■ **SYSTEMATIC REVIEW**

Outcomes following total elbow arthroplasty for rheumatoid arthritis versus post-traumatic conditions

A SYSTEMATIC REVIEW AND META-ANALYSIS

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Aims
The aim of this meta-analysis was to compare the outcome of total elbow arthroplasty (TEA) undertaken for rheumatoid arthritis (RA) with TEA performed for post-traumatic conditions with regard to implant failure, functional outcome, and perioperative complications.

Materials and Methods
We completed a comprehensive literature search on PubMed, Web of Science, Embase, and the Cochrane Library and conducted a systematic review and meta-analysis. Nine cohort studies investigated the outcome of TEA between RA and post-traumatic conditions. The preferred reporting items for systematic reviews and meta-analysis (Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)) guidelines and Newcastle-Ottawa scale were applied to assess the quality of the included studies. We assessed three major outcome domains: implant failures (including aseptic loosening, septic loosening, bushing wear, axle failure, component disassembly, or component fracture); functional outcomes (including arc of range of movement, Mayo Elbow Performance Score (MEPS), and the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire), and perioperative complications (including deep infection, intraoperative fracture, postoperative fracture, and ulnar neuropathy).

Results
This study included a total of 679 TEAs for RA (n = 482) or post-traumatic conditions (n = 197). After exclusion, all of the TEAs included in this meta-analysis were cemented with linked components. Our analysis demonstrated that the RA group was associated with a higher risk of septic loosening after TEA (odds ratio (OR) 3.96, 95% confidence interval (CI) 1.11 to 14.12), while there was an increased risk of bushing wear, axle failure, component disassembly, or component fracture in the post-traumatic group (OR 4.72, 95% CI 2.37 to 9.35). A higher MEPS (standardized mean difference 0.634, 95% CI 0.379 to 0.890) was found in the RA group. There were no significant differences in arc of range of movement, DASH questionnaire, and risk of aseptic loosening, deep infection, perioperative fracture, or ulnar neuropathy.

Conclusion
The aetiology of TEA surgery appears to have an impact on the outcome in terms of specific modes of implant failures. RA patients might have a better functional outcome after TEA surgery.

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Total elbow arthroplasty (TEA) has been established as an effective treatment for various pathologies of the elbow. It significantly relieves pain, restores function, and allows patients to return to activities of daily living.[1-4] However, in comparison with arthroplasty of other joints, TEA has a higher complication rate and inferior implant survival.[4-6] Several complications, including periprosthetic fracture, implant loosening, instability, infection, triceps disruption, and neuropathy, are frequently reported in literature.[4]
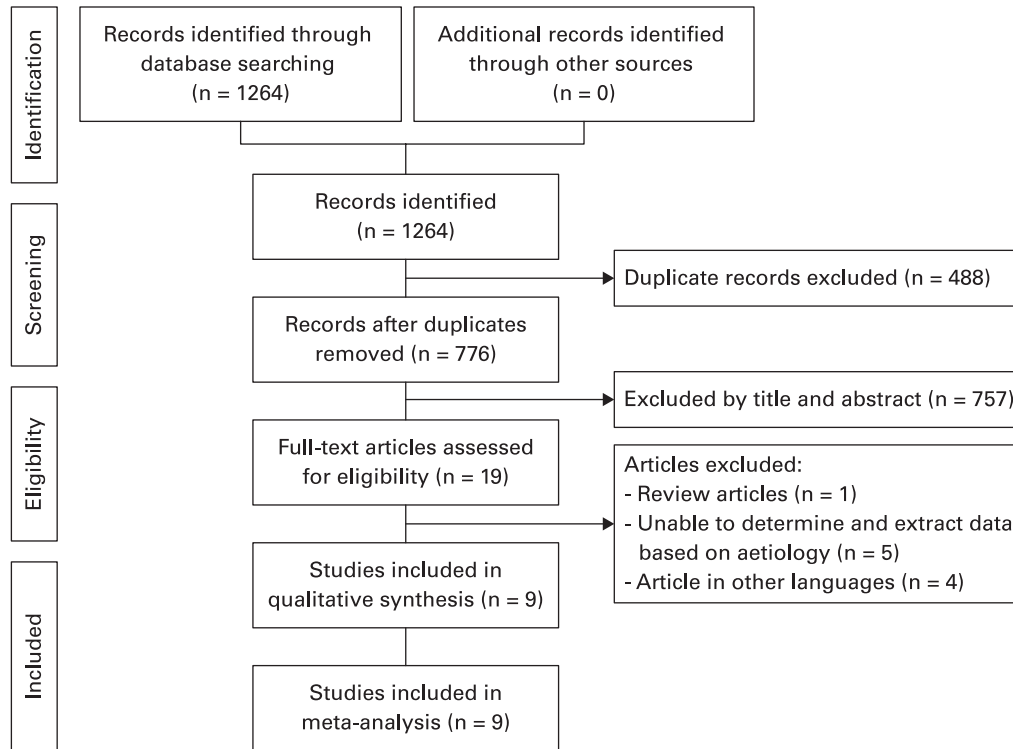
Fig. 1

Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flowchart for the searching and identification of included studies.

Rheumatoid arthritis (RA) and post-traumatic related conditions including osteoarthritis, fracture, and nonunion accounted for over 90% of TEAs.[7,8] However, outcome reports of TEA for RA and post-traumatic related conditions reveal quite different results. Concerning implant failure, some studies reveal higher overall failure in post-traumatic TEA,[9,10] but another study reported a trend towards a higher overall revision rate in RA-related TEA.[11] For functional outcome, better functional scores have been found in patients with RA patients after TEA,[11-14] but Amirfeyz and Blewitt[15] demonstrated a marked improvement in functional scores in both post-traumatic and RA patients without a significant difference between groups at final follow-up. The literature is unclear about the risk of infection with RA considered to pose a greater risk in some reports,[9,11] but considered similar elsewhere.[10,16,17] Finally, there is limited discussion in the literature about the hazards of intraoperative fracture, postoperative fracture, triceps insufficiency, and neuropathy in these patients.

Welsink et al[2] concluded that overall results after TEA were similar among different implant designs. However, outcome comparison between the two major aetiologies of TEA (RA and post-traumatic related conditions) has not been well established. Therefore, the purpose of this meta-analysis is to compare the outcome after TEA between RA and post-traumatic related conditions. We hypothesize that the outcome is different between the two aetiologies in terms of implant failure, functional score, and overall complication rates.

Materials and Methods

Search strategy. A comprehensive review of the published literature was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[18] It was carried out by searching databases including PubMed, MEDLINE, Embase, Cochrane Central, and Google Scholar electronic databases from the earliest record until April 2019. The following search terms were used in variable combination: "total elbow arthroplasty", "total elbow replacement", "rheumatoid arthritis", "inflammatory arthritis", "arthritis", "posttraumatic osteoarthritis", "elbow trauma", and "elbow injury". Two authors (HHM and SWT) independently conducted all the searches and screened the titles and abstracts to identify relevant studies of clinical outcomes and complications after TEA. Differences were solved by discussion. The search strategy is presented in Figure 1.

Inclusion criteria and study selection. We identified studies that compared the outcome in patients who had undergone primary TEA for either the RA (including juvenile RA) or post-traumatic indications (patients with post-traumatic arthritis, acute fracture, or fracture nonunion). Patients with other aetiologies were excluded. We also excluded case reports, reviews, letters to the editor, expert opinion, and studies in which data were not obtainable. Literature that did not include comparisons or clinical outcomes were also excluded.

Data extraction and quality assessment. Two reviewers (HHM and SWT) examined all the identified studies and

Table I. Characteristics of included studies, all of which compared rheumatoid arthritis (RA), including juvenile RA, and post-traumatic related conditions; all implants were cemented

Author (year)	Study design	Enrolled sample number, RA:post-trauma	Implant type and design	Outcome measurements									
				A	B	C	D	E	F	G	H	I	J
Gschwend et al[16] (1999)	Retrospective	28:4	GSB III* (linked)	Y	Y	Y	Y			Y	Y	Y	
Hildebrand et al[14] (2000)	Retrospective	19:15	Coonrad–Morrey† (linked)		Y		Y	Y	Y	Y			
Peden and Morrey[17] (2008)	Retrospective	3:10	Coonrad–Morrey† (linked)	Y	Y					Y	Y		
Amirfeyz and Blewitt[15] (2009)	Retrospective	40:14	GSB III* (linked)	Y		Y	Y	Y			Y	Y	
Celli and Morrey[12] (2009)	Retrospective	36:19	Coonrad–Morrey† (linked)					Y			Y		Y
Mansat et al[13] (2013)	Prospective	45:18	Coonrad–Morrey† (linked)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Schöni et al[10] (2013)	Retrospective	203:56	GSB III* (linked)	Y		Y				Y		Y	
Toulemonde et al[11] (2016)	Prospective	45:33	Coonrad–Morrey† (linked)	Y	Y	Y		Y	Y	Y	Y	Y	Y
Perretta et al[9] (2017)	Retrospective	63:28	Capitellocondylar,‡ Discovery,† Coonrad–Morrey† (linked)	Y	Y	Y				Y		Y	

*Allo Pro AG, Baar, Switzerland

†Zimmer Biomet, Warsaw, Indiana

‡Johnson & Johnson, New Brunswick, New Jersey

A, aseptic loosening; B, septic loosening; C, prosthesis design failure; D, arc of range of movement; E, Mayo Elbow Performance Score; F, the Disabilities of Arm, Shoulder and Hand questionnaire; G, deep infection; H, intraoperative fracture; I, postoperative fracture; J, ulnar neuropathy

Table II. Study quality of included studies based on the Newcastle-Ottawa scale. The maximum possible score on this scale is 9. 'Good' was defined as a total score of 7 to 9, 'fair' as a score of 4 to 6, and 'poor' as a score of less than 4

Study author (year)	Criteria								Total	Quality
	1	2	3	4	5	6	7	8		
Gschwend et al[16] (1999)	1	1	1	1	2	1	1	0	8	Good
Hildebrand et al[14] (2000)	1	1	1	1	2	1	0	0	7	Good
Peden and Morrey[17] (2008)	1	1	1	1	2	1	0	1	8	Good
Amirfeyz and Blewitt[15] (2009)	1	1	1	1	2	1	0	1	8	Good
Celli and Morrey[12] (2009)	1	1	1	1	2	1	1	1	9	Good
Mansat et al[13] (2013)	1	1	1	1	2	1	1	1	9	Good
Schöni et al[10] (2013)	1	1	1	1	2	1	1	0	8	Good
Toulemonde et al[11] (2016)	1	1	1	1	2	0	1	1	8	Good
Perretta et al[9] (2017)	1	1	1	1	2	1	1	0	8	Good

1, representativeness of the exposed cohort; 2, selection of the nonexposed cohort; 3, ascertainment of exposure; 4, demonstration that outcome of interest was not present at start of the study; 5, comparability of cohorts on the basis of the design or analysis; 6, assessment of the outcome; 7, was follow-up long enough for outcomes to occur?; 8, adequacy of follow-up of cohort (lost to follow-up rate more than 10% is considered inadequate)

extracted data using a predetermined form. We recorded the first author, year of publication, study design, enrolled sample number, cemented or cementless implant fixation, implant designs, outcome parameters to assess implant failure, functional score, and complications. Data from each article are summarized in Table I.[9-17] The methodologies of the included studies were assessed independently by two authors (HHM and SWT) using the Newcastle-Ottawa quality assessment scale.[19] The maximum possible score on this scale was 9. 'Good' was defined as a total score of 7 to 9, 'fair' as a score of 4 to 6, and 'poor' as a score of less than 4 (Table II). Discrepancies between the two reviewers were solved after thorough discussion.

Evaluation of publication bias. A thorough risk-of-bias assessment was completed to identify factors that may have altered the results of this analysis. Funnel plots were constructed to visually detect the presence of publication bias.

Data synthesis. The primary outcome was the odds ratio (OR) for each cause of failure, including aseptic loosening, septic loosening, bushing wear, axle failure, component disassembly, and component fracture in the RA group compared with the post-traumatic group. The standardized mean differences

(SMDs) for arc of range of movement (ROM), Mayo Elbow Performance Score (MEPS),[20] the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire,[21] and ORs of deep infection, intraoperative fracture, postoperative fracture, and ulnar neuropathy in the RA group compared with the post-traumatic group were the secondary outcome. A random effect model was adopted to pool individual SMDs and ORs. Analyses were performed using Comprehensive Meta-Analysis (CMA) software, version 3 (Biostat, Englewood, New Jersey). Between-trial heterogeneity was determined by using I^2 tests; values > 50% were regarded as considerable heterogeneity. Funnel plots and Egger's test were used to examine potential publication bias. Statistical significance was defined as p-value < 0.05.

Results

Search results. We identified 1264 relevant articles according to the search strategy. Duplicate records (n = 488) were removed using Endnote software (Clarivate Analytics, Philadelphia, Pennsylvania). After reading the title and abstract, 757 studies were excluded. According to the inclusion criteria, ten studies were excluded after reading the full article. Finally,
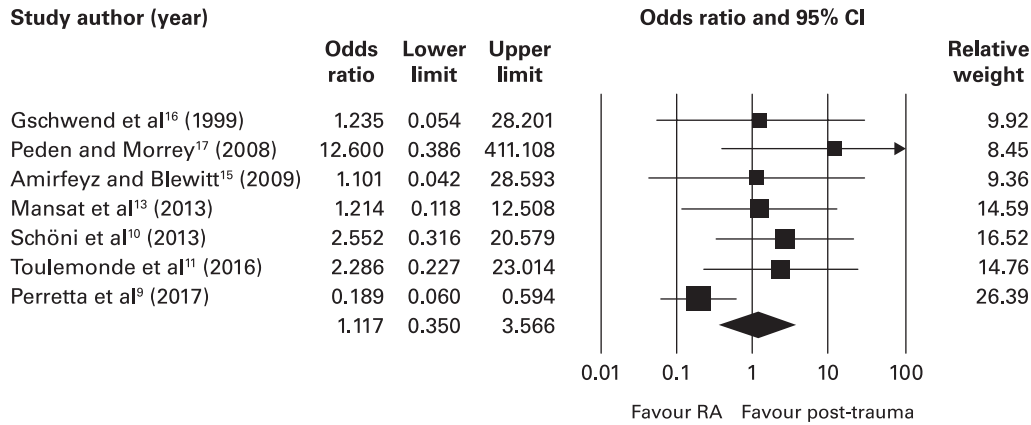
Study author (year)	Odds ratio	Lower limit	Upper limit	Odds ratio and 95% CI	Relative weight
Gschwend et al[16] (1999)	1.235	0.054	28.201		9.92
Peden and Morrey[17] (2008)	12.600	0.386	411.108		8.45
Amirfeyz and Blewitt[15] (2009)	1.101	0.042	28.593		9.36
Mansat et al[13] (2013)	1.214	0.118	12.508		14.59
Schöni et al[10] (2013)	2.552	0.316	20.579		16.52
Toulemonde et al[11] (2016)	2.286	0.227	23.014		14.76
Perretta et al[9] (2017)	0.189	0.060	0.594		26.39
	1.117	0.350	3.566		

0.01 0.1 1 10 100

Favour RA   Favour post-trauma

Fig. 2

Analysis of the likelihood of aseptic loosening in the rheumatoid arthritis (RA) group *versus* the post-traumatic group. CI, confidence interval.

Study author (year)	Odds ratio	Lower limit	Upper limit	Odds ratio and 95% CI	Relative weight
Gschwend et al[16] (1999)	1.235	0.054	28.201		16.55
Hildebrand et al[14] (2000)	2.514	0.095	66.199		15.14
Peden and Morrey[17] (2008)	12.600	0.386	411.108		13.33
Mansat et al[13] (2013)	3.047	0.150	62.006		17.84
Toulemonde et al[11] (2016)	5.518	0.275	110.558		18.03
Perretta et al[9] (2017)	6.443	0.351	118.432		19.11
	3.955	1.108	14.121		

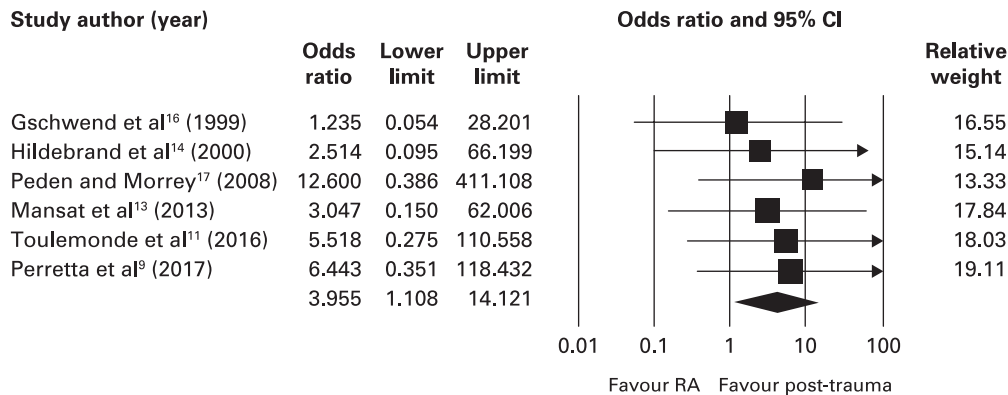0.01 0.1 1 10 100

Favour RA   Favour post-trauma

Fig. 3

Analysis of the likelihood of septic loosening in the rheumatoid arthritis (RA) group *versus* the post-traumatic group. CI, confidence interval.

nine articles that compared the outcome between RA and post-traumatic group were included for our meta-analysis. The baseline characteristics of the nine included studies are summarized in Table I. There was a total of 679 TEAs, including 482 in the RA group and 197 in the post-traumatic group. All of the TEAs included in this meta-analysis were cemented and used a linked design.

Meta-analysis results. The incidence of aseptic loosening was reported in seven studies and a total of 590 elbows were evaluated. No significant difference was found in the RA group compared with the post-traumatic group (OR 1.117, 95% confidence interval (CI) 0.350 to 3.566; $I^2 = 43.20$; Fig. 2).

Septic loosening as a cause of implant failure was recorded in six studies with 311 elbows evaluated. In comparison with the post-traumatic group, patients with RA had a higher risk of septic loosening that required further revision surgeries (OR 3.955, 95% CI 1.108 to 14.121; $I^2 < 0.001$; Fig. 3).

Bushing wear, axle failure, component disassembly, and component fracture were reported in six studies with a total of 42 events in 577 total elbow surgeries. Incidence of these

failures was lower in the RA group than the post-traumatic group. (OR 0.212, 95% CI 0.107 to 0.422; $I^2 < 0.001$; Fig. 4).

There were four studies including 183 elbows that reported arc of ROM. No significant differences were found in both groups (SMD -0.252, 95% CI -1.100 to 0.596; $I^2 = 84.33$; Fig. 5).

MEPS was reported in five studies including 284 elbows. The score was higher for patients in the RA group in comparison with patients in the post-traumatic group (SMD -0.634, 95% CI -0.890 to -0.379; $I^2 < 0.001$; Fig. 6).

The DASH questionnaire was used to validate functional outcome in three studies with a total of 175 elbows. The scores were similar between the RA and post-traumatic group (SMD -0.019, 95% CI -0.330 to 0.293; $I^2 < 0.001$; Fig. 7).

Seven studies with 570 TEAs included have reported deep infection as a postoperative complication. Incidence of deep infection was not different in the RA group compared with that of the post-traumatic group (OR 2.180, 95% CI 0.826 to 5.752; $I^2 < 0.001$; Fig. 8).

The incidence of intraoperative fracture was reported in six studies and a total of 295 elbows were evaluated. No significant

Study author (year)	Odds ratio	Lower limit	Upper limit	Odds ratio and 95% CI	Relative weight
Gschwend et al[16] (1999)	0.273	0.032	2.360		10.15
Amirfeyz and Blewitt[15] (2009)	1.101	0.042	28.593		4.46
Mansat et al[13] (2013)	0.128	0.005	3.299		4.48
Schöni et al[10] (2013)	0.143	0.062	0.332		67.00
Toulemonde et al[11] (2016)	0.727	0.044	12.067		5.99
Perretta et al[9] (2017)	0.885	0.077	10.185		7.92
	0.212	0.107	0.422		

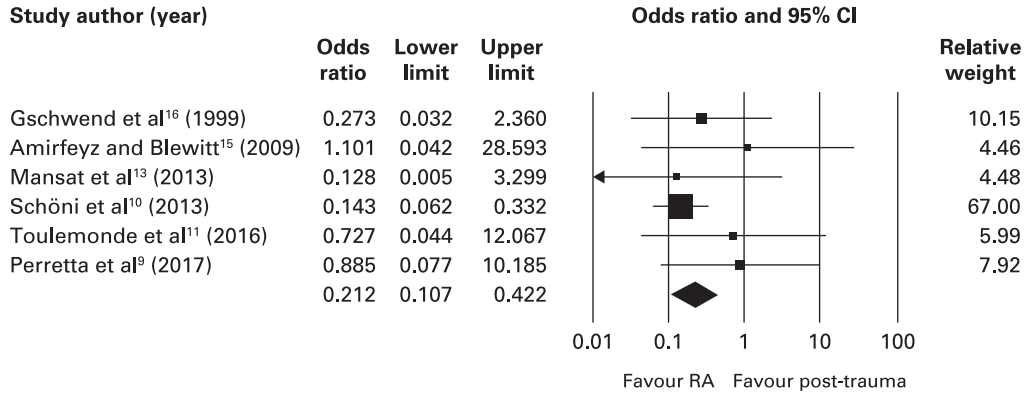0.01   0.1   1   10   100

Favour RA   Favour post-trauma

Fig. 4

Analysis of the likelihood of bushing wear, axle failure, component disassembly, and component fracture in the rheumatoid arthritis (RA) group *versus* the post-traumatic group. CI, confidence interval.

Study author (year)	Std diff in means	Lower limit	Upper limit	Std diff in means and 95% CI	Relative weight
Gschwend et al[16] (1999)	-2.396	-3.597	-1.195		19.09
Hildebrand et al[14] (2000)	0.191	-0.487	0.870		25.82
Amirfeyz and Blewitt[15] (2009)	0.087	-0.522	0.696		26.68
Mansat et al[13] (2013)	0.467	0.012	0.923		28.40
	-0.252	-1.100	0.596		

-4.00   -2.00   0.00   2.00   4.00

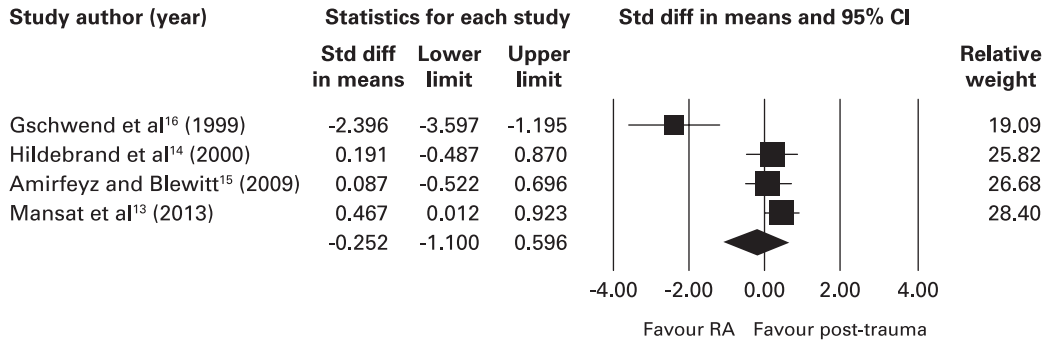Favour RA   Favour post-trauma

Fig. 5

The effect of aetiologies (rheumatoid arthritis (RA) *versus* post-traumatic conditions) on arc of range of movement. Std diff, standardized difference; CI, confidence interval.

Study author (year)	Std diff in means	Lower limit	Upper limit	Std diff in means and 95% CI	Relative weight
Hildebrand et al[14] (2000)	-0.828	-1.533	-0.123		13.16
Amirfeyz and Blewitt[15] (2009)	-0.460	-1.075	0.154		17.30
Celli and Morrey[12] (2009)	-0.632	-1.201	-0.064		20.26
Mansat et al[13] (2013)	-0.640	-1.235	-0.044		18.45
Toulemonde et al[11] (2016)	-0.648	-1.108	-0.187		30.84
	-0.634	-0.890	-0.379		

-2.00   -1.00   0.00   1.00   2.00

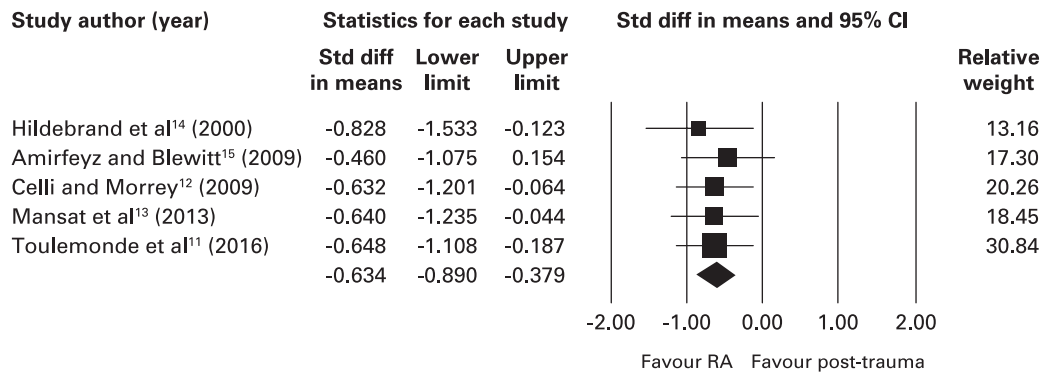Favour RA   Favour post-trauma

Fig. 6

The effect of aetiologies (rheumatoid arthritis (RA) *versus* post-traumatic conditions) on Mayo Elbow Performance Score. Std diff, standardized difference; CI, confidence interval.

differences were found between the RA and the post-traumatic group (OR 0.516, 95% CI 0.187 to 1.422; I^2 = 34.95; Fig. 9).

Postoperative fractures were reported in six studies (577 TEAs) as a postoperative complication. The fracture rates were similar between the two groups (OR 0.584, 95% CI 0.215 to 1.589; I^2 < 0.001; Fig. 10).

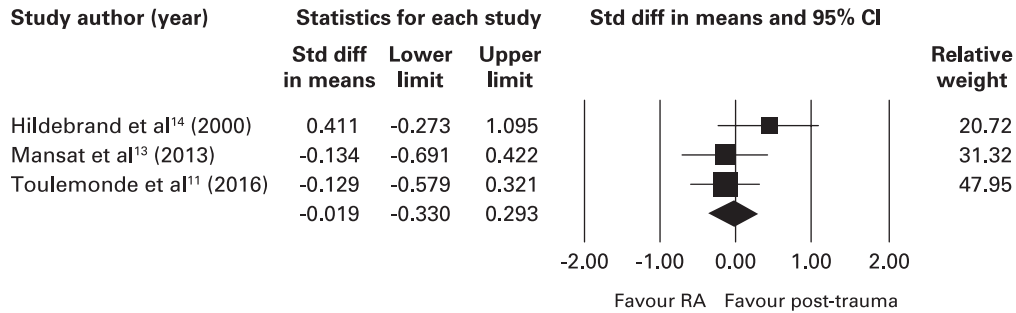Ulnar neuropathy was reported in three studies with 196 elbows as a postoperative complication. The overall incidence

Study author (year)	Statistics for each study			Std diff in means and 95% CI	Relative weight
	Std diff in means	Lower limit	Upper limit		
Hildebrand et al[14] (2000)	0.411	-0.273	1.095		20.72
Mansat et al[13] (2013)	-0.134	-0.691	0.422		31.32
Toulemonde et al[11] (2016)	-0.129	-0.579	0.321		47.95
	-0.019	-0.330	0.293		

-2.00   -1.00   0.00   1.00   2.00

Favour RA   Favour post-trauma

Fig. 7

The effect of aetiologies (rheumatoid arthritis (RA) *versus* post-traumatic conditions) on the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. Std diff, standardized difference; CI, confidence interval.

Study author (year)	Odds ratio	Lower limit	Upper limit	Odds ratio and 95% CI	Relative weight
Gschwend et al[16] (1999)	1.235	0.054	28.201		9.62
Hildebrand et al[14] (2000)	6.576	0.314	137.910		10.16
Peden and Morrey[17] (2008)	2.000	0.115	34.822		11.53
Mansat et al[13] (2013)	3.047	0.150	62.006		10.37
Schöni et al[10] (2013)	0.964	0.195	4.777		36.75
Toulemonde et al[11] (2016)	5.518	0.275	110.558		10.47
Perretta et al[9] (2017)	6.443	0.351	118.432		11.10
	2.180	0.826	5.752		

0.01   0.1   1   10   100

Favour RA   Favour post-trauma

Fig. 8

Analysis of the likelihood of deep infection in the rheumatoid arthritis (RA) group *versus* the post-traumatic group. CI, confidence interval.

Study author (year)	Odds ratio	Lower limit	Upper limit	Odds ratio and 95% CI	Relative weight
Gschwend et al[16] (1999)	0.500	0.041	6.082		12.39
Peden and Morrey[17] (2008)	12.600	0.386	411.108		7.24
Amirfeyz and Blewitt[15] (2009)	1.101	0.042	28.593		8.12
Celli and Morrey[12] (2009)	0.314	0.048	2.067		18.34
Mansat et al[13] (2013)	0.154	0.044	0.543		28.25
Toulemonde et al[11] (2016)	0.906	0.224	3.671		25.67
	0.516	0.187	1.422		

0.01   0.1   1   10   100

Favour RA   Favour post-trauma
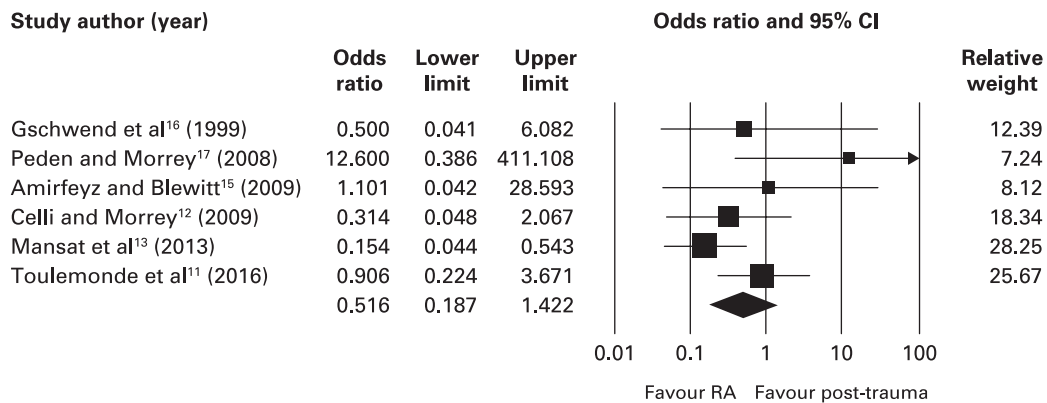
Fig. 9

Analysis of the likelihood of intraoperative fracture in the rheumatoid arthritis (RA) group *versus* the post-traumatic group. CI, confidence interval.

was similar between the two groups (OR 0.902, 95% CI 0.324 to 2.508; $I^2 < 0.001$; Fig. 11).

Discussion

The main finding of this study was that TEA in patients with RA was associated with an increased risk of septic loosening, while an increased risk of bushing wear, axle failure, component disassembly, and component fracture was observed in patients in the post-traumatic group. Functional outcome as assessed by MEPS was available in five studies and was superior in the RA group. Arc of ROM, DASH score (available in only three studies), and risk of each complication including deep infection,
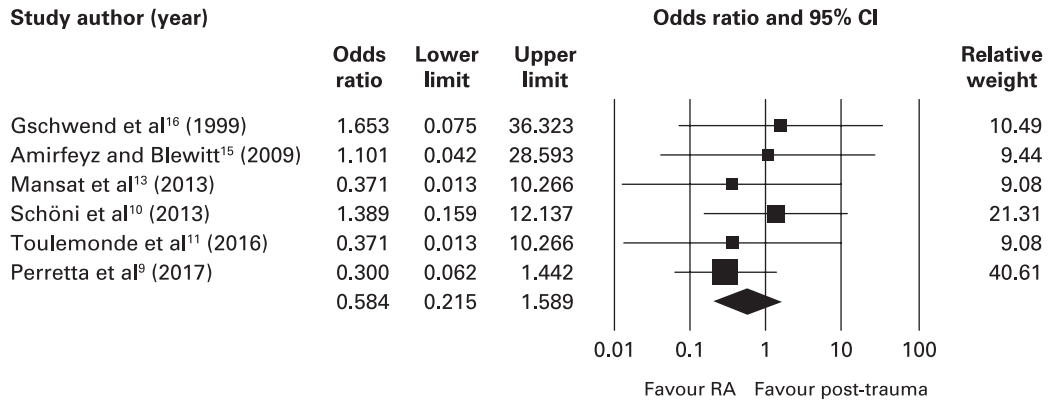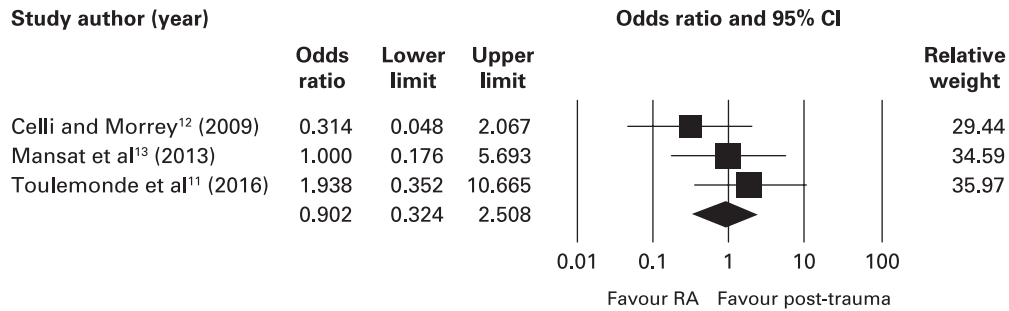
Study author (year)	Odds ratio	Lower limit	Upper limit	Odds ratio and 95% CI	Relative weight
Gschwend et al[16] (1999)	1.653	0.075	36.323		10.49
Amirfeyz and Blewitt[15] (2009)	1.101	0.042	28.593		9.44
Mansat et al[13] (2013)	0.371	0.013	10.266		9.08
Schöni et al[10] (2013)	1.389	0.159	12.137		21.31
Toulemonde et al[11] (2016)	0.371	0.013	10.266		9.08
Perretta et al[9] (2017)	0.300	0.062	1.442		40.61
	0.584	0.215	1.589		

0.01 0.1 1 10 100

Favour RA   Favour post-trauma

Fig. 10

Analysis of the likelihood of postoperative fracture in the rheumatoid arthritis (RA) group *versus* the post-traumatic group. CI, confidence interval.

Study author (year)	Odds ratio	Lower limit	Upper limit	Odds ratio and 95% CI	Relative weight
Celli and Morrey[12] (2009)	0.314	0.048	2.067		29.44
Mansat et al[13] (2013)	1.000	0.176	5.693		34.59
Toulemonde et al[11] (2016)	1.938	0.352	10.665		35.97
	0.902	0.324	2.508		

0.01 0.1 1 10 100

Favour RA   Favour post-trauma

Fig. 11

Analysis of the likelihood of ulnar neuropathy in the rheumatoid arthritis (RA) group *versus* the post-traumatic group. CI, confidence interval.

ulnar neuropathy, and intraoperative and postoperative fracture were similar between the two aetiologies.

Our meta-analysis is the first to compare the outcome after TEA surgery between the two major aetiologies: RA and post-traumatic conditions. Since these two aetiologies differ greatly in terms of pathophysiology, the rate and mode of failure might be expected to differ. Compared with the post-traumatic group, Toulemonde et al[11] found a higher risk of overall revision, aseptic loosening, and septic loosening in the RA group. In contrast, two other cohort studies reported higher reoperation rate, revision rate, and inferior implant survival in the post-traumatic group.[9,10] Rather than an overall risk comparison, we compared each implant failure mode and noted a higher risk of septic loosening in the RA group and a higher risk of bushing wear, axle failure, component disassembly, and component fracture in the post-traumatic group.

Implant infection is one of the most devastating complications after joint arthroplasty with several studies indicating that RA patients are at greater risk.[22-25] In our analysis, there are two different endpoints for prosthetic joint infection (PJI): deep infection and septic loosening, which are not mutually exclusive. Deep infection was defined as infection that involves the

implant and its surrounding deep tissue, for which debridement, antibiotics, and implant retention was undertaken. Septic loosening was defined as a persistent, recurrent deep infection that was refractory to systemic antibiotics and surgical debridement with radiographic evidence of prosthesis loosening. Treatment involved one- or two-stage exchange arthroplasty. Based on whether the implants were retained or not, we considered deep infection as a complication and septic loosening as a mode of implant failure. Our study found a similar risk for developing deep infection between RA and the post-traumatic group. However, the RA group was associated with a higher risk of septic loosening that required further revision surgery. This can partially be attributed to the unique anatomy of the elbow joint with a relatively thin soft-tissue coverage and frequent exposure to external forces.[11,14] RA patients with severe arthritis that require arthroplasty often present with higher disease activity and a relatively immunocompromised status.[26-28] Regular medications, including glucocorticoids, disease-modifying antirheumatic drugs (DMARDs), and biological agents, are frequently administered to control the inflammatory process.[26,28] Administration of glucocorticoids and DMARDs in treating RA could be immunosuppressive and negatively affect immunity. The

risk of infection is dose-dependent, especially with common pathogens like bacteria and fungi.[26,28] Under this immunocompromised status, infection risk could potentially be higher.

Current literature has discussed several modes of failure, including bushing wear, axle failure, component disassembly, and component fracture. Among all, disassembly accounted the majority of the failure modes in the post-traumatic group.[10] Morrey et al[29] reported a consecutive series of 55 TEAs in patients with post-traumatic arthritis. Patients had mostly undergone two operations before the TEA. Bone loss from the humerus or ulna was reported in all of the patients. Up to 40% of the patients had severe humeral bone loss with the absence of either one of the supracondylar column or loss of the whole distal humerus to the level of olecranon fossa.[29] Schneeberger et al[30] reported a series of 41 post-traumatic TEAs. The authors concluded that elbow deformity before arthroplasty and overuse of elbow, including strenuous or repetitive physical activities, were associated with higher rates of prosthesis failure (e.g. breakage of the component and wear of the bushings).[30] Other factors, including a surgical site operated on multiple times, excessive bone loss, and distorted anatomy were more commonly observed in post-traumatic TEA, which might lead to a suboptimal implant position. In addition, with a higher activity level in this population, increased loading to the implant might result in potential risks for bushing wear, axle failure, component disassembly, and component fracture.[10,29,30]

MEPS and QuickDASH score are two common questionnaires utilized to assess functional outcome after TEA surgery with sufficient reliability and validity.[31] Toulemonde et al[11] reported that RA patients obtained higher MEPS, compared with the post-traumatic group (mean 90 points (SD 13) vs 80 points (SD 17); p < 0.01). Similar results were validated from Celli and Morrey[12] (93 in RA vs 84 in post-traumatic group), Mansat et al[13] (89 points in RA vs 80 in post-trauma group), and Hildebrand et al[14] (90 in RA vs 78 in post-trauma group). In contrast, Amirfeyz and Blewitt[15] reported no significant difference between the two groups. Our results showed that patients with RA obtained higher MEPS but similar quick-DASH scores. Schneeberger et al[30] conducted a consecutive series of 41 patients with post-traumatic osteoarthritis who had undergone TEA surgery and found that common characteristics of this population, such as higher physical demand and younger age (< 60 years old), might have contributed to an inferior outcome. Post-traumatic patients usually do not have other joint involvement and would therefore often return to their preinjury level of activity.[15,30] As a result, the higher demand placed on the implant could contribute to this inferior outcome.[30] In contrast, RA patients often have polyarthralgia and have a relatively lower physical demand. Although our results indicate that the RA group had a better functional outcome at the final follow-up, patients in both groups achieved significant functional improvement after the surgery.[12,17]

Voloshin et al[4] conducted a comprehensive systematic review discussing the complications of TEA. The reported incidence of aseptic loosening, septic loosening, bushing wear, axle failure, component disassembly, and component fracture ranged from 2.3% to 5.1%. The incidence of other complications that did not require revision arthroplasty, including deep infection, intraoperative fracture, postoperative fracture, and ulnar neuropathy was 2.4% to 3.0%,[4] which was much lower compared with earlier reports (3.2% to 10.4%).[5] In our study, there were no significant differences between the RA and post-traumatic groups with regard to incidence of deep infection, intraoperative fracture, postoperative fracture, and ulnar neuropathy.

To our knowledge, our study is the first meta-analysis to compare the outcome between RA and post-traumatic TEAs in terms of each implant failure mode, function, and each type of complication. However, there are several limitations that should be recognized. First, we searched only for English articles, which might be a potential source of publication bias. Secondly, a high heterogeneity among studies should be recognized, including different types of implant design and follow-up time. Interestingly, in the systematic review conducted by Welsink et al,[2] several different implant designs were compared (e.g. linked vs unlinked prosthesis). The authors reported satisfactory results for patients that underwent TEA and had similar outcomes despite different implant designs.[2] However, we still consider this as a limitation of our study. Thirdly, although implant designs (linked or unlinked) and use of cement were not listed as inclusion criteria, all implants included were linked and cemented. Although this was unintentional, most of the studies that used other designs did not meet our inclusion criteria. Accordingly, results of this meta-analysis might not be applicable to patients who receive a cementless or unlinked TEA. Finally, other parameters of clinical importance such as triceps disruption, instability, and heterotopic ossification were not presented because it was scarcely reported in the included articles.

In conclusion, the present meta-analysis revealed that RA patients are at a higher risk of septic loosening after TEA. In patients with post-traumatic arthritis, an increased risk of subsequent bushing wear, axle failure, component disassembly, and component fracture were noted. The functional outcome, assessed by the MEPS, showed greater improvements in patients with RA. Therefore, our meta-analysis suggests that the aetiology leading to TEA might have an impact on the outcome in terms of function and specific modes of implant failure.

Take home message

- Risk of septic loosening after total elbow arthroplasty (TEA) is higher in the rheumatoid arthritis (RA) group.
- Risk of bushing wear, axle failure, component disassembly, or component fracture after TEA is higher in the post-traumatic group.
- A higher Mayo Elbow Performance Score after TEA was observed in the RA group.

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