Nonoperative treatment of distal humerus fractures in the elderly yields satisfactory functional outcomes and low conversion to delayed surgery: a systematic review

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Running title: Nonoperative Management of Distal Humerus Fractures

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Nonoperative treatment of distal humerus fractures in the elderly yields satisfactory functional outcomes and low conversion to delayed surgery: a systematic review

Abstract:

Background: Distal humerus fractures (DHF) pose a treatment challenge in elderly patients. We sought to systematically review and report the clinical outcomes of the nonoperative approach (e.g., “bag of bones”) for the treatment of these injuries, and the rate of conversion to delayed surgery.

Methods: A comprehensive review of the literature using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines was conducted. Studies involving outcomes following nonoperative treatment of DHF in patients >65 years of age were included from 1985 to present. Data regarding patient age, DHF type, nonoperative treatment method, complications, conversion to delayed surgery, range of motion, union rate, and surgeon and patient reported outcome measures were extracted.

Results: A total of five studies met inclusion criteria (all level IV evidence), yielding a total of 143 patients (mean age: 73.5 years to 87.4 years) with 7.1 months to 55 months of follow-up. The mean Mayo Elbow Performance Index (MEPI) scores were good to excellent across several studies (range 83 - 93.1). Multiple studies reported good range of motion (mean arc of motion: 81 to 106 degrees) and low levels of upper extremity disability (mean Quick Disability of the Arm-Shoulder-Hand (Q-DASH) scores: 31.3 to 38.5) at final follow-up. The rate of conversion to total elbow arthroplasty and operative fixation ranged from 0% to 7.5% and 0% to 5%, respectively.
Conclusion: Nonoperative management of distal humerus fractures in the elderly seems to be associated with acceptable functional outcomes and low rates of delayed surgery. This information is important for patient counseling and treatment decision-making.

Level of Evidence: Level IV

Keywords: nonoperative, distal humerus fracture, elderly, geriatric, conversion, total elbow arthroplasty

Distal humerus fractures (DHF) account for 1-2% of all fractures and represent 30% of fractures about the elbow. These injuries often occur in elderly patients with osteoporotic bone following low energy falls. Prior to the 1960’s, DHFs were treated nonoperatively with brief immobilization followed by early range of motion. Historical small volume studies reported favorable outcomes with this so-called "bag of bones" approach. However, after development of the Arbeitsgemeinschaft für Osteosynthesefragen (AO) fracture fixation principles, surgical implants and techniques improved, and patients experienced better outcomes with open reduction internal fixation (ORIF). Plate osteosynthesis has since remained the gold standard of treatment for most DHF fractures, particularly in patients with good bone quality. However, in patients with osteoporosis and multifragmentary comminution, the feasibility of ORIF is challenged. Prosthetic replacement with total elbow arthroplasty (TEA) has shown promise in these patients, as well as those with rheumatoid arthritis, failed fixation, and nonunion.
Consequently, nonoperative treatment has been reserved for low demand, medically unwell patients with advanced comorbidities that preclude surgery.\textsuperscript{20,31}

However, operative management is not without risk. Infection, neurovascular injury, hardware failure, and elbow stiffness are well documented postoperative complications.\textsuperscript{1,37} The incidence of postoperative complications after ORIF and TEA is 53\% and 11 - 38\%, respectively.\textsuperscript{36,39}

Thus, in addition to the general anesthetic risks of surgery, the risk of perioperative complications must be weighed against the added clinical benefits of operative intervention.

The purpose of this study was to systematically review and report the clinical outcomes and the rate of conversion to delayed surgery following nonoperative management of geriatric DHF.

\textbf{Materials and Methods:}

\textit{Identification of studies}

This study was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.\textsuperscript{25} We performed a literature search using the PubMed, Scopus, and Cochrane Central Registrar of Controlled Trials databases from 1985 to present. 1985 was the year that ORIF gained acceptance over nonoperative management for DHF and was therefore used as a set point for our inclusion criteria.\textsuperscript{18,19} Our search was conducted using several combinations of the terms ‘nonoperative’, ‘management’, ‘conservative’, ‘treatment’, ‘distal humerus fracture’, ‘fractures of the distal humerus’, ‘elderly’ and ‘geriatric’.
Two reviewers (S.S and R.P) independently screened titles and abstracts for inclusion and exclusion criteria. Full-text articles were obtained and reviewed when necessary. The references of all selected articles were reviewed to find articles that may have been overlooked or were not indexed in the databases.

Inclusion criteria: all available studies that reported on outcomes following nonoperative management of DHF of AO/OTA classification A, B, and C. A minimum average follow-up of 6 months was required. Mean inclusion age was ≥65 years to remain consistent with other reports that examined fragility fracture management of the upper extremity in elderly patients.2,4,7

Exclusion criteria: case reports or case series with <2 patients, studies with abstract-only available, studies that failed to separate outcomes amongst surgically and nonsurgically treated patients with DHF, and studies published before 1985.

Analysis of Bias

Two reviewers (S.S and R.P) independently appraised the quality of each study with use of the Methodological Index for Non-Randomized Studies (MINORS) criteria.34 The criteria assess 8 critical aspects of study design for non-comparative clinical studies. Each item is given a score of 0 if information is not reported, 1 if information is reported but inadequate, and 2 if information is reported and adequate. Therefore, the maximum possible score is 16 for non-comparative studies. If there was any discrepancy between the results of the 2 reviewers, the item in question
was discussed with the senior author (M.E.M), who made the final determination of the
MINORS score.

**Data Extraction**

Study characteristics, AO/OTA fracture classification, and intervention details were extracted. If
the level of evidence was not explicitly stated in the study, we used the classification as specified
by Wright et al\textsuperscript{38} to determine the level of evidence. Clinical outcome measures (Oxford Elbow
Score (OES), American Shoulder and Elbow Surgeons score (ASES), MEPI, Q-DASH, or elbow
range of motion) and conversion to delayed surgery (TEA or ORIF) served as our primary
outcomes. The indication for reoperation was provided if available. Secondary outcomes
included radiographic assessment of healing (Bröberg-Morrey classification or fracture union
rate).

**Statistical Analysis**

Given the inherent heterogeneity and limitations of Level IV studies, pooled statistics were not
reported to avoid potentially inaccurate conclusions. The means and standard deviations (or
range of data in cases where the standard deviation was not reported) were extracted from each
study. Confidence intervals and effect sizes were calculated. This data was used to produce a
forest plot depicting the conversion rates to delayed surgery following nonoperative management
of geriatric DHF (Fig. I).
Results:

Study Characteristics

Study identification and screening is summarized in Figure II. Of the 397 total articles identified, 5 were included in the final review. There were 5 retrospective reviews (Level IV) and 1 prospective review (Level IV evidence) reported within the 5 articles.\(^1,3,10,30,35\) Reported studies were conducted in Canada (n=1),\(^10\) France (n=1),\(^30\) Japan (n=1),\(^35\), and the UK (n=2).\(^1,3\) Risk of bias was assessed using MINORS criteria, with scores ranging from 8 to 12 (Table I).

Patient Characteristics, Fracture Classification, and Treatment Details

A total of 143 patients were included. Patient samples ranged from 14 to 40 patients and were predominantly women (range, 57% to 91%). The mean age and follow-up period ranged from 73.5 to 87.4 years and from 7.1 to 55 months, respectively. The ASA scores were reported in three studies.\(^10,30,35\) The Charlson Comorbidity index was reported in one study.\(^1\) Five studies used the AO/OTA classification to categorize fractures of the distal humerus.\(^1,3,10,30\) In total, 47 fractures were type A, 26 type B, and 56 type C (Table I).

Nonoperative management varied with immobilization method (sling, splint, fiberglass or plaster cast), duration (mean range 2-7 weeks), and structure of physiotherapy (supervised or unsupervised) (Table II).

Patient-Reported Outcome Measures
Patient-reported outcome measures (PROMs) were used in all studies. Three studies reported 3 or more PROMs. The most commonly reported outcome measure was the MEPI (60%). The Q-DASH, OES, Visual Analogue Scale (VAS), and Katz Index of Independence of Activities of Daily Living (Katz ADL) were reported in two studies. Pre-trauma and end of follow-up Katz scores were provided in one study and were found to be nearly identical. Each of the remaining PROMs were obtained at the end of follow-up.

The mean MEPI scores were good to excellent across three studies (range, 83-93.1). The mean Q-DASH and OES scores ranged from 31.3 to 38.5 and 30 to 46, respectively. Pain at rest ranged from 0.4 to 4 whereas pain with activity ranged from 1.3 to 5.5. The other outcome measures and their frequency of use are shown in Table III.

**Range of Motion**

Three studies reported range of motion data. Mean flexion ranged from 110° to 128° and the mean arc of motion was 81° to 102.3°. Mean pronation and supination were 72° and 77° as reported in one study (Table IV).

**Conversion to Delayed Surgery**

Four studies reported on conversion to ORIF or TEA following nonoperative management of DHF. The rate of conversion to TEA and time to conversion to TEA ranged from 0% to
Nonoperative Management of Distal Humerus Fractures

7.5% and from 3 months to 17 months, respectively. The rate of conversion to ORIF and time to conversion for ORIF ranged from 0% to 5% and 3 months to 13 months (Table V).

Radiographic Outcomes

Four studies reported on union rate and one study reported on the presence of post-treatment osteoarthritis with use of the Broberg Morrey classification.\(^1,10,30,35\) Standard anteroposterior and lateral radiographs of the elbow taken at 6 months follow-up were used to assess for fracture union. Overall, the mean union rate was 53% to 100%.\(^1,10,30,35\) Thirty percent to 48% of patients had radiographic evidence of OA (grade > 1) at final-follow-up (range: 7 weeks to 60 months) (Table VI).\(^30\)

Other Outcomes

Quality of life scores from the 12-item Short Form Survey (SF-12) were 44 ± 11 on the physical component and 59 ± 6 on the mental component as reported in one study.\(^10\) The mean Patient Reported Elbow Evaluation (PREE) Score was 15.6 ± 22.7 (range, 0-83) as reported in one study.\(^10\) Strength was evaluated using the Medical Research Council Scale (MRCS) in one study. No differences in elbow flexion and extension and grip strength were found when the injured side was compared with the uninjured side.\(^10\) The mean satisfaction score was 7.1 ± 2.7 as reported in one study.\(^1\)

Effect Size
Effect sizes ranged from 0\% - 10\% (Fig. I) among studies that reported on rates of conversion to delayed surgery (TEA or ORIF) after nonoperative treatment of DHF.\textsuperscript{1,3,10,35}

Risk of Bias

Risk-of-bias assessment, performed using the MINORS criteria scores, ranged from 8 to 12. The most common sources of possible bias were inadequate blinding or an unbiased assessment of endpoints, greater than 5\% loss of patients at final follow-up, absence of a prospective calculation of study sample size, and lack of a prospective collection of data.

Discussion:

Complex distal humerus fractures in elderly patients continue to present treatment challenges, and their prevalence is expected to rise 3-fold by 2030.\textsuperscript{28} This systematic review aimed to evaluate outcomes following nonoperative treatment of geriatric DHF. Importantly, we show that acceptable functional outcomes are achieved with low conversion rates to delayed surgery.

Patient-centric care initiatives have changed the way providers view clinical outcome measures.\textsuperscript{17} Focus has shifted towards PROMs, especially in cases where the added clinical benefit of invasive treatment options is questioned.\textsuperscript{33} The MEPI score and the Q-DASH score were frequently reported PROMs within this study. The MEPI score is a reliable outcomes instrument for elbow function that is used to assess nonsurgical treatment.\textsuperscript{9} The performance index includes a score for pain (45 pts), mobility (20 pts), stability (10 pts) and daily activity (25
pts). On the basis of this system, the results are classified as excellent [100—90 pts], good [89—75 pts], average [74—60 pts] and poor [<60 pts].6 The mean MEPI scores were good to excellent across all studies within this review (range 83–93.1). Similarly, the Q-DASH is a well-recognized self-report questionnaire designed to measure the overall functional capacity of the upper limb.6 A 5-point Likert scale is used to grade the severity and function level for each of the 11 items on the questionnaire.24 Scaled scores range from 0 (no disability) to 100 (most severe disability).16 Patients in this study experienced low levels of upper extremity disability (Q-DASH 31.3 to 38.5) after nonoperative management of DHF.

Historic criticisms of nonoperative management include poor cast tolerance in the elderly with substantial risk for stiffness.10 However, we found that a functional range of motion may be achieved after a mean period of 2 to 7 weeks of elbow immobilization. While immobilization methods differed (sling, splint, fiberglass or plaster cast), complications were few and relatively benign. In total, 2 hematomas,10 2 localized pressure ulcers,10,30 3 fracture displacements not requiring surgery,10 2 symptomatic pseudoarthroses, 1 asymptomatic pseudoarthrosis,30 3 malunions, 6 cases of mild varus and valgus elbow laxity,30 2 cases of heterotopic ossification (HO) not requiring surgery,30 and 4 cases of elbow stiffness secondary to bony impingement occurred.30 All patients reported good function with ability to compensate adequately with the contralateral arm. No deep infections or elbow contractures requiring surgical release were reported.

A variable rate of fracture union (52.6% to 100%) resulted from nonoperative management of DHF. This was not unexpected as the majority of fractures evaluated were comminuted and
intra-articular. However, most nonunions were asymptomatic and compatible with the requirements of low-demand elderly patients, as evidenced by a low conversion rate to delayed surgery. Interestingly, a recent systematic review of 83 studies and 2363 elbows reported an overall reoperation rate of 21% following ORIF of intra-articular DHFs. The reoperation rate for TEA varies across published studies, ranging from 5.7% to 11.3%.

The indications for delayed surgery in our review included stiffness, poor function, and continued pain in 6 of 87 patients. PROMs following delayed TEA were available for 1 patient. She had a PREE score of 2, MEPI score of 100, and adequate range of motion (flexion-extension: 5 to 115 degrees; pronation 90 degrees; supination 65 degrees) 37 months postoperatively. These results underscore the effectiveness of TEA in the delayed setting. Prasad and Dent compared outcomes of primary TEA and delayed TEA following failure of conservative treatment for geriatric DHF. At a mean follow-up of 56.1 months (18 to 88 months), both groups experienced good outcomes according to their MEPI scores (84 in the early group and 79 in the delayed group; p>0.05). Subjective satisfaction was 92% in both groups and no differences in survivorship were found. It has been proposed that elderly low demand patients with DHF should first be treated nonoperatively, as successful salvage can be achieved with delayed TEA.

Conversion to delayed surgery is ultimately dependent on patient autonomy. Desloges et al described 2 patients who developed symptomatic nonunion following nonoperative management. While both patients were offered delayed TEA, only 1 patient accepted. The other patient had a history of metastatic colon cancer and was receiving chemotherapy at the time of acute DHF.
She preferred to continue with nonoperative management as she felt that her symptoms were manageable and her function was adequate. Similarly, one patient who developed an extension malunion and subsequent bony impingement refused surgical release as he was otherwise pain free and content with his overall function. These cases support the usefulness of PROMs and may be used by surgeons to set expectations and to provide patients with the information they need to make the most informed decisions regarding the totality of their treatment options.

The conclusions of this study are most limited by the quality of included studies. The risk of selection bias was high and therefore no meta-analysis was performed. Furthermore, each study failed to include uniform outcome reporting and only nonsurgical treatment methodologies were included. Thus, direct comparisons against surgical outcomes cannot be made. In addition, it was assumed that all patients in this study were low demand. While patients with a minimum of 65 years of age are often defined as elderly, there is little evidence to support the correlation of chronological age with functional ability.

**Conclusion:**

Nonoperative treatment of geriatric DHF can achieve satisfactory functional outcomes with little risk for complications or need for delayed surgery. While surgical intervention may afford patients better functional outcomes, the risks of surgery and the likelihood of reoperation must be considered in low demand elderly patients. The results from this study may be used by surgeons to provide patients with the information they need to make informed decisions regarding the totality of their treatment options.
References:


**Figure and Table Legends:**

**Figure I:** Rate of conversion to delayed surgery (TEA or ORIF) after nonoperative management of DHF, with forest plot displaying effect size (ES) (conversion rate represented by diamonds) and 95% confidence intervals (CIs) (horizontal lines).

**Figure II:** Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA article search flow diagram.

**Table I:** Patient Demographics and Characteristics of Included Studies

**Table II:** Nonoperative Treatment Details

**Table III:** Patient Reported Outcome Measures

**Table IV:** Range of Motion Data

**Table V:** Conversion to Operative Management

**Table VI:** Incidence of Fracture Union and Osteoarthritis at Final Follow-up
<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Setting</th>
<th>Design</th>
<th>Level of Evidenc</th>
<th>Total Patients (M/F), n</th>
<th>Age, mean (range), year</th>
<th>Follow-up, mean (range), months</th>
<th>Fracture Classification</th>
<th>Subjective Outcome</th>
<th>Functional and Radiographic Outcomes</th>
<th>MINORS Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pidhorz et al. (2013)</td>
<td>France</td>
<td>RS</td>
<td>IV</td>
<td>34 (5/29)</td>
<td>84.7</td>
<td>20.2 (6 - 92)</td>
<td>A: 8 (23%)</td>
<td>B: 4 (12%)</td>
<td>C total: 22 (64%)</td>
<td>C1: 12</td>
</tr>
<tr>
<td>Pidhorz et al. (2013)</td>
<td>France</td>
<td>PS</td>
<td>IV</td>
<td>22 (2/20)</td>
<td>87.4</td>
<td>8.6 (6 - 20)</td>
<td>A: 10 (45%)</td>
<td>B: 4 (12%)</td>
<td>C total: 8 (36%)</td>
<td>C1: 4</td>
</tr>
<tr>
<td>Desloges et al. (2015)</td>
<td>Canada</td>
<td>PS</td>
<td>IV</td>
<td>19 (8/11)</td>
<td>77 (56 - 91)</td>
<td>27 +/- 14 (6 - 57)</td>
<td>A: 3 of 19</td>
<td>B: 8 of 19</td>
<td>C: 8 of 19</td>
<td>SF-12</td>
</tr>
<tr>
<td>Aitken et al. (2015)</td>
<td>UK</td>
<td>RS</td>
<td>IV</td>
<td>40 (11/29)</td>
<td>73.5 (50 to 93)</td>
<td>46 (5 - 73)</td>
<td>A: 19/40 (47.5%)</td>
<td>B: 7/40 (17.5%)</td>
<td>C: 14/40 (35%)</td>
<td>Satisfaction score</td>
</tr>
<tr>
<td>Tomori et al. (2019)</td>
<td>Japan</td>
<td>RS</td>
<td>IV</td>
<td>14 (6/8)</td>
<td>78 (46 - 98)</td>
<td>7.1 (3-16)</td>
<td>NR</td>
<td>NR</td>
<td>MEPS, ROM</td>
<td>9</td>
</tr>
</tbody>
</table>

MEPS, Mayo Elbow Performance Index; Q-DASH, quick-disability of the arm-shoulder-hand; OES, Oxford Elbow Score; VAS, Visual Analog Scale; PREE, Patient-Rated Elbow Evaluation; SF-12, Short Form-12; MCS, Mental Health Composite Score; PCS, Physical Health Composite Score; MINORS, Methodological Index for Nonrandomized Studies
<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Treatment Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pidhorz et al.⁵⁰ (2013)</td>
<td>Initial BABP plaster cast immobilization and Dujaerrier bandage with switch to resin BABP cast at 3–4 weeks. Total immobilization time averaged 7 weeks (range, 15—120 days).</td>
</tr>
<tr>
<td>Desloges et al.⁵⁰ (2015)</td>
<td>Immobilized at 90 degrees of elbow flexion with neutral forearm rotation for a mean of 5 weeks (range, 3–8 weeks), followed by active range of motion and supervised physiotherapy once radiographic union was achieved.</td>
</tr>
<tr>
<td>Aitken et al.¹ (2015)</td>
<td>Initial above-elbow plaster splint with change to a sling at the first outpatient visit (within 14 days of injury) and instruction to perform unsupervised physiotherapy.</td>
</tr>
<tr>
<td>Batten et al.³ (2018)</td>
<td>Initial sling placement for comfort alone with instruction to immediately start supervised physical therapy.</td>
</tr>
<tr>
<td>Tomori et al.³⁵ (2019)</td>
<td>Initial immobilization in a fiberglass cast or splint with removal at 6 weeks and commencement of active range of motion.</td>
</tr>
<tr>
<td>Study (Year)</td>
<td>Katz</td>
</tr>
<tr>
<td>-------------------</td>
<td>------</td>
</tr>
<tr>
<td>Pidhorz et al.10  (2013) RS</td>
<td>4.2</td>
</tr>
<tr>
<td>Pidhorz et al. 10 (2013) PS</td>
<td>4.3</td>
</tr>
<tr>
<td>Desloges et al.10 (2015)</td>
<td>-</td>
</tr>
<tr>
<td>Aitken et al.11 (2015)</td>
<td>-</td>
</tr>
<tr>
<td>Batten et al.13 (2018)</td>
<td>-</td>
</tr>
<tr>
<td>Tomori et al.15 (2019)</td>
<td>-</td>
</tr>
</tbody>
</table>

RS; retrospective study, PS; prospective study, MEPI; Mayo Elbow Performance Index, Q-DASH; quick-DASH, OES; Oxford Elbow Score, VAS; Visual Analog Scale, PREE; Patient-Rated Elbow Evaluation, SF-12; Short Form-12, MCS; Mental Health Composite Score, PCS; Physical Health Composite Score.

*First value is pain reported at rest, second value is pain with activity.
<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Flexion (degrees)</th>
<th>Extension (degrees)</th>
<th>Arc of Motion (degrees)</th>
<th>Pronation (degrees)</th>
<th>Supination (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pidhorz et al. (2013) RS</td>
<td>110</td>
<td>-</td>
<td>81</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pidhorz et al. (2013) PS</td>
<td>120</td>
<td>-</td>
<td>94</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Desloges et al. (2015)</td>
<td>128 ± 16</td>
<td>-</td>
<td>106 ± 17</td>
<td>72 ± 13</td>
<td>77 ± 14</td>
</tr>
<tr>
<td>Tomori et al. (2019)</td>
<td>121.2 (90-140)</td>
<td>19.2 (5-30)</td>
<td>102.3 (70-130)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

RS; retrospective study, PS; prospective study
<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Time to conversion (months)</th>
<th>TEA, %</th>
<th>ORIF, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desloges et al. (2015)</td>
<td>16</td>
<td>5.3</td>
<td>0</td>
</tr>
<tr>
<td>Aitken et al. (2015)</td>
<td>9</td>
<td>7.5</td>
<td>5</td>
</tr>
<tr>
<td>Batten et al. (2018)</td>
<td>N/a</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tomori et al. (2019)</td>
<td>N/a</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

RS: retrospective study, PS: prospective study, TEA: total elbow arthroplasty, ORIF: open reduction internal fixation, N/a: not applicable
<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Assessment Time (months)</th>
<th>Union Rate</th>
<th>OA*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pidhorz et al. (2013)</td>
<td>20.2</td>
<td>95%</td>
<td>30%, 48%</td>
</tr>
<tr>
<td>Desloges et al. (2015)</td>
<td>12</td>
<td>81%</td>
<td>NR</td>
</tr>
<tr>
<td>Aitken et al. (2015)</td>
<td>12</td>
<td>53%</td>
<td>NR</td>
</tr>
<tr>
<td>Tomori et al. (2019)</td>
<td>1.75</td>
<td>100%</td>
<td>NR</td>
</tr>
</tbody>
</table>

OA; osteoarthritis, NR; not recorded
*classified as a Broberg Morrey Classification grade >1 for the PS and RS, respectively
<table>
<thead>
<tr>
<th>Study</th>
<th>Conversion</th>
<th>Total</th>
<th>ES</th>
<th>95% - CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desloges et al. 2015 (TEA)</td>
<td>1</td>
<td>19</td>
<td>0.05</td>
<td>[0.00; 0.26]</td>
</tr>
<tr>
<td>Aitken et al. 2015 (TEA)</td>
<td>3</td>
<td>40</td>
<td>0.1</td>
<td>[0.02; 0.27]</td>
</tr>
<tr>
<td>Aitken et al. 2015 (ORIF)</td>
<td>2</td>
<td>40</td>
<td>0.07</td>
<td>[0.01; 0.23]</td>
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<td>Batten et al. 2018</td>
<td>0</td>
<td>14</td>
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<td>[0; 0.23]</td>
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<td>Tomori et al. 2019</td>
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<td>[0; 0.23]</td>
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