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Review Article

Surgical versus non-surgical treatment of ankle fractures in patients above the age of 50: A systematic review and meta-analysis

Abduljabbar Alhammoud, MD.[1], Isam S. Moghamis, MBBS.[2], Motasem Salameh, MD.[2], Karim Mahmoud, MD.[3], Mohammed M. Mekhaimar, FRCS.[2], Miluska Bromley, MD.[3], Timo Siepmann, PhD.[4]

[1]Department of Spine Surgery, Upstate Medical University, Syracuse, New York, [2]Department of Orthopedics Surgery Warren Alpert Medical School of Brown University, Providence, Rhode Island, [3]Department of Orthopedics, Augusta Orthopedic and Sports Medicine Specialist, Philadelphia, Pennsylvania, United States, [4]Department of Orthopedics, Sao Paulo University, Instituto Ivo Pitanguy, Sao Paulo, Brazil, [5]Department of Neurology, University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany.

***Corresponding author:**
Abduljabbar Alhammoud, Spine surgery, Upstate Medical University, Syracuse, New York.

aghammoud85@hotmail.com

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ABSTRACT

Ankle fractures management in old individuals has been discussed controversially. We aimed to assess clinical outcomes in patients undergoing surgery and those receiving non-surgical treatment. MEDLINE, PubMed, EMBASE, Google Scholar, and Cochrane databases were searched in June 2019. In the synthesized analyses, patients above 50 years of age who received surgical treatment through open reduction and internal fixation (ORIF) were compared to those who underwent non-surgical treatment through closed reduction and casting for relevant clinical outcome parameters. We identified 12 eligible studies with a total of 54,699 patients. Of these, 27,110 received surgical and 27,588 non-surgical treatment. Surgical treatment was associated with a lower risk of non-unions (odds ratio [OR]: 0.127; 95% confidence interval [CI]: 0.055, 0.292, $P < 0.001$) as well as mal-unions (OR: 0.128, 95% CI: [0.063, 0.262], [$P < 0.001$]), and mortality at 1-year post-treatment (OR: 0.509, 95% CI: [0.266, 0.975], [$P = 0.042$]). Similarly, the duration of return to pre-injury activity was significantly shorter in a surgical group whereas skin complications were associated with a higher risk in the surgical group (OR: 4.923, 95% CI: [3.720, 6.515], [$P < 0.001$]). Neither rates of satisfaction and re-admission nor duration of hospital stay and period in cast differed between surgical and non-surgical treatment groups. In patients above the age of 50 years, ORIF seems to be superior to non-surgical treatment for relevant clinical outcomes such as non-union, mal-union, and mortality rates; as well as return to pre-injury level was better in the surgical group.

Keywords: Ankle, Fracture, Middle-aged, Surgical fixation, Non-surgical treatment

INTRODUCTION

Ankle fractures are the third most common orthopedic injuries seen in patients older than 50 years after proximal femur and distal radius fractures, constituting a major source of morbidity and mortality.[1] Furthermore, ankle fracture incidence is expected to rise in the future due to the constant global increase in average life expectancy. A three-fold rise in elderly ankle fractures was reported in Finland between 1970 and 2000.[2]

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Ankle fracture may lead to loss of independence and might affect the quality of life if not treated properly. Elderly patients with ankle fractures pose a challenge to orthopedic surgery since they frequently present with multiple comorbidities, including peripheral vascular disease, hypertension, and diabetes mellitus, as well as poor bone quality. These factors combined may significantly affect complications rates among surgically treated patients. Some authors report infection rates of up to 12% in older patients with surgically treated ankle fractures.[3]

Fractures treatment in the elderly population generally is controversial. In a recent prospective study, non-surgical treatment of olecranon fracture provided excellent early functional outcomes with no complications.[4] Similarly, several reports found no difference in functional outcome between the non-surgical and surgical treatment of distal radius fractures in the elderly.[5,6] To date, there have been inconsistent data, with no agreement regarding the optimal management of ankle fractures in older individuals. And, hence, we aimed to assess the superiority of surgical treatment to non-surgical treatment in improving clinical outcomes in patients older than 50 years with ankle fractures.

MATERIALS AND METHODS

We conducted a systematic review and meta-analysis following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[7]

Eligibility criteria

We included all studies that compared surgical treatment with open reduction and internal fixation (ORIF) versus non-surgical treatment with closed reduction and casting or casting alone for ankle fractures. If patients were treated with casting alone, the fracture had to be reduced in acceptable alignment. We included only studies reporting on patients above 50 years and reporting at least one outcome measure [Table 1].

Search strategy

The databases search was performed in June 2019 in MEDLINE, PubMed, EMBASE, Google Scholar, and Cochrane databases. ("ankle fractures" AND "elderly" OR "geriatric" AND "conservative" OR "Casting" OR "non-surgical" OR "surgical" OR "open reduction and internal fixation"). Two independent authors screened articles based on titles and abstracts. In addition, a full-text review was performed on potentially eligible articles. Furthermore, the references of eligible studies were manually searched. Unpublished studies and articles not in English were not sought.

Data items and collection process

The collected data items included authors' names, study year, level of evidence, follow-up period, patients' number, age, gender, type of treatment, and outcome measures. The primary outcome measure was the non-union rate. The secondary outcomes were mal-union, hospital stay, re-admission rate, the period in a cast, return to pre-injury level, patient satisfaction, and complication rate. Two authors extracted the data independently.

Risk of bias assessment and data analysis

The methodology quality of selected studies was evaluated by two authors independently utilizing the Newcastle–Ottawa Scale to assess the quality of non-randomized studies and Cochrane risk of a bias assessment tool for randomized control trials (RCTs). The data analysis was performed by constructing a random-effects model using the Comprehensive Meta-Analysis Software; Borenstein, Hedges, Higgins, and Rothstein, (2005). For continuous variables, mean difference or standardized mean difference was utilized for estimating effect, whereas an odds ratio (OR) was used for dichotomous variables. A 95% confidence interval (CI) was used for both types of variables. Statistical heterogeneity across the studies was tested using I^2 and the level of evidence was assigned according to Cochrane Handbook for Systematic Reviews and Interventions.

Closed reduction and casting under sedation were used in the non-surgical group, whereas standard ORIF as per fracture type was used in the surgical group.

RESULTS

Search strategy

A total of 277 studies were screened by titles and abstracts. From those, a total of 211 articles were excluded from the study. Afterward, 66 articles were eligible for full-text review. Out of the 66 studies, 54 articles were excluded because they had not satisfied the eligibility criteria, leaving 12 studies for inclusion. [Figure 1] displays the PRISMA flowchart.

Characteristics of included studies

The characteristics of included studies and details of interventions are shown in [Table 2]. The 12 included studies were either prospective or retrospective cohort studies. The patients' total number was 54,699, with 27,110 undergoing ORIF, and 27,588 undergoing non-surgical treatment.

Risk of bias of included studies

[Table 3] summarize the results for different domains of study quality adapted from the Newcastle–Ottawa scale

Table 1: Summary of included studies.

Study name	Year	Country	Design	Level of Evidence	Patients (*n*)	Type of management	N	Age (y)	Gender M/F (*n*)	Follow up (months)
Beauchamp *et al.*[3]	1983	UK	Retrospective	III	126	Group 1: ORIF Group 2: MUA and casting	71 55	>50	34/92	33
Ali *et al.*[9]	1988	UK	Retrospective	III	100	Group 1: ORIF Group 2: MUA and casting	50 50	>60	21/79	84
Anand and Klenerman[10]	1993	UK	Retrospective	III	80	Group 1: ORIF Group 2: MUA and casting	39 41	>60	16/64	12
Willett *et al.*[11]	2016	UK	RCT	I	558	Group 1: ORIF Group 2: MUA and casting	291 267	>60	NA	6
Makwana *et al.*[12]	2001	UK	Prospective randomized	II	43	Group 1: ORIF Group 2: MUA and casting	22 21	>55	12/31	27
Wronka *et al.*[13]	2011	UK	Retrospective	III	126	Group 1: ORIF Group 2: MUA and casting	94 32	>60	31/95	6
Vioreanu *et al.*[14]	2006	UK	Retrospective	III	112	Group 1: ORIF Group 2: MUA and casting	72 40	>70	9/21	5
Salai *et al.*[15]	2000	Israel	Prospective randomized	II	65	Group 1: ORIF Group 2: MUA and casting	49 16	>65	13/52	37
Koval *et al.*[16]	2007	USA	Retrospective	III	33,704	Group 2: Non operative Group 1: ORIF	22550 15,193	>65	7,752/25,952	24
Bariteau *et al.*[17]	2015	USA	Retrospective	III	19,648	Group 1: ORIF Group 2: Non-operative	15,193 4455	>65	4241/15,407	12
Buckingham *et al.*[18]	2000	UK	Retrospective	III	87	Group 1: ORIF Group 2: MUA/casting alone	34 25/28	>60	NA	12
Kurar *et al.*[19]	2016	UK	Retrospective	III	50	Group 1: ORIF Group 2: MUA and casting	42 8	>50	16/34	NA

ORIF: Open reduction and internal fixation, MUA: Manipulation under anesthesia, RCT: Randomized clinical trial

for the ten non-randomized studies.[8] There were only two randomized studies that showed high quality according to the Cochrane risk of a bias assessment tool for RCTs. All the non-randomized studies were judged on eight points, categorized into three groups: Study group selection, group comparability, and ascertainment of the outcome of interest. A total of nine stars were awarded to the study with the highest quality. Eight of the ten non-randomized studies scored the maximum number of stars on the selected domain. Three studies scored two stars on the comparability domain, while the other seven studies scored one star due to lack of control for additional confounding factors. Four studies scored the maximum number of stars on the outcomes' domain. Four studies scored two stars on the outcomes' domains due to significant loss to follow-up, while the two remaining studies did not provide an adequate follow-up period and the loss to follow-up was not stated in the manuscript. Thus, only two studies scored the maximum total score of nine stars.

Data analysis

Surgical treatment was associated with a lower non-union rate compared with non-surgical treatment. (OR: 0.127, 95% CI: [0.055, 0.292], [$P < 0.001$]). Furthermore, surgical treatment was associated with a lower mal-union rate than non-surgical management (OR: 0.128, 95% CI: [0.063, 0.262], [$P < 0.001$]), [Figure 2].

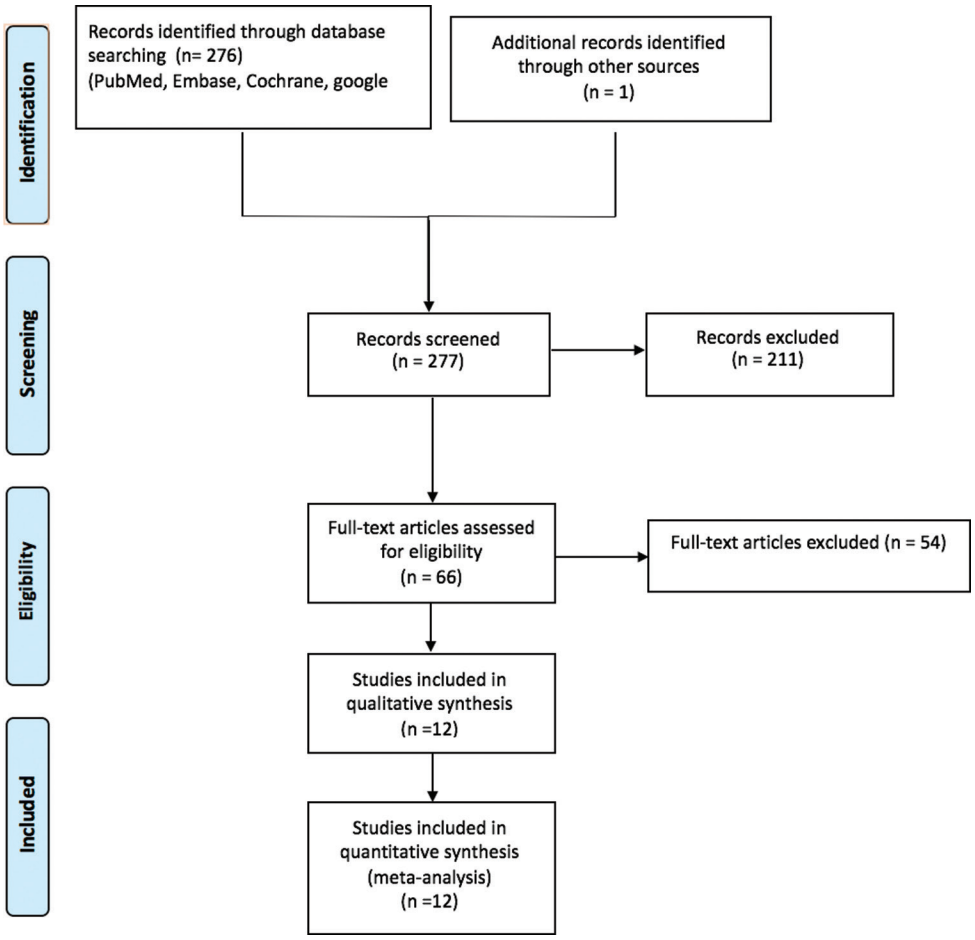

Figure 1: PRISMA flow chart.

Table 2: Inclusion criteria.

Inclusion criteria
• Retrospective/prospective studies • Compare the open reduction and internal fixation to the non-surgical management (closed reduction and casting) • For Ankle fractures • In patients above age 50 • Primary outcome: non-union rate. The secondary outcomes were mal-union, hospital stay, re-admission rate, the period in a cast, return to pre-injury level, patient satisfaction, and complication rate • In English literature • Without time restriction

No difference in hospital-stay was found between the two groups (SDM: –0.098, 95% CI: [–1.369, 1.174], [$P = 0.880$]) and similarly in period in cast reported between the two groups (SDM: –0.471, 95% CI: [–1.333, 0.391], [$P = 0.284$]). Mortality rate was less associated in the surgical group comparing to non-surgical one (OR: 0.509, 95% CI: [0.266, 0.975], [$P = 0.042$]), [Figure 3]. Return to pre-injury level was better associated in the surgical group compared to the non-surgical one (OR: 3.908, 95% CI: [2.140, 7.138], [$P < 0.001$]), whereas there was no difference in patient-satisfaction between the two groups (OR: 3.950, 95% CI: [0.845, 18.461], [$P = 0.081$]) and similarly in re-admission rate (OR: 1.739, 95% CI: [0.515, 5.877], [$P = 0.284$]), [Figure 4].

No difference was observed in deep venous thrombosis (DVT) incidence between the two groups (OR: 0.623, 95% CI: [0.385, 1.006], [$P = 0.053$]) whereas the incidence of pulmonary embolism was more associated with the surgical group (OR: 3.823, 95% CI: [2.214, 6.603], [$P < 0.001$]), [Figure 5].

Non-surgical group was associated with higher total number of skin complications (OR: 4.923, 95% CI: [3.720, 6.515], [$P < 0.001$]), [Figure 6].

DISCUSSION

Based on this systematic review and meta-analysis, the operative management of ankle fractures in patients above

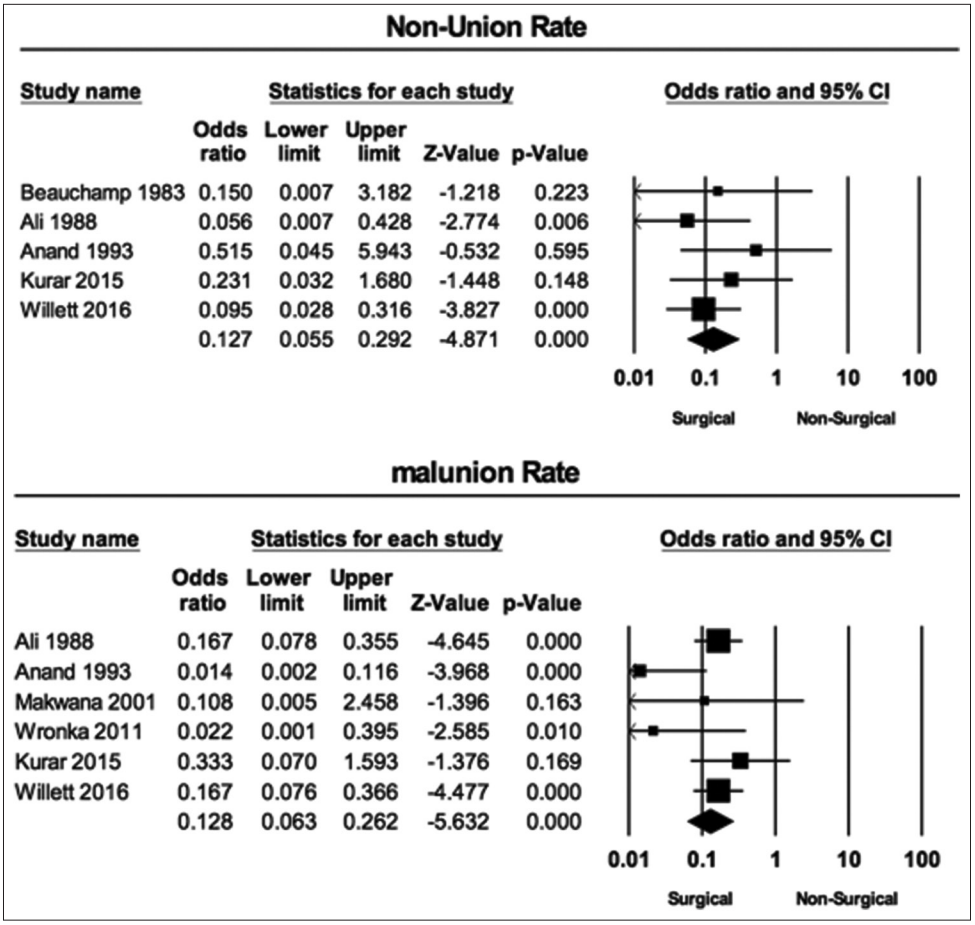

Figure 2: Meta-analysis (non-union and mal-union).

Table 3: Quality assessment. (Newcastle–Ottawa Scale).

Study name	Year	LOE	Selection	Comparability	Exposure
Beauchamp *et al.*[3]	1983	III	****	*	**
Ali *et al.*[9]	1988	III	****	*	*
Anand *et al.*[10]	1993	III	***	*	**
Makwana *et al.*[12]	2001	II	****	**	**
Vioreanu *et al.*[14]	2006	III	****	*	**
Wronka *et al.*[15]	2011	III	***	*	***
Koval *et al.*[16]	2007	III	****	**	***
Bariteau *et al.*[17]	2015	III	****	**	***
Buckingham *et al.*[18]	2000	III	****	*	**
Kurar *et al.*[19]	2016	III	****	*	*

50 years yielded improved outcomes regarding non-union and mal-union rates and return to pre-injury level in surgical compared to non-surgical management.

Our review identified a substantial number of studies that aimed to define rates of non-union and mal-union after ankle fractures in older patients. One of the greater goals of these studies, as well as our synthesized analysis, is to understand if and how surgical and non-surgical treatment regimens lead to the union of fractured bone segments and how non-union or mal-union can be prevented. In a retrospective analysis of 100 ankle fractures, nearly 50% of the conservatively treated patients developed non-union or mal-union.[9] Similarly, another observational study reported that 27 out 37 (72.9%) patients treated with manipulation under anesthesia (MUA) and casting had developed the same complications.[10] In a recent RCT, a higher incidence of radiographic mal-union was detected in the casting group (15%) compared to the surgical group (3%) with low overall non-union rates.[11] The risk of loss of reduction after MUA and casting is very high in the literature. For example, in a prospective study of

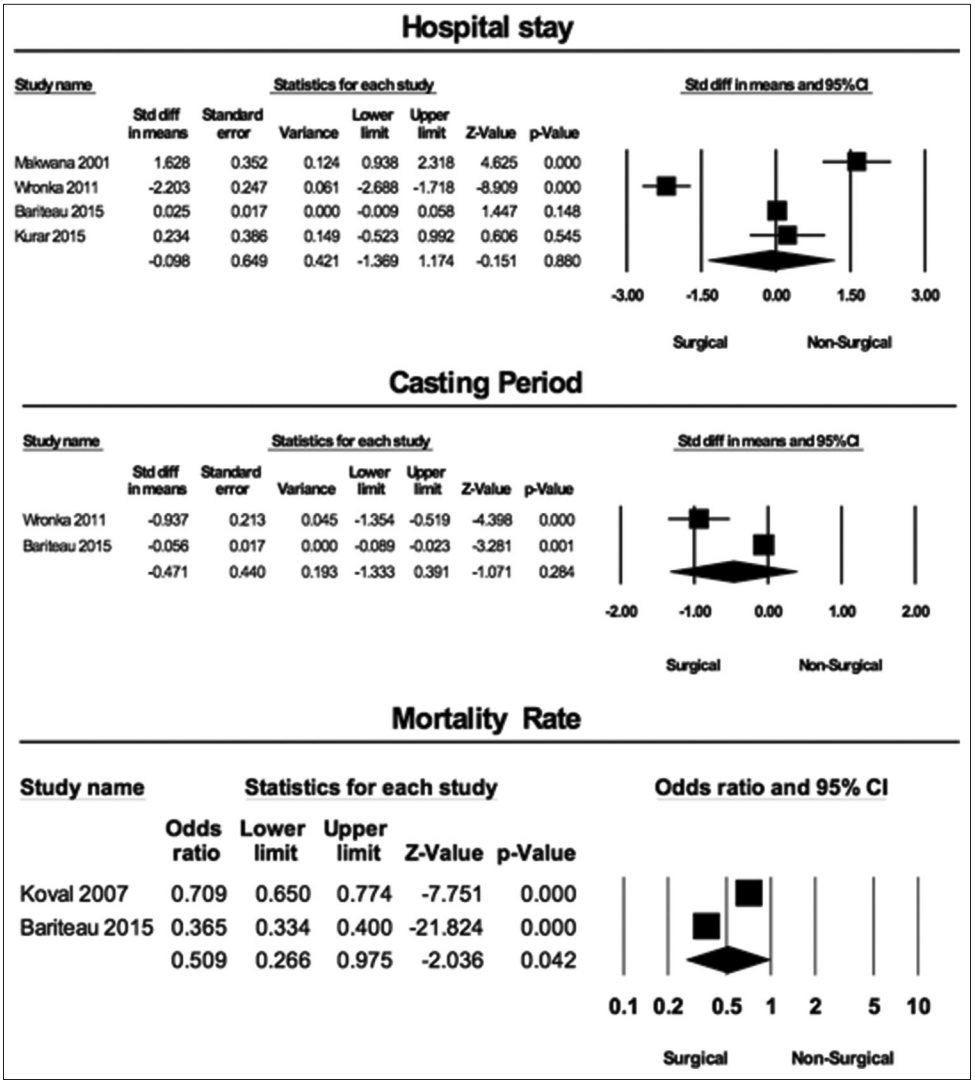

Figure 3: Meta-analysis (hospital stay, casting period, and mortality rate).

47 patients older than 55 years, 38% of the conservatively treated ankle fractures lost their acceptable reduction over three weeks.[12] On the other hand, none of the operated cases lost reduction. Similarly, two prospective studies reported 10% and 48% loss of reduction rates in the non-surgical group.[9,13]

One of the ultimate goals of treating ankle fractures in general and especially in older patients with multiple comorbidities is to ensure early mobilization and return to the pre-injury level of activity. Our analysis showed better results following ORIF. For instance, a retrospective study reported a 72% return to pre-injury mobility level in patients treated with ORIF compared to 42% in the MUA and casting group.[14] Similarly, in a retrospective study, 59 out of 94 patients (62.7%) treated surgically returned to their pre-injury activity level compared to 8 out of 32 (25%) in the conservative group.[13]

Although the patients' satisfaction rates regarding the treatment were similar between the two groups in four articles, several studies reported more validated ways to assess the satisfaction issue.[3,9,10,12] In a prospective study, higher American Orthopedic Foot & Ankle Society scores were observed in patients receiving non-surgical treatment versus those undergoing surgery.[15] In contrast, a prospective study reported significantly better Olerud and Molander Ankle Score (OMAS) in the ORIF group.[12] However, in 2016 in a level 1 evidence study, they reported no difference in the functional outcome represented by the OMAS at 6 months.[11]

One of the drawbacks of surgical management is the possible need for subsequent operations. Prospective study analysis of the data from Medicare national claims history system of 33,704 patients reported a significantly higher rate of additional ankle surgery (revision of internal fixation, ankle

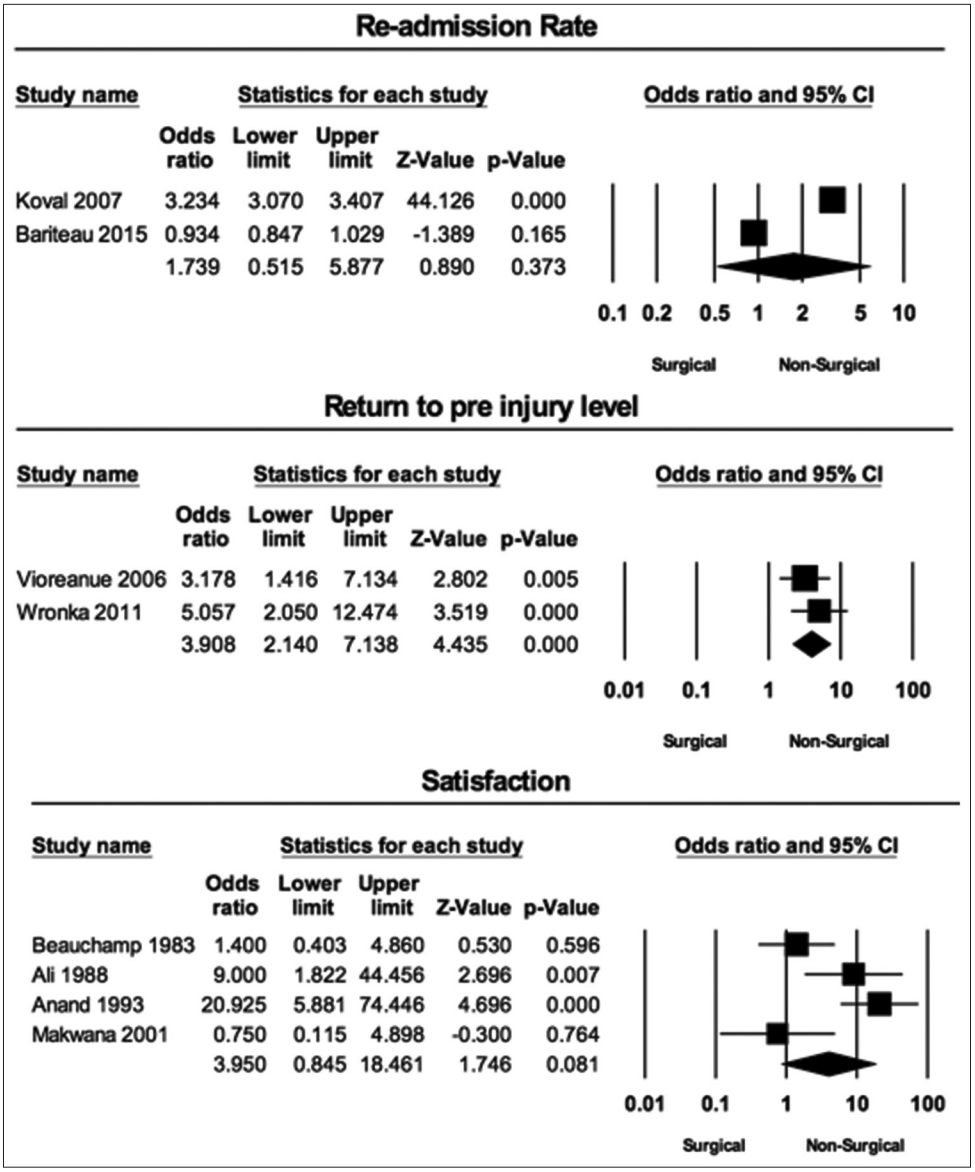

Figure 4: Meta-analysis (re-admission rate, return to pre-injury level, and satisfaction).

arthrodesis, and lower extremity amputation) in patients with ankle fractures, which were treated surgically. They also reported an 11% rate of implant removal later on.[16] Another retrospective study also reported a high rate (33%) of implant removal in the surgical group.[15]

Our meta-analysis found no difference in the hospital stay or period in cast between surgical and the non-surgical groups. In a retrospective study, which reported a significant higher (P = 0.04) hospital-stay in the MUA and casting group with an average of 14 days compared to 5 in the ORIF group, however, another retrospective analysis of 19,648 patients from the Medicare database in 2015 reported an average of 4.5 and 4.6 days length of stay for the non-surgical and the surgical groups, respectively.[13,17]

Although confounders can affect this finding, our analysis yielded a higher mortality rate after conservative management compared to ORIF. A retrospective study, reported a significantly higher mortality rate in the non-surgical group at 6, 12, and 24 months.[13] With increasing age and male gender considered risk factors for mortality at 1 year in both groups. Similarly, another retrospective study reported a 22% mortality rate in conservatively treated patients compared to 9% in patients treated with ORIF.[17]

The strengths of our analyses include the exhaustive literature search, as well as the clinical importance of our subject. However, we noted considerable heterogeneity of included studies and uncertainty concerning bias in the investigations included in our analysis. However, we found evidence supporting the superiority of surgical

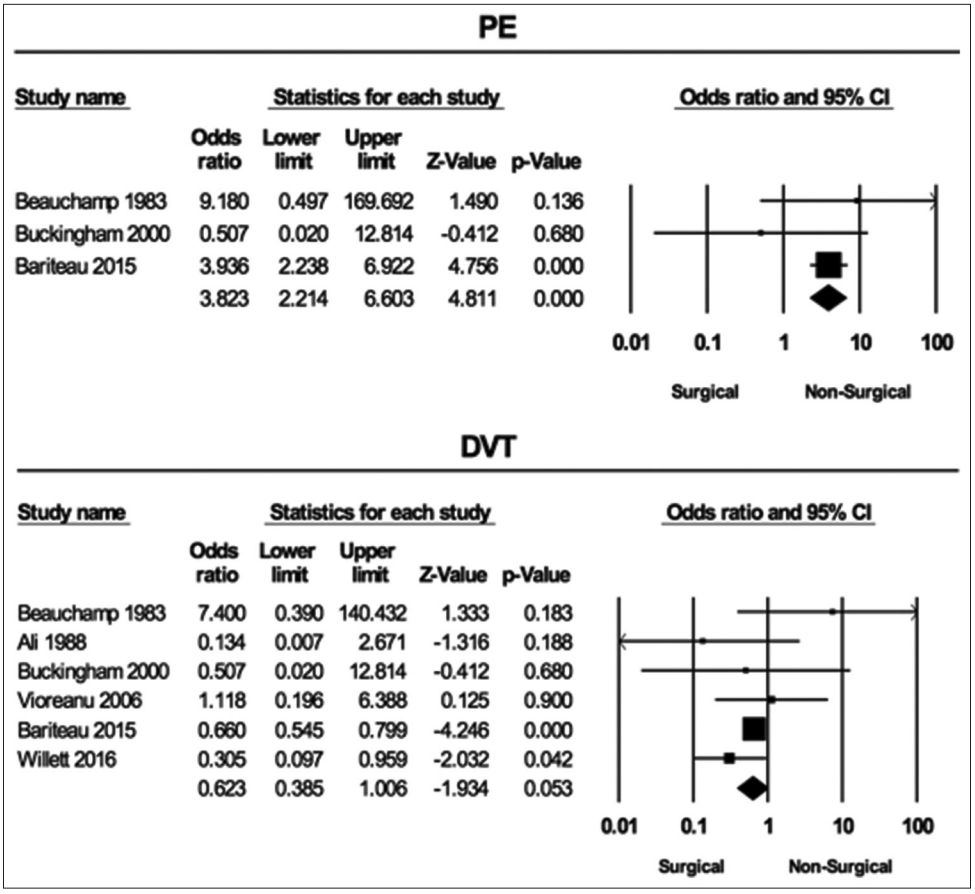

Figure 5: Meta-analysis (deep venous thrombosis and pulmonary embolism).

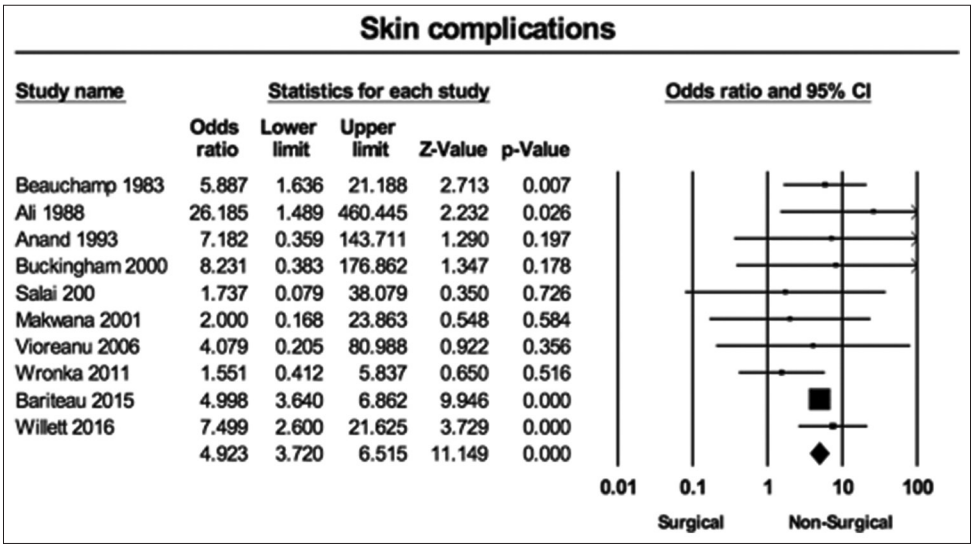

Figure 6: Meta-analysis (Skin complications).

over non-surgical treatment in avoiding mal-union and non-union. However, we were neither able to compare different subtypes of ankle fractures nor comment on whether lower rates of mal-union or non-union translated into higher quality of life and lower socioeconomic burden. Therefore, our review may help develop RCT comparing ORIF to non-surgical for ankle fractures in older patients.

CONCLUSION

In patients above the age of 50 years, ORIF seems to be superior to non-surgical treatment concerning relevant clinical outcomes such as non-union, mal-union, and mortality rates, as well as return to pre-injury level, was better in the surgical group and, hence it is recommended.

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AUTHORS' CONTRIBUTIONS

AA and KM conceived the idea, AA, IM, MS, KM, OA, MMM, MB, and TS collected and organized the data, AA, IM, and MS wrote the manuscript, and MB, and TS revised it and provided critical input. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

ETHICAL APPROVAL

The authors confirm that this systematic review and meta-analysis had been prepared following COPE rules and regulations. Given the nature of the systematic review and meta-analysis and the fact that it did not include any patient-related data, the IRB review was not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patients consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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