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Thumb CMCJ prosthetic total joint replacement: a systematic review

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- Thumb carpometacarpal joint (CMCJ) arthritis is a common and painful condition. Thumb CMCJ prosthetic replacement aims to restore thumb biomechanics and improve pain and function. Early reviews demonstrated a lack of high-quality studies, but more recently a significant number of higher-quality studies have been published. This review provides a concise and systematic overview of the evidence to date.
- A systematic review of several databases was conducted according to PRISMA guidelines. Studies evaluating the outcomes of thumb CMCJ prosthetic total joint replacement were included. Data extracted included patient-reported outcome measures (PROMs), pain scores, range of motion, strength, survival rates and complications.
- A total of 56 studies met all inclusion criteria and were analysed. There was one randomized controlled trial, three prospective comparative cohort studies, five retrospective comparative cohort studies, and 47 descriptive cohort studies. The reported studies included 2731 patients with 3048 thumb total CMCJ prosthetic joint replacements. Follow up ranged from 12 months to 13.1 years.
- In general, good results were demonstrated, with improvements in PROMs, pain scores and strength. Failure rates ranged from 2.6% to 19.9% depending upon implant studied. Comparative studies demonstrated promising results for replacement when compared to resection arthroplasty, with modest improvements in PROMs but at a cost of increased rates of complications.
- Studies reporting outcomes in thumb CMCJ prosthetic total joint replacement are increasing in both number and quality. Failure, in terms of loosening and dislocation, remains a concern, although in the medium-term follow up for modern implants this issue appears to be lower when compared to their predecessors.
- Functional outcomes also look promising compared to resection arthroplasty, but further high-quality studies utilizing a standardized resection arthroplasty technique and modern implants, together with standardized core outcome sets, will be of value.

Keywords: arthroplasty; CMCJ; replacement; thumb; TMCJ

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Introduction

Thumb carpometacarpal joint (CMCJ) arthritis is a painful and debilitating condition with a preponderance for women and clinically affecting around 1.4% of the population.[1] Surgical treatment options include trapeziectomy, interposition arthroplasty, arthrodesis, or total joint replacement. Despite the use of total joint arthroplasty being widespread in Europe, early systematic reviews have highlighted a lack of high-quality evidence to support its use.[2] More recently, however, a large number of articles have been published on this topic, and therefore a contemporary review of the literature is necessary. This review aims to provide a systematic and concise update of the available evidence for the use of thumb CMCJ prosthetic total joint replacement.

Materials and methods

Search strategy

We conducted an online systematic literature search in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. It was prospectively registered on the International Prospective Register of Systematic Reviews (PROSPERO).

PubMed, MEDLINE, EMBASE and The Cochrane Library were searched in April 2020 using the terms (thumb CMC or thumb CMCJ or thumb carpometacarpal or trapeziometacarpal or TMCJ) and (arthroplasty or replacement or prosthesis). Our search was not limited by year of publication, journal type, language, or level of evidence. All bibliographies of included articles were checked for further relevant studies.

Eligibility criteria

The inclusion criteria were: articles with patients undergoing thumb CMCJ prosthetic total joint replacement for arthritis, results published as a full paper in any language; outcome measures including patient or clinician-reported, subjective scales (e.g. pain), radiographic analysis, failure rates; randomized controlled trials, cohort studies, case series (with greater than 10 patients); mean follow up of at least 12 months.

The exclusion criteria were: case reports; case series with fewer than 10 patients; meeting abstracts without full articles; revision procedures; cadaveric studies; biomechanical studies; interposition arthroplasties (including hemiarthroplasty, spacer implants); studies where it is not possible to separate the patients with different underlying aetiologies (i.e. inflammatory arthritis from osteoarthritis); follow up less than 12 months.

Two authors reviewed all abstracts for inclusion according to the above criteria, and where a study met all the criteria, or where there was uncertainty, the full texts were obtained and reviewed by both authors to assess eligibility. In cases of disagreement over study inclusion, a senior author was consulted and disagreement resolved by consensus.

Data extraction and analysis

The following data were extracted: study type, exclusion/inclusion criteria, recruitment procedure used, number of cases, patient demographics, underlying pathology, surgical treatment details including implants (and approaches where available), post-operative rehabilitation protocols, follow up period/timings, clinical and radiological outcomes, adverse events, failure rates.

Risk of bias of the studies was assessed according to the Coleman Methodology score.[3] This method was designed to evaluate the study design of the included articles.

Statistical analysis

All continuous data were pooled, and a descriptive data analysis performed.

Results

The initial literature search resulted in a total of 1047 articles. Fig. 1 shows the PRISMA flowchart for study selection. A total of 56 studies met all inclusion criteria and were analysed. There was one randomized controlled trial, three prospective comparative cohort studies, five retrospective comparative cohort studies, and 47 descriptive cohort studies. The methodological bias assessment for all 56 studies is included in Table 1.

Study characteristics

The 56 studies (Table 1) included a total of 2731 patients with 3048 thumb total CMCJ prosthetic joint replacements; 84% of patients were female (2210/2632 reported), with a mean age of 62.5 years (range, 50 to 71). Methodological analysis was poor to moderate across most of the studies, with higher Coleman scores for those with a more rigorous study design i.e. comparative cohorts or randomized controlled trials. Surgical experience level, surgical approaches, and post-operative rehabilitation were sporadically reported.

Follow up

All studies reported their follow up period, with mean follow up ranging from 12 months to 13.1 years.

Underlying aetiology

In all but one study the underlying aetiology was exclusively osteoarthritis (OA), and in the remaining study the underlying aetiology was inflammatory joint disease.[4] Of the 16 studies excluded due to mixed aetiologies, few of these included a significant proportion of inflammatory arthritis cases.

Assessment of clinical outcomes

Quantifiable patient-reported outcome measures were reported in 34 studies.[5–38] Comparable pre and post-operative values were reported in 12 studies.[7,9,10,13,16,17,19,23,27,29,32,33] The most commonly used patient-reported outcome measures (PROMs) were the Disabilities of the Arm Shoulder and Hand measure (DASH) or quick DASH which are general upper extremity scoring systems. Other measures included the Michigan Hand Questionnaire (MHQ) which is more specific to hand complaints, the Nelson score, which is specific to thumb outcomes, the Patient Related Wrist Evaluation (PRWE) score which is a wrist-specific measure, and the Sollerman score which is a measure of hand function. Most studies reporting pre and post-operative PROMs demonstrated a significant improvement from pre-operative values. The measures of spread of data (i.e. standard deviation or equivalent) were inconsistently reported.

Quantifiable satisfaction scores were reported in seven studies,[8,11,16,22,24,39,40] and pain scores in 30 studies.[4–7,9–11,13,15–17,19–24,26,27,29–35,38–41] Comparable pre and post-operative values were reported in two studies for satisfaction,[16,39]

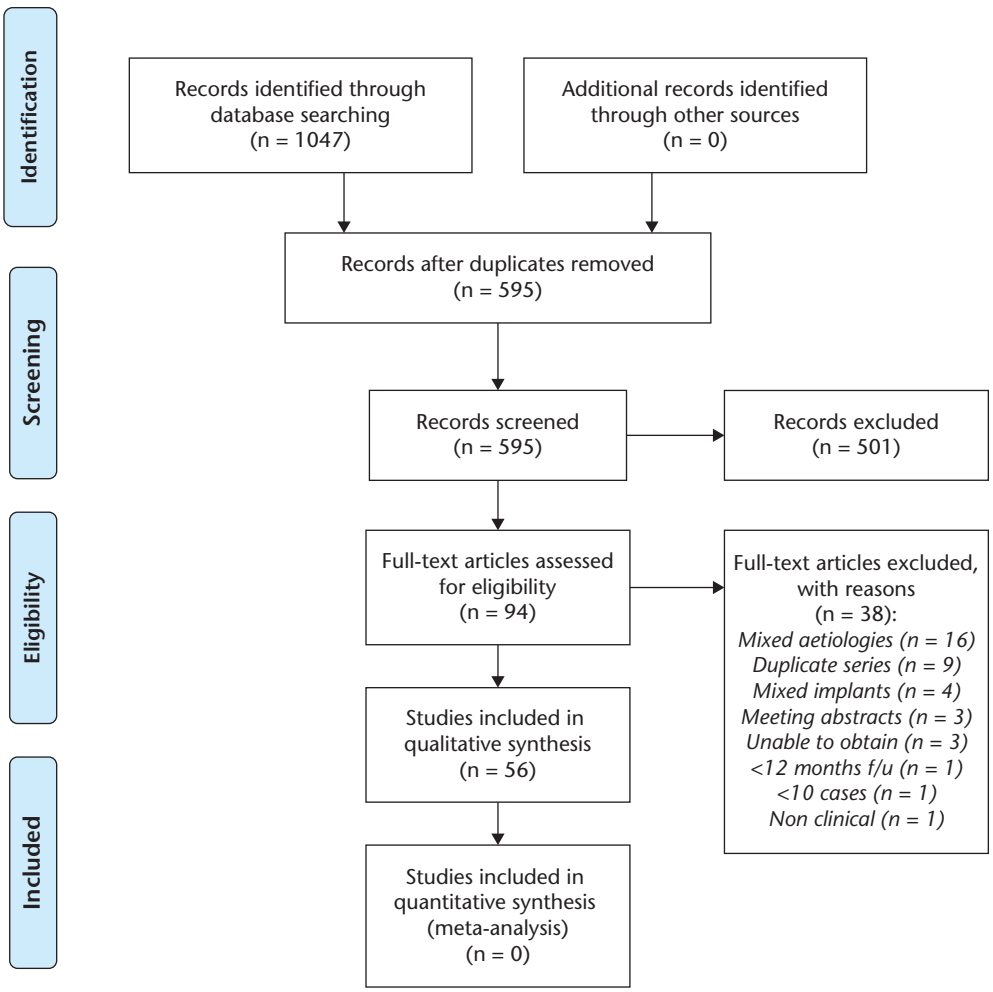

Fig. 1 PRISMA 2009 flow diagram.

Table 1. Study characteristics

Implant	Author (year)	Evidence level	Final follow up patients (implants)	Original cohort lost to follow up	Age (years)	Follow up (months)	Coleman score	Survivorship (*cumulative survival analysis)
ARPE	Dumartinet-Gibaud (2020)[5]	DC	43 (53)	34%	59	138 (120–280)	41	10 years 92%. 15 years 85% (without learning curve cases)*
ARPE	Gómez-Garrido (2019)[6]	DC	137 (137)	–	61.6	60.5 (55–66)	41	60.5 months 92.7%
ARPE	Martin-Ferrero (2020)[7]	DC	188 (216)	5%	59	126 (120–?)	52	10 years 93% (offered revision surgery whether agreed or not)*
ARPE	Craik (2017)[8]	RCC	62 (83)	24%	65	2 yrs	67	2 years 95%
ARPE	Robles-Molina (2017)[9]	RCC	31 (31)	0%	56.37	55.81 (*SD* 41.66)	46	–
ARPE	Martínez-Martínez (2016)[10]	PCC	15 (15)	0%	61	12	49	–
ARPE	Eecken (2012)[11]	DC	29 (35)	29%	55	6 yrs (3–11)	45	5 years 97%
ARPE	Apard (2007)[12]	DC	26 (32)	26%	59.4	86 (5 yrs–?)	41	5 years 85%. 11 years 79%
ARPE	Jacoulet (2005)[42]	DC	25 (–)	–	67	36 (?–7 yrs)	24	–
ARPE	Brutus (2004)[40]	DC	63 (63)	–	55.3	14.8 (5–40)	27	–
ARPE	Isselin (2001)[43]	DC	45 (45)	25%	61.8	22.4 (4–51)	12	–
Beznoska	Jurča (2016)[13]	RCC	11 (11)	0%	59	12	32	–

(continued)

Table 1 (continued)

Implant	Author (year)	Evidence level	Final follow up patients (implants)	Original cohort lost to follow up	Age (years)	Follow up (months)	Coleman score	Survivorship (*cumulative survival analysis)
Braun-Cutter	Badia (2006)[44]	DC	25 (26)	0%	71	59 (26–68)	55	–
DLC	Skyttä (2005)[4]	DC	24 (27)	53%	50	13 yrs (7–22)	52	10 years 87% (95% CI 73–94)*
DLC	De Smet (2004)[14]	DC	40 (43)	0%	54	26 (15–69)	59	–
DLC	Van Cappelle (1999)[45]	DC	49 (61)	21%	62	8.5 yrs (2–16)	36	16 years 72%*
DLC	Nonnenmacher (1994)[46]	DC	16 (20)	0%	55	5 yrs (1–11)	27	–
DLC	Nicholas (1992)[47]	DC	17 (20)	0%	57.25	64.2 (8–120)	24	–
Elektra	Froschauer (2020)[15]	RCC	29 (32)	14%	54	13.1 yrs (12.2–14.3)	33	–
Elektra	Thorkildsen (2019)[48]	RCT	19 (19)	5%	Md 64	2 yrs	86	2 years 75% (95% CI 55–94)*
Elektra	Chug (2014)[16]	DC	14 (16)	0%	70	26 (12–38)	37	–
Elektra	Hernández-Cortéz (2012)[17]	DC	19 (19)	0%	57	29 (24–36)	39	–
Elektra	Hansen (2008)[18]	DC	16 (17)	0%	54	35 (22–52)	39	–
Elektra	Ulrich-Vinther (2008)[41]	PCC	36 (36)	14%	58	12	57	–
Elektra	Regnard (2006)[54]	DC	100 (100)	0%	59	54 (36–78)	35	–
Elektra	Krukhaug (2014)[57]	DC	– (29)	0%	62	Md 2 yrs	14	5 years 90% (95% CI 75–100)*
Elektra	Hansen (2013)[58]	DC	13 (13)	19%	60	24 months	35	–
Guepar I	Alnot (1993)[49]	DC	32 (36)	0%	62	3.5 yrs (1–9)	24	–
Guepar II	Lemoine (2009)[50]	DC	68 (84)	0%	61	50 (12–115)	38	–
Guepar II	Masmejean (2003)[55]	DC	60 (64)	0%	58.1	29 (12–84)	37	–
ISIS	Seng (2013)[19]	DC	26 (30)	0%	59.8	30 (18–47)	37	42 months 93% (loosening or non-osteointegration)*
IVORY	Tchurukdichian (2020)[20]	DC	90 (105)	5%	61	– (120–?)	61	10 years 95.5%*
IVORY	Cebrian-Gomez (2019)[21]	PCC	84 (84)	0%	60	4.1 yrs (2–5)	80	5 years 96.4% (95% CI 92.5–100.0)*
IVORY	Erne (2018)[22]	RCC	39 (39)	0%	56.2	42 (12–72)	34	–
IVORY	Vissers (2019)[23]	DC	24 (26)	22%	71	130 (120–142)	49	10 years 85%
IVORY	Spaans (2016)[24]	DC	20 (20)	17%	60	37 (26–52)	44	–
Maia	Andrzejewski (2019)[25]	DC	93 (113)	41%	59.5	63 (32–143)	34	5 years 92% (retained implants)
Maia	Caekebeke (2018)[26]	DC	35 (50)	0%	57	65 (56–71)	39	65 months 96% (95% CI 85–99)
Maia	Toffoli (2017)[27]	DC	80 (96)	–	68	Md 76 (60–102)	56	5 years 93% (95% CI 87–98) (any significant complication)*
Maia	Bricout (2016)[28]	DC	139 (156)	0%	62.7	37.8 (13.4–71.0)	36	62 months 90.8%
Maia	Kubát (2012)[29]	DC	34 (36)	0%	60	42 (37–?)	30	–
Moje	Kaszap (2012)[30]	DC	12 (12)	0%	64	50	26	–
Moje	Kollig (2017)[31]	DC	26 (27)	7%	62	33 (9–62)	39	–
Moovis	Martins (2020)[32]	DC	41 (41)	11%	68	60 (24–72)	53	–
Moovis	Tchurukdichian (2019)[33]	DC	175 (196)	2%	66	48.2 (36–60)	62	–
Moovis	Dreant (2019)[34]	DC	25 (28)	10%	63.4	27.5 (12–45)	48	–
Motec	Thillemann (2016)[35]	DC	40 (42)	0%	59	26 (14–46)	38	1 year 79% (95% CI 63–88). 2 years 58% (95% CI 40–72)*
Motec	Krukhaug (2014)[57]	DC	– (53)	0%	63	Md 1.9 yrs	14	3 years 91% (95% CI 81–100)
Nahigan	Hannula (1999)[56]	DC	30 (34)	19%	58	47 (15–86)	24	–
Roseland	Semere (2015)[36]	DC	51 (64)	37%	58.2	12.5 yrs (*SD* 1.8)	39	–
Roseland	Guardia (2010)[51]	DC	68 (79)	0%	61.1	43.8	49	–
Roseland	Zollinger (2010)[39]	DC	34 (40)	0%	60.8	44	45	–
Roseland	Moutet (2001)[52]	DC	24 (27)	0%	62	38 (24–61)	39	–
Roseland	Schuhl (2001)[59]	DC	43 (45)	0%	59.7	14 (1–50)	27	–
Rubis II	Dehl (2017)[37]	DC	95 (115)	55%	71	10 yrs (6–17)	39	10 years 89%
SR TMC	Pendse (2009)[38]	DC	50 (62)	0%	Md 64.5	Md 36 (24–84)	55	3 years 91% (revision surgery or loosening)*
SR TMC	Pérez-Ubeda (2003)[53]	DC	19 (20)	0%	65	33 (24–45)	43	–

Notes. All values mean (range) unless otherwise stated. DC, descriptive cohort; RCC, retrospective comparative cohort; PCC, prospective comparative cohort; RCT, randomized controlled trial; Md, median; CI, confidence interval.

and 16 studies for pain.[7,9,10,13,16,17,19,20,23,27,29,32–34,39,41] Subjective satisfaction and pain scores using the visual analogue scale (VAS) system were collected to provide a comparative outcome measure. A number of studies reported pain and satisfaction as a percentage of patients 'satisfied' or 'pain free', but these measures were not felt to be reliable and useful for comparative analysis. The use of the VAS score for pain, documented pre and post-operatively was well utilized in 29% of studies. Most studies reporting pre and post-operative VAS scores for pain and/or satisfaction showed significant improvements from pre-operative values.

Quantifiable range of motion measurements/scores were reported in 38 studies.[4,5,9,10,12–17,19,21,23–27,30,32–34,36–40,42–53] Comparable pre and post-operative values were reported in 13 studies.[10,13,19,23,24,27,33,34,36,39,48,50,53] Objective range of motion assessment included the Kapandji Opposition score, degrees of thumb abduction (either radial or palmar), and the Buck-Gramcko score, which is a measure of various movements. Small improvements in range of motion were seen in most studies reporting pre and post-operative scores/ranges.

Strength measurement was reported in 36 studies.[4,6,7,9,10,12,14,16,19–27,29,32–34,36–38,40–42,44,46,48–50,53–56] Comparable pre and post-operative values were reported in 16 studies.[7,9,10,14,20,23,27,29,33,40,41,44,48,49,53,56] Strength measurements of grip, key pinch and tip pinch were included. Modest improvements in strength were seen, particularly for grip and key pinch strength in most studies reporting pre and post-operative scores.

The most significant complications were those of failure, loosening or dislocation of implants. A number of other complications including fracture, infection, chronic regional pain syndrome, superficial radial nerve symptoms, tendon irritation, and heterotopic ossification were noted, but only reported in this review for the comparative studies.

Survival estimates were provided in 21 studies.[4–8,11,12,19–21,23,25–28,35,37,38,45,48,57] The definition of survival varied considerably between studies, with the most common definition being that of an implant that has not either been removed or had a component exchanged. The most common cumulative survival analysis method was that of Kaplan-Meier; however, a number of studies either did not perform a formal analysis or did not provide details.

Outcomes of different prostheses

The ARPE prosthesis was reported in 11 studies comprising three comparative cohorts[8–10] and eight descriptive cohorts,[5–7,11,12,40,42,43] with a total of 735 replacements (Tables 2 and 3, Figures 2 and 3). Two studies reported >

Table 2. Study outcomes

Implant	Author (year)	Patient-reported outcomes	Range of motion	Grip strength (Kgf)	Key pinch strength (Kgf)	Tip pinch strength (Kgf)	Failures	Loosening	Dislocation
ARPE	Dumartinet-Gibaud (2020)[5]	**qDASH**: Md 23. **VAS Pain**: 3	**KS**: 9	–	–	–	40%	13%	13%
ARPE	Gómez-Garrido (2019)[6]	**DASH**: 19.55. **VAS Pain**: 1	–	–	5.8	–	7%	4%	4%
ARPE	Martin-Ferrero (2020)[7]	**DASH**: Pre 59 Post 13. **VAS Pain**: Pre 8.2 Post 1.1	–	–	Pre 3.1 Post 4.5	–	7%	5% (cup)	6%
ARPE	Craik (2017)[8]	**qDASH**: 16.8. **VAS Satisfaction**: 8.7	–	–	–	–	5%	0%	10%
ARPE	Robles-Molina (2017)[9]	**qDASH**: Pre 74.67 Post 21.79 **VAS Pain**: Pre 9.3 Post 1.33	**KS**: 9.52	–	Pre 11.14 lbs Post 11.8 lbs	–	10%	0%	10%
ARPE	Martínez-Martínez (2016)[10]	**DASH**: Pre 58.72 Post 11.44 **VAS Pain**: Pre 7.67 Post 1.27	**KS**: Pre 7.2 Post 9.4 **Abd**: Pre 40.73° Post 52.67°	Pre 19.13 Post 23.47	Pre 4.78 Post 7.03	Pre 3.67 Post 5.83	0%	0%	0%
ARPE	Eecken (2012)[11]	**DASH**: 8 **VAS Satisfaction**: 9.6 **VAS Pain**: 1	–	–	–	–	11%	3% (cup)	6%
ARPE	Apard (2007)[12]	**DASH**: 27.4	**KS**: 9.8	Op 20 NonOp 19.6	Op 5.7 NonOp 5.3	–	22%	16%	3%
ARPE	Jacoulet (2005)[42]	–	**KS**: 10 **Abd**: 56°	23	4	–	12%	4%	12%
ARPE	Brutus (2004)[40]	**VAS Function**: 9.9 **Satisfaction**: 4.7 (0–5 scale) **Residual pain:** 0.1 (0–4 scale)	**KS**: 10	–	–	Pre 2.4 Post 6.6	6%	6%	10%
ARPE	Isselin (2001)[43]	–	**Abd**: 45.4°	–	–	–	–	–	–
Beznoska	Jurča (2016)[13]	**DASH**: Pre 56 Post 7 **VAS Pain**: Pre 5 Post 1	**KS**: Pre 7.4 Post 9.8	–	–	–	9%	9%	0%

(continued)

Table 2 (continued)

Implant	Author (year)	Patient-reported outcomes	Range of motion	Grip strength (Kgf)	Key pinch strength (Kgf)	Tip pinch strength (Kgf)	Failures	Loosening	Dislocation
Braun-Cutter	Badia (2006)[44]	–	**Buck-Gramcko score**: 53 **RAbd**: 60°	–	Pre 3.5 Post 5.5	–	4%	0%	4%
DLC	Skyttä (2005)[4]	**VAS Pain**: Md 90	**KS**: 5 **PAbd**: 42° **RAbd**: 37°	12.4	4.2	3.3	26%	30% (26% cup)	11%
DLC	De Smet (2004)[14]	**DASH**: 24.2	**KS**: 9 **Abd**: Op 89° NonOp 95°	Pre 17.63 Post 23.81	Pre 5.32 Post 5.97	–	2%	44% (42% cup)	0%
DLC	Van Cappelle (1999)[45]	–	**RAbd**: 33°	–	–	–	25%	44%	2%
DLC	Nonnenmacher (1994)[46]	–	**Abd**: 30°	17	–	–	–	40% (15% cup)	0%
DLC	Nicholas (1992)[47]	–	**Abd**: 39°	–	–	–	10%	5% (cup)	5%
Elektra	Froschauer (2020)[15]	**DASH**: 23 **VAS Pain**: 0	**RAbd**: 56° **PAbd**: 50°	–	–	–	53%	65% (cup)	3%
Elektra	Thorkildsen (2019)[48]	–	**KS**: Pre Md 9 Post Md 9 **Abd**: 49°	Pre Md 17 Post Md 23	Pre Md 6 Post Md 7	Pre Md 4 Post Md 5	26%	11% (cup)	16%
Elektra	Chug (2014)[16]	**PRWE**: Pre 68.6 Post 11.6 **MHQ Satisfaction**: Pre 39.2 Post 84.5 **PRWE Pain**: Pre 34.2 Post 5.3	**KS**: 8.2 **RAbd**: Op 47° NonOp 50° **PAbd**: Op 40° NonOp 41°	Op 27 NonOp 28	Op 3.6 NonOp 3.9	Op 4 NonOp 4.3	6%	0%	0%
Elektra	Hernández-Cortéz (2012)[17]	**qDASH**: Pre 69.4 Post 37.9 **VAS Pain**: Pre 8.4 Post 4.6	**KS**: 9	–	–	–	21%	47% (cup)	0%
Elektra	Hansen (2008)[18]	**DASH**: 38	–	–	–	–	35%	29% (cup)	6%
Elektra	Ulrich-Vinther (2008)[41]	**VAS Pain**: Rest Pre 3.8 Post 0.5 **Activity**: Pre 8.2 Post 1.1	–	–	–	Pre 4 Post 5.2	3%	3%	0%
Elektra	Regnard (2006)[54]	–	–	28	6	–	18%	15%	7%
Elektra	Krukhaug (2014)[57]	–	–	–	–	–	7%	3%	3%
Elektra	Hansen (2013)[58]	–	–	–	–	–	15%	8%	8%
Guepar I	Alnot (1993)[49]	–	**Abd**: 40°	Pre 16 Post 30	–	Pre 2 Post 8	6%	36% (14% cup)	0%
Guepar II	Lemoine (2009)[50]	–	**KS**: Pre 8.8 Post 9.5 **Abd**: Pre 35° Post 36°	Op 20.8 NonOp 20.4	Op 6 NonOp 5.8	Op 4 NonOp 4.2	1%	6% (3% cup)	0%
Guepar II	Masmejean (2003)[55]	–	–	19	6.1	–	2%	2% (0% cup)	0%
ISIS	Seng (2013)[19]	**qDASH**: Pre 68.5 Post 37.8 **VAS Pain**: Pre 8.1 Post 3.4	**KS**: Pre 7.8 Post 9.1 **Abd**: 31.7°	Op 17.2 NonOp 22	Op 5.1 NonOp 6.8	'Pulp' pinch: Op 3.1 NonOp 4.3	3%	10% (7% cup)	0%
IVORY	Tchurukdichian (2020)[20]	**qDASH**: all ≤ 14 **VAS Pain**: Pre 7.5 Post 0.24	–	Pre 19 Post 26	Pre 3.8 Post 6.4	Pre 1.9 Post 3.5	6%	0%	8%
IVORY	Cebrian-Gomez (2019)[21]	**qDASH**: 11.4 **VAS Pain**: 0.6	**KS**: 9.7 **RAbd**: 38.8°	20.3	2.3	–	4%	1%	2%
IVORY	Erne (2018)[22]	**DASH**: 10.1 **VAS Satisfaction**: 9.5 **VAS Pain**: 0.5	–	–	1 bar	–	8%	3%	0%
IVORY	Vissers (2019)[23]	**qDASH**: Pre 58.9 Post 29.2 **VAS Pain**: Pre 7.3 Post 1.4	**KS**: Pre 8.4 Post 9.1 **Abd**: 54.6°	Pre 16.7 Post 19.2	Pre 4.1 Post 4.4	'Pulp' pinch: Post 3.1	12%	8% (cup)	0%
IVORY	Spaans (2016)[24]	**DASH:** 32.1 **MHQ**: 68.2 **VAS Satisfaction**: 2.9 **VAS Pain**: 1.9	**KS**: Pre 8.8 Post 8.8 **RAbd**: Op 50.4° NonOp 57.4° **PAbd**: Op 41.8° NonOp 48.7°	Op 23.7 NonOp 26.1	Op 4.5 NonOp 4.5	Op 2.4 NonOp 2.6	10%	0%	10%

(continued)

Table 2 (continued)

Implant	Author (year)	Patient-reported outcomes	Range of motion	Grip strength (Kgf)	Key pinch strength (Kgf)	Tip pinch strength (Kgf)	Failures	Loosening	Dislocation
Maia	Andrzejewski (2019)[25]	**DASH**: 26.7	**KS**: 8.9 **Abd**: 44°	–	Op 4.8 NonOp 5.4	–	12%	2%	10%
Maia	Caekebeke (2018)[26]	**DASH**: 7 **MHQ**: 91 **VAS Pain**: Rest 0 Loading activities 1	**KS**: 9 **Abd**: 76°	Op 29 NonOp 27	Op 7 NonOp 7	–	4%	0%	0%
Maia	Toffoli (2017)[27]	**qDASH**: Pre 61.3 Post 17.5 **VAS Pain**: Pre 7.9 Post 1.2	**KS**: Pre 9 Post 9.2 **RAbd**: Pre 32.9° Post 33° **PAbd**: Pre 32.1° Post 34.2°	Pre 13.3 Post 23.4	Pre 4.3 Post 5.6	–	8%	4% (cup)	1%
Maia	Bricout (2016)[28]	**qDASH**: 14.3	–	–	–	–	12%	3% (cup)	4%
Maia	Kubát (2012)[29]	**qDASH**: Pre 71.7 Post 22.5 **VAS Pain**: Pre 8.4 Post 0.4	–	Pre 15.8 Post 26.8	Pre 2.7 Post 5.7	Pre 2.3 Post 4.9	6%	3% (cup)	3%
Moje	Kaszap (2012)[30]	**DASH**: 27 **VAS Pain**: Rest 1.4 Maximal loading 3.9	**RAbd**: 37° **PAbd**: 38°	–	–	–	42%	100%	0%
Moje	Kollig (2017)[31]	**DASH**: 23 **VAS Pain**: 1.9	–	–	–	–	56%	48%	0%
Moovis	Martins (2020)[32]	**qDASH**/Md: Pre 68 Post 24 **MHQ**/Md: 90 **VAS Pain**/Md: Pre 6 Post 0	**KS**: Op 9 NonOp 8 **RAbd**: Op 45 NonOp 50 **PAbd**: Op 50° NonOp 50°	Md: Op 21 NonOp 19	Md: Op 7 NonOp 6	–	0%	0%	0%
Moovis	Tchurukdichian (2019)[33]	**qDASH**: Pre 79.3 Post 35 **VAS Pain**: Pre 6.2 Post 0.76	**KS**: Pre 5.46 Post 9.1	Pre 18.3 Post 26.8	Pre 4.2 Post 7.5	–	3%	0%	0.5%
Moovis	Dreant (2019)[34]	**qDASH**: 12 **MHQ**: 87.5 **VAS Pain**: Pre 8 Post 1	**KS**: Pre 7 Post 10	28	7.5	'Pulp' pinch: 4.5	4%	4%	0%
Motec	Thillemann (2016)[35]	**DASH**: 28.4 **VAS Pain**: Rest 1 Activity 4	–	–	–	–	40%	21% (cup)	7%
Motec	Krukhaug (2014)[57]	–	–	–	–	–	6%	6%	0%
Nahigan	Hannula (1999)[56]	–	–	Pre 36.2 Post 43.4	Pre 3.6 Post 6.2	–	15%	32%	0%
Roseland	Semere (2015)[36]	**qDASH**: 27.6	**KS**: Pre 8.1 Post 9.3 **Abd**: Pre 36.7° Post 39.2°	21.7	6.1	4.5	9%	3% (cup)	2%
Roseland	Guardia (2010)[51]	–	**KS**: 97% 9–10	–	–	–	4%	0%	3%
Roseland	Zollinger (2010)[39]	**VAS Satisfaction**: Pre 2.2 Post 8.7 **VAS Pain**: Pre 7.6 Post 1.3	**Abd**: Pre 59.3° Post 74.7°	–	–	–	10%	3% (cup)	5%
Roseland	Moutet (2001)[52]	–	**Abd**: 50°	–	–	–	–	4% (stem)	0%
Roseland	Schuhl (2001)[59]	–	–	–	–	–	18%	27% (cup 22%)	0%
Rubis II	Dehl (2017)[37]	**qDASH**: 30	**KS**: 9 **Abd**: 51°	11	8.3	6.3	10%	1%	13%
SR TMC	Pendse (2009)[38]	**qDASH**: 30.4 **Sollerman score**: 77.3 **VAS Pain**: 1.29	**KS**/Md: 8 **Abd**/Md: 59.1°	19.2	–	4.1	11%	8%	3%
SR TMC	Pérez-Ubeda (2003)[53]	–	**KS**: Pre 8 Post 9 **Abd**: Pre 27° Post 35°	Pre 13.8 Post 16.25	Pre 3.75 Post 4.38	Pre 3.49 Post 4.2	20%	55%	0%

Notes. All values mean (range) unless otherwise stated. (q)DASH, (quick) Disabilities of the Arm, Shoulder and Hand score; VAS, visual analogue scale; KS, Kapandji score; Abd, abduction; RAbd, radial abduction; PAbd, palmar abduction; Md, median; PRWE, Patient-Rated Wrist Evaluation; MHQ, Michigan Hand Outcomes Questionnaire.

Table 3. Implant outcomes

Implant	*N*	Follow up (months)	Failure	Loosening	Dislocation
ARPE	735	78	10.3%	4.8%	6.8%
DLC	144	68	14.5%	38.2%	1.4%
Elektra	281	48	19.9%	19.6%	5.0%
IVORY	274	82	6.2%	1.5%	4.4%
Maia	451	59	9.8%	2.4%	4.4%
Moovis	265	48	2.6%	0.4%	0.4%
Roseland	255	60	9.2%	6.3%	2.0%

Notes. All values mean unless otherwise stated. Follow up for each implant group calculated using the following formula: (N individual study implants × mean individual study follow up)/N total implants. Only incorporates studies with OA as underlying aetiology.

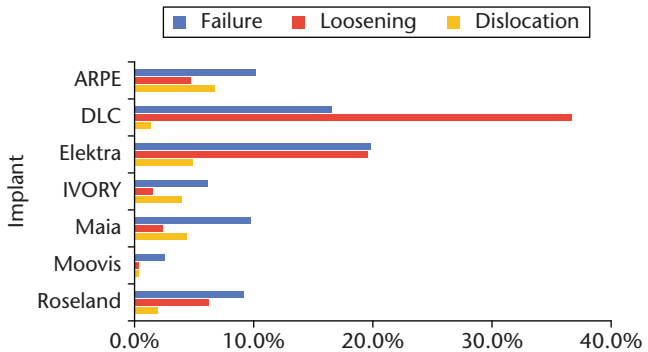

Fig. 2 Implant outcomes.
Note. DLC, de la Caffinière

10 year survival rates with cumulative survivorship analysis. One study reported significantly better survivorship after correcting for the learning curve procedures (15 year survival 80% to 85% after correction), demonstrating the importance of technical performance in obtaining good long-term results and minimizing complications.[5] The other study reported 93% survival at 10 years as defined by being offered revision surgery, although 50% of these declined.[7] One study demonstrated much poorer survival rates of 79% at 11 years with most of the failures being due to loosening.[12] A small trapezium was found to be a risk factor for trapezial loosening/failure,[7] emphasizing the importance of appropriate patient selection. At a mean of 78 months follow up, failure rates were 10.3%, loosening rates 4.8%, and dislocation rates 6.8%.

The de la Caffinière (DLC) prosthesis was reported in five studies,[4,14,45–47] all of which were descriptive cohorts, with a total of 171 replacements (144 for osteoarthritis). Two studies reported survival rates with cumulative survival analysis. One of these reported 72% survival at 16 years.[45] The other study reported 87% survival at 10 years.[4] At a mean of 68 months follow up, cases undertaken for osteoarthritis demonstrated failure rates of 14.5%, loosening rates of 38.2%, and dislocation rates of 13.8%. The single series evaluating cases undertaken for inflammatory arthritis evaluating outcomes at a mean of 13 years demonstrated, out of 27 cases, failure rates of 26%, loosening rates of 29.6%, and dislocation rates of 11.1%.[4]

The Elektra prosthesis was reported in nine studies, comprising one randomized controlled trial,[48] two comparative cohorts,[15,41] and six descriptive cohorts,[16–18,54,57,58] with a total of 281 replacements. Two studies reported survival rates with cumulative survival analysis, demonstrating 72% survival at two years[48] and 90% survival at five years[57] respectively. At a mean of 48 months follow up, failure rates were 19.9%, loosening rates 19.6%, and dislocation rates 5%.

The IVORY prosthesis was reported in five studies, comprising two comparative cohorts,[21,22] and three descriptive cohorts,[20,23,24] with a total of 274 replacements. Two studies reported survival rates with cumulative survival analysis, demonstrating 95.5% survival at 10 years[20] and 96.4% survival at five years[21] respectively. At a mean of 82 months follow up, failure rates were 6.2%, loosening rates 1.5%, and dislocation rates 4.4%.

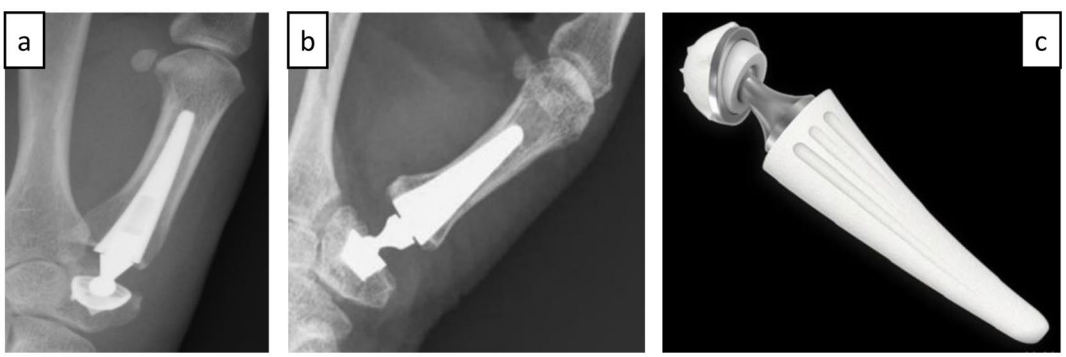

Fig. 3 Examples of implants
Implants: (a) ARPE, (b) IVORY[73], (c) Touch.

The Maia prosthesis was reported in five studies,[25–29] all of which were descriptive cohorts, with a total of 451 replacements. One study reported survival rates with cumulative survival analysis, demonstrating 93% survival at five years.[27] At a mean of 59 months follow up, failure rates were 9.8%, loosening rates 2.4%, and dislocation rates 4.4%.

The Moovis prosthesis was reported in three studies,[32–34] all of which were descriptive cohorts, with a total of 265 replacements. At a mean of 48 months follow up, failure rates were 2.6%, loosening rates 0.4%, and dislocation rates 0.4%.

The Roseland prosthesis was reported in five studies,[36,39,51,52,59] all of which were descriptive cohorts, with a total of 255 replacements. At a mean of 60 months follow up, failure rates were 9.2%, loosening rates 6.3%, and dislocation rates 2%.

The other prostheses were reported in much lower numbers and fewer studies, thus limiting the interpretation of the results. The Beznoska,[13] Braun-Cutter,[44] ISIS,[19] first generation Guepar,[49] second generation Guepar,[50,55] Moje,[30,31] Motec,[35,57] Nahigan,[56] Rubis II,[37] and SR TMC[38,53] prostheses have been described in mostly retrospective series (Table 2). Of these the Moje prosthesis demonstrated a particularly high failure rate of 42–56%.

Radiolucencies were common in some series,[19,25,27,48,50,55,56] but most cases were minor with no significant progression or clinical symptoms.[37] Heterotopic ossification was identified post-operatively in some series, but only rarely causing significant enough symptoms to warrant intervention.[6,7,12,25,27,37,38] Trapezial fracture, either intra-operatively, or after surgery due to trauma was identified in several studies, but in most cases the fracture was not severe enough to cause cup loosening or displacement and responded well to a period of immobilization.[5,33,36,46,52]

Outcomes of comparative studies

The resection arthroplasty groups underwent trapeziectomy with ligament reconstruction and tendon interposition (LRTI) using flexor carpi radialis (FCR) in five studies,[9,10,13,21,48] abductor pollicis longus (APL) in two studies,[22,41] extensor carpi radialis longus (ECRL) in one study,[15] and a synthetic interposition in one study[8] (Table 4). Due to both the heterogeneity of surgical techniques and outcome measures, it was not possible to perform a meta-analysis of these data.

Thorkildsen et al[48] undertook a randomized controlled trial (RCT) comparing the Elektra prosthesis to trapeziectomy with LRTI using FCR with 20 patients in each group, with a follow up of two years. qDASH scores were better in the replacement group at three and six months but not at one to two years (based upon a minimally clinical important difference (MCID) of 15). The Nelson score demonstrated better results in the replacement group at three months but not beyond this. Range of movement and grip strength were not significantly different between the two groups. The prosthetic group demonstrated five failures (two for cup loosening, three for dislocation) and one infection. The trapeziectomy group demonstrated three complications, with one haematoma, one FCR-related pain, and one base of thumb pain.

The other studies were comparative cohorts comparing ARPE,[8–10] IVORY,[21,22] Elektra,[15,41] and Beznoska[13] prostheses against resection arthroplasty. Follow up ranged from 12 months to 13.6 years. PROMs were shown to be statistically significantly better in the replacement group in 4/7 studies,[8,13,21,22] pain relief better in 3/7 studies,[9,21,41] range of motion better in 4/6 studies,[9,10,21,41] and strength better in 4/5 studies.[9,10,21,41] In the remainder of studies any difference seen was statistically insignificant. There were no studies demonstrating a statistically significant superiority of resection arthroplasty over replacement. Pain relief was achieved faster in the replacement group in three studies,[21,22,41] and return to work was faster in one study.[22] Complications were more common in the replacement groups in terms of failures, with the majority of issues in the replacement group being loosening and dislocation. Out of a total of 389 replacements, there were 62 reported complications (16%). This comprised 26 cases of loosening, 17 dislocations, five superficial radial nerve symptoms, three implant failures, three infections, two tendon issues, two fractures, one suture irritation, one heterotopic ossification, one chronic regional pain syndrome (CRPS), and one allergic reaction. Out of a total of 343 resection arthroplasties, there were 31 reported complications (9%). This comprised nine superficial radial nerve symptoms, six tendon issues, three proximal migrations, two infections, two CRPS, two STTJ OA progression, two metacarpo-phalangeal joint hyperextension deformities, one case of scar tenderness, one base of thumb pain, one FCR pain, one haematoma, and one instability.

Discussion

Thumb CMCJ prosthetic total joint replacement outcomes have now been published with fair to good long-term functional outcomes, and demonstrate encouraging clinical outcomes in comparative studies with resection arthroplasty at short–medium-term follow up. This comes with a cost of increased rates of complications, largely in terms of loosening and dislocation of the implants.

Thumb CMCJ replacement is a technically demanding procedure, and appropriate patient selection and surgical experience are thought to be fundamental to obtaining

Table 4. Comparative studies

Implant – Author (year)	Study details	Patient-reported outcomes	Kapandji score/ Abduction (°)	Grip strength (Kgf)	Key pinch strength (Kgf)	Tip pinch strength (Kgf)	Complications
Beznoska – Jurča (2016)[13]	**RCC** *Repl*: 11 (age 59) *RA*: 17 (age 58) Both 12 months follow up	**DASH**: ***Repl*** Pre 56 Post 19 ***RA*** Pre 58 Post 7 **VAS Pain**: ***Repl*** Pre 5 Post 1 ***RA*** Pre 5 Post 1	**KS**: ***Repl*** Pre 7.4 Post 9.8 ***RA*:** Pre 6.4 Post 8.9	–	–	–	***Repl***: failure 1, loosening 1 (traumatic) ***RA***: infection 1, parasthesias 4
Elektra – Froschauer (2020)[15]	**RCC** *Repl*: 37 (5 lost to f/u, age 54, 13.1 yrs f/u) *RA*: 18 (5 lost to f/u, age 58, 13.6 yrs f/u)	**DASH**: ***Repl*** 23 ***RA*** 37 **VAS Pain**/**Md**: ***Repl*** 0 ***RA*** 0	**RAbd**: ***Repl*** 56 ***RA*** 51 **PAbd**: ***Repl*** 50 ***RA*** 57	–	–	–	***Repl***: failures 17, aseptic cup loosening 17, cup tilting 4, dislocation 1, allergic reaction 1 ***RA***: proximal migration of thumb 1, instability 1
Elektra – Thorkildsen (2019)[48]	**RCT** *Repl*: 20 (1 lost to f/u, age Md 64, 2 yrs f/u) *RA*: 20 (age 61, 2 yrs f/u)	***qDASH** better in ***Repl*** at 3/6 months but not 1–2 yrs (MCID set at 15) ***Nelson score** better at 3 months but not beyond	**KS**: ***Repl*** Pre 9 Post 9 ***RA*** Pre 9 post 9 **Abd**: ***Repl*** 49 ***RA*** 42	***Repl*** Pre 17 Post 23 ***RA*** Pre 19 Post 20	***Repl*** Pre 6 Post 7 ***RA*** Pre 6 Post 6	***Repl*** Pre 4 Post 5 ***RA*** Pre 5 Post 6	***Repl***: failures 5, cup loosening 2, dislocation 3, infection 1 ***RA***: haematoma 1, FCR pain 1, thumb base pain 1
Elektra – Ulrich-Vinther (2008)[41]	**PCC** *Repl*: 42 (6 lost to f/u, age 58, 12 months f/u) *RA*: 70 (8 lost to f/u, age 62, 12 months f/u)	***VAS Pain**: better in ***Repl*** from 3 months	***Repl*** better in flex/ext, abd/add, pulp palm distance from 3 months onwards	*Better in ***Repl*** from 3 months	*Better in ***Repl*** from 3 months	*Better in ***Repl*** from 3 months	***Repl***: failure 1, tendon issues 2, implant failure 1 ***RA***: tendon issues 6, scar tenderness 1, sensory changes 1
IVORY – Cebrian-Gomez (2019)[21]	**PCC** *Repl*: 84 (age 60, 4.1 yrs f/u) *RA*: 62 (age 60 3.6 yrs f/u)	***qDASH**: ***Repl*** 11 ***RA*** 16 ***VAS Pain**: ***Repl*** 0.6 ***RA*** 1.7	***KS**: ***Repl*** 9.7 ***RA*** 9 ***RAbd**: ***Repl*** 38.8 ***RA*** 30.5	***Repl*** 20.3 ***RA*** 19.9	***Repl*** 2.3 ***RA*** 1.7	–	***Repl***: failures 3, infection 1, SRN dysthesia 1, CRPS 1, dislocation 2, cup loosening 1 ***RA***: CRPS 1, painful TMCJ collapse 2, STT OA progression with pain 2
IVORY – Erne (2018)[22]	**RCC** *Repl*: 39 (age 56.2, 42 months f/u) *RA*: 32 (age 54.3, 36 months f/u)	***DASH**: ***Repl*** 10.1 ***RA*** 21.5 **VAS Pain**: ***Repl*** 0.5 ***RA*** 1 **VAS Satisfaction**: ***Repl*** 9.5 ***RA*** 8.5	–	–	***Repl***: 1 bar ***RA***: 0.8 bar	–	***Repl***: failures 3, broken proximal component 2, loosening 1, SRN injury 1 ***RA***: SRN injury 1
ARPE – Craik (2017)[8]	**RCC** *Repl*: 110 (24% loss to f/u, age 65, 2 yrs f/u) *RA*: 75 (39% loss to f/u, age 69, 3.4 yrs f/u)	***qDASH**: ***Repl*** 16.8 ***RA*** 25.1 ***VAS Satisfaction** ***Repl*** 8.7 ***RA*** 7.8	–	–	–	–	***Repl***: failures 4, atraumatic dislocation 5, traumatic dislocation 3, fracture 1, HO 1, infection 1 ***RA***: 0
ARPE – Robles-Molina (2017)[9]	**RCC** *Repl*: 31 (age 56.3, 56 months f/u) *RA*: 34 (age 60.5, 59 months f/u)	**qDASH**: ***Repl*** Pre 75 Post 22 ***RA*** Pre 78 Post 26 **VAS Pain**: ***Repl*** Pre 9.3 Post 1.3 ***RA*** Pre 9.2 Post 1.4	***KS**: ***Repl*** 9.5 ***RA*** 9	–	***Repl***: Pre 11.1 lbs Post 11.8 lbs ***RA***: Pre 9.9 lbs Post 8.4 lbs	–	***Repl***: SRN dysthesias 2, dislocation 3 ***RA***: SRN dysthesias 2, repeat surgery for MCPJ hyperextension 2
ARPE – Martínez-Martínez (2016)[10]	**PCC** *Repl*: 15 (age 61, 56 months f/u) *RA*: 15 (age 58, 59 months f/u)	**DASH**: ***Repl*** Pre 59 Post 11 ***RA*** Pre 64 Post 17 **VAS Pain**: ***Repl*** Pre 8 Post 1 ***RA*** Pre 6 Post 1	**KS**: ***Repl*** Pre 7.2 Post 9.4 ***RA*** Pre 7.5 Post 9.3 ***Abd**: ***Repl*** Pre 41 Post 53 ***RA*** Pre 44 Post 49	***Repl***: Pre 19.1 Post 23.5 ***RA***: Pre 17.2 Post 23.5	***Repl***: Pre 4.8 Post 7 ***RA***: Pre 4.3 Post 5.3	***Repl***: Pre 3.7 Post 5.8 ***RA***: Pre 3.1 Post 5.3	***Repl***: SRN dysthesia 1, suture irritation 1, trapezial fracture 1 ***RA***: SRN dysthesia 1, infection 1, CRPS 1

Notes. All values mean unless otherwise stated. RCC, retrospective comparative cohort; PCC, prospective comparative cohort; RCT, randomized controlled trial; Repl, replacement; RA, resection arthroplasty; (q)DASH, (quick) Disabilities of the Arm, Shoulder and Hand score; VAS, visual analogue scale; KS, Kapandji score; Abd, abduction; RAbd, radial abduction; PAbd, palmar abduction; Md, median; FCR, flexor carpi radialis; SRN, superficial radial nerve; CRPS, chronic regional pain syndrome; MCPJ, metacarpophalangeal joint; TMCJ, trapeziometacarpal joint; STT OA, scaphotrapeziotrapezoidal osteoarthritis; HO, heterotopic ossification.

*Statistically significant $p < 0.05$.

optimal outcomes and reducing complications. There is a significant learning curve to replacement operations, with higher failure rates and complications demonstrated in one series in the first 30 cases as compared to subsequent 50 cases.[5] Accurate and comparative reporting of experience level is important to aid the interpretation of published results, with systems in existence to enable this.[60] Computer-assisted surgery has been piloted in a cadaveric study to attempt to obtain reliable and accurate position of the cup component, but has not yet been translated into clinical practice.[61]

OA is the most common indication for replacement procedures. Several manufacturers advise specifically not to undertake CMCJ replacement in patients with inflammatory arthritis due to the theoretically higher risks of failure due to poor bone and soft tissue quality. Only one study evaluated CMCJ replacement in purely inflammatory arthritis cases,[4] with a failure rate of 26%, loosening rate of 30% and dislocation rate of 11%, somewhat supporting this theory.

Surgical approach is thought by some surgeons to determine either optimal exposure or preservation of important ligamentous/capsular complexes. Surgical approaches were not reported in a significant number of studies; however, dorsal approaches were described in 29 studies, and volar approaches in eight studies. Advocates of the volar (Wagner) approach suggest that because the two important structures in stability of the thumb CMCJ are the anterior oblique ligament (which is already attenuated in CMCJ OA) and the dorsal capsule, a volar approach preserves the remaining dorsal capsule to maximize post-operative stability and reduce dislocation rates.[62] Advocates of the dorsal approach suggest that the trapezial exposure is significantly better with this approach, and therefore a more accurate implantation of the trapezial component can be established.[5,7] The only study to assess this found that implant positioning was significantly better in their cohort with the dorsal approach compared to the volar approach.[7] This has yet to be validated by other studies and with other prostheses and no conclusions regarding optimal approach can be made on the basis of this.

Patient-reported outcomes are critical to evaluating the subtle differences in improvement between CMCJ replacement and resection arthroplasty. The most commonly used outcome measures, i.e. DASH/qDASH, may not be sensitive enough to assess this. Thorkildsen et al[48] reported an MCID of 15 in their randomized controlled trial using qDASH as the comparative outcome measure, but this was based upon a study evaluating a heterogenous group of hand conditions and therefore was not specific to thumb outcomes.[63] The Nelson score is a thumb-specific measure with positive ratings according to the Consensus-based Standards for the Selection of Health Status Measurement Instruments (COSMIN),[64] but is not commonly used. Pain is the major presenting feature with which patients pursue surgical intervention, and therefore the accurate and comparable recording of pain-related outcomes is essential. The use of the VAS score for pain, documented pre and post-operatively is probably the most easily comparable score available. Standardization of whether this represents pain at rest or on activity will help define outcomes even further. Survival rates are a key index reporting measure in large joint arthroplasty, and will play a useful role in the comparative outcomes of thumb CMCJ replacement. It is important, however, to standardize the definition of survival e.g. as removal or exchange of prostheses, and to perform cumulative survival analysis to enable accurate comparison of implants at different time points. A core outcome set for thumb CMCJ outcomes has not yet been defined, but will be important in future comparative studies.[65,66]

Early implants, e.g. de la Caffinière, used cemented fixation techniques of the trapezial and metacarpal components with a semi-constrained prosthesis, which may explain the relatively high loosening rates for these protheses, as the thumb CMCJ will undergo significant shear as well as compressive forces.[67] Subsequent protheses (Table 5) developed either hydroxyapatite coated

Table 5. Characteristics of commonly used implants

Implant	Cup	Stem	Bearing	Still marketed?	Manufacturer	Origin of publications
ARPE	HAC	HAC	Metal on PE	Yes	Zimmer Biomet	France, Italy, Spain, UK, Belgium
DLC	Cemented, polyethylene	Cemented, cobalt chrome	Metal on PE	No	Fixano/Sbi	Belgium, Netherlands, France, UK, Finland
Elektra	HAC	HAC	Metal on PE	No	Fixano/Sbi	Austria, Norway, Australia, Spain, Denmark, France
IVORY	HAC	HAC	Metal on PE	No	Stryker	France, Spain, Germany, Belgium, Netherlands
Maia	HAC	HAC	Metal on PE	Yes	Lepine	Belgium, France, Czech Republic
Moovis	HAC	HAC	Metal on PE (dual mobility)	Yes	Sbi/Stryker	France
Roseland	HAC	HAC	Metal on PE	No	De Puy	France, Netherlands

Note. HAC, hydroxyapatite coated metal (uncemented); PE, polyethylene.

or porous coated titanium implants (e.g. ARPE, Elektra, IVORY, Maia, Roseland) to encourage more robust bone integration. Other implants, e.g. Moovis, have evolved to incorporate dual mobility bearing characteristics with the theoretical advantages of reducing both loosening and dislocation rates. This is borne out in the early–medium-term data presented in this review, as Moovis has the lowest rates of both loosening and dislocation, although with a mean follow up of two years (maximum five years). Longer-term results are awaited to determine the longevity of these implants.

Of the commonly reported implants, DLC, Elektra, Roseland and IVORY are no longer on the market. This has occurred either due to high levels of failure (e.g. Elektra) or for commercial reasons (e.g. Roseland, IVORY). ARPE, Moovis, and Maia are CE marked for use in Europe. Another promising modern implant with CE marking is the Touch prosthesis (Keri Medical, dual mobility). It has not yet been reported upon but is commonly used in Europe and as a result Keri Medical are in the process of seeking Food and Drug Administration (FDA) approval for its use in the USA.

Resection arthroplasty, i.e. trapeziectomy with or without LRTI, is held as the standard of surgical care for CMCJ OA for which to compare other interventions. The comparative studies in this review use a wide range of LRTI interventions, which alongside different reporting outcomes negates the usefulness of meta-analysis of the data. In addition to clinical measures, failure is often reported as a measure of comparison between the interventions.[68] One option for a failed replacement is to perform a secondary trapeziectomy, which has been shown to have equivalent outcomes when compared to patients who undergo a primary trapeziectomy from the beginning (i.e. no replacement at all).[50,56,69–71] The main comparative study utilized trapeziectomy without LRTI.[70]

There are concerns regarding the increased cost of using implants in replacement compared to trapeziectomy, and cost-effectiveness studies are lacking in the literature. Only one study has evaluated relative costs of trapeziectomy vs. trapeziectomy with LRTI vs. CMCJ replacement/fusion (as a combined group due to low overall numbers).[72] They looked at 3501 patients from 2001–2010, and calculated the Medicare and secondary insurance payouts for each procedure. They calculated the hospital outpatient total spending at a mean of 3199 USD for trapeziectomy, 3412 USD for CMCJ replacement/fusion, and 4186 USD for trapeziectomy with LRTI. It is difficult to extrapolate this fully to our day-to-day practice due to the combined replacement/fusion group, and now relatively old data. Further studies should incorporate cost-effectiveness evaluations into the study design.

A precise definition of how loosening was identified was lacking in most studies. Only two studies specifically defined how they assessed loosening – one with radiolucent lines in three or more zones of 0.5 mm or more,[38] and one with radiolucent lines greater than 1 mm.[14] The other studies simply described radiographic loosening or migration of the implant. A universal definition of loosening would help make reliable comparisons across studies and implants.

This systematic review has some weaknesses. The quality of evidence has improved since the last systematic review on this topic,[2] with a further seven comparative trials (including one RCT), however the majority of studies are still of a moderate methodological quality, even amongst the comparative studies. The quality of reporting did not allow for a meta-analysis due to the heterogeneous datasets. Therefore it is not possible to draw a definitive conclusion regarding the superiority of replacement versus resection arthroplasty. The definitions of loosening were variable and therefore difficult to accurately report between studies. The inclusion of core outcome sets, standardizing reporting of outcomes, will help in future meta-analyses of datasets to enable more definite conclusions to be reached.

Conclusion

The number of studies reporting outcomes in thumb CMCJ prosthetic total joint replacement are increasing both in number and quality. Failure, in terms of loosening and dislocation, remains a concern, although in the medium-term follow up for modern implants this issue appears to be of less concern when compared to their predecessors. Functional outcomes also look promising compared to resection arthroplasty, but further high-quality studies utilizing a standardized resection arthroplasty technique and modern implants, together with standardized core outcome sets, will be of value.

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