problems with the data were created by the use of disparate systems for fracture classification and functional scoring, and the wide variation in study size and length of follow-up. However, the present study aimed to provide stronger evidence for clinical treatment of proximal humeral fractures by comparing the clinical outcomes reported in all available related RCTs.

In summary, compared with operative treatment for closed comminuted proximal humeral fractures in elderly patients, conservative treatment can effectively reduce the risk of additional surgeries and complications. However, there is no statistical difference between operative and nonoperative treatment in terms of clinical outcome. Sufficient evidence is not available in the current studies to support the belief that operation may lead to better functional recovery. Limitations of the article remain, and results need to be further verified by more high-quality trials. We hope there will be more multicenter, large-scale RCTs with high methodological quality comparing proximal humeral fracture therapeutic strategies, reporting in a consistent and standardized manner to produce more reliable results.

Conflics of Interest: No conflicts declared.

References

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury 2006;37:691–7.
2. Barrett JA, Baron JA, Karagas MR, Beach ML. Fracture risk in the U.S. Medicare population. J Clin Epidemiol 1999;52:243–9.
3. Baron JA, Barrett JA, Karagas MR. The epidemiology of peripheral fractures. Bone 1996;18(3 Suppl):209–213.
4. Palvanen M, Kannus P, Niemi S, Parkkari J. Update in the epidemiology of proximal humeral fractures. Clin Orthop Relat Res 2006;442:87–92.
5. Bengnér U, Johnell O, Redlund-Johnell I. Changes in the incidence of fracture of the upper end of the humerus during a 30-year period. A study of 2125 fractures. Clin Orthop Relat Res 1988;231:179–82.
6. Neer CS 2nd. Displaced proximal humeral fractures. I. Classification and evaluation. J Bone Joint Surg Am 1970;52:1077–89.
7. Neer CS 2nd. Displaced proximal humeral fractures. II. Treatment of three-part and four-part displacement. J Bone Joint Surg Am 1970;52:1090–103.
8. Court-Brown CM, Garg A, McQueen MM. The epidemiology of proximal humeral fractures. Acta Orthop Scand 2001;72:365–71.
9. Lanting B, MacDermid J, Drosdowech D, Faber KJ. Proximal humeral fractures: a systematic review of treatment modalities. J Shoulder Elbow Surg 2008;17:42–54.
10. Bhandari M, Matthys G, McKee MD; Evidence-Based Orthopaedic Trauma Working Group. Four part fractures of the proximal humerus. J Orthop Trauma 2004;18:126–7.
11. Handoll HH, Gibson JN, Madhok R. Interventions for treating proximal humeral fractures in adults. Cochrane Database Syst Rev 2003:434.
12. Vallier HA. Treatment of proximal humerus fractures. J Orthop Trauma 2007;21:469–76.
13. Nho SJ, Brophy RH, Barker JU, Cornell CN, MacGillivray JD. Management of proximal humeral fractures based on current literature. J Bone Joint Surg Am 2007;89 Suppl 3:44–58.

14. Ring D. Current concepts in plate and screw fixation of osteoporotic proximal humerus fractures. Injury 2007;38 Suppl 3:59–68.
15. Resch H, Povacz P, Fröhlich R, Wambacher M. Percutaneous fixation of three- and four-part fractures of the proximal humerus. J Bone Joint Surg Br 1997;79:295–300.
16. Wall B, Walch G. Reverse shoulder arthroplasty for the treatment of proximal humeral fractures. Hand Clin 2007;23:425-30.
17. Misra A, Kapur R, Maffulli N. Complex proximal humeral fractures in adults-a systematic review of management. Injury 2001;32:363–72.
18. Oremus M, Wolfson C, Perrault A, Demers L, Momoli F, Moride Y. Interrater reliability of the modified Jadad quality scale for systematic reviews of Alzheimer's disease drug trials. Dement Geriatr Cogn Disord 2001;12:232–6.
19. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Ann Intern Med 2009;151:65–94.
20. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ 2003;327:557–60.
21. LB, MC. An introduction to sensitivity analysis. 1996;41–107.
22. Boons HW, Goosen JH, van Grinsven S, van Susante JL, van Loon CJ. Hemiarthroplasty for humeral four-part fractures for patients 65 years and older: a randomized controlled trial. Clin Orthop Relat Res 2012;470:3483-91.
23. Zyto K, Ahrengart L, Sperber A, Törnkvist H. Treatment of displaced proximal humeral fractures in elderly patients. J Bone Joint Surg Br 1997;79:412–7.
24. Olerud P, Ahrengart L, Ponzer S, Saving J, Tidermark J. Internal fixation versus nonoperative treatment of displaced 3-part proximal humeral fractures in elderly patients: a randomized controlled trial. J Shoulder Elbow Surg 2011;20:747–55.
25. Olerud P, Ahrengart L, Ponzer S, Saving J, Tidermark J. Hemiarthroplasty versus nonoperative treatment of displaced 4-part proximal humeral fractures in elderly patients: a randomized controlled trial. J Shoulder Elbow Surg 2011;20:1025–33.
26. Fjalestad T, Hole MØ, Hovden IA, Blücher J, Strømsøe K. Surgical treatment with an angular stable plate for complex displaced proximal humeral fractures in elderly patients: a randomized controlled trial. J Orthop Trauma 2012;26:98–106.
27. Stableforth PG. Four-part fractures of the neck of the humerus. J Bone Joint Surg Br 1984;66:104–8.
28. Olerud P, Ahrengart L, Söderqvist A, Saving J, Tidermark J. Quality of life and functional outcome after a 2-part proximal humeral fracture: a prospective cohort study on 50 patients treated with a locking plate. J Shoulder Elbow Surg 2010;19:814–22.
29. Misra A, Kapur R, Maffulli N. Complex proximal humeral fractures in adults-a systematic review of management. Injury 2001;32:363–72.
30. Kontakis G, Koutras C, Tosounidis T, Giannoudis P. Early management of proximal humeral fractures with hemiarthroplasty: a systematic review. J Bone Joint Surg Br 2008;90:1407–13.
31. den Hartog D, de Haan J, Schep NW, Tuinebreijer WE. Primary shoulder arthroplasty versus conservative treatment for comminuted proximal humeral fractures: a systematic literature review. Open Orthop J 2010;4:87–92.
32. Iyengar JJ, Devcic Z, Sproul RC, Feeley BT. Nonoperative treatment of proximal humerus fractures: a systematic review. J Orthop Trauma 2011;25:612–7.
33. Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand) [corrected]. The Upper Extremity Collaborative Group (UECG) Am J Ind Med 1996;29:602–8.
34. Brooks R. EuroQol: the current state of play. Health Policy 1996;37:53–72.
35. PH, Aj C. Shoulder and elbow. In: Pynsent P, Fairbank J, Carr AJ, editors. Outcome messures in orthopedics and orthopedic trauma. 2004;172–95.
36. Cofield RH. Total shoulder arthroplasty with the Neer prosthesis. J Bone Joint Surg Am 1984;66:899–906.