Meta-analysis of First Metatarsophalangeal Joint Implant Arthroplasty

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Management of late-stage degenerative joint disease of the first metatarsophalangeal joint (MPJ) is a complex topic that is frequently the source of debate among foot and ankle surgeons. Several surgical interventions have been described to treat this condition. One of the most contested of these treatments is implant arthroplasty of the first MPJ.

The primary aim of this meta-analysis was to evaluate the clinical benefit of first MPJ implant arthroplasty in regard to patient satisfaction. Reviewers formally trained in meta-analysis abstraction techniques searched databases and indices using medical subject heading terms and other methods to identify all relevant studies published since 1990. Initially, 3874 citations were identified and evaluated for relevance. Abstract screening produced 112 articles to be read in entirety, of which 47 articles studying 3049 procedures with a mean 61.48 (SD 45.03) month follow-up met all prospective inclusion criteria necessary for analysis.

Overall crude patient satisfaction following first MPJ implant arthroplasty was 85.7% (95% confidence interval: 82.5%–88.3%). When adjusting for lower quality studies (retrospective, less than 5 years of follow-up, higher percent of patients lost to follow-up), the overall patient satisfaction increased to 94.5% (89.6%–97.2%) in the highest-quality studies. This adjustment also significantly decreased heterogeneity across studies (crude Q = 184.6, high-quality studies Q = 2.053). Additional a priori sources of heterogeneity were evaluated by subgroup analysis and meta-regression.

In regards to patient satisfaction, this comprehensive analysis provides supportive evidence to the clinical benefit of first MPJ implant arthroplasties. Level of Clinical Evidence: 1 (The Journal of Foot & Ankle Surgery xx(x):xxx, 2009)

Key Words: hallux rigidus, implant, joint replacement, metatarsophalangeal arthroplasty, prosthesis

First metatarsophalangeal joint (MPJ) implant arthroplasty was first developed in the 1950s as an alternative solution for patients in whom a joint arthrodesis, metatarsal

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osteotomy, or excisional type arthroplasty was not the ideal choice. As with other joint replacements throughout the body, initially this alternative option was met with great enthusiasm. Widespread use of first MPJ implant arthroplasty ensued before complete understanding of implant design and material flaws as well as appropriate candidates for this procedure. Initial studies were optimistic, reporting high patient satisfaction and favorable outcomes. Over time, it became clearer that certain implant designs, implant materials, and patient characteristics were associated with poorer outcomes (1–7). The mechanical demands, biomechanical complexity, and material interactions relating to the first MPJ have been continuously addressed. Implant designs and materials have consequently undergone continuous revisions over the years to address conceptual advances (8–14).

Despite attempts to improve implant designs, improve materials, and identify the ideal implant candidate, many foot and ankle surgeons are uncertain if implant arthroplasty is a viable option (15). Trepidation related to earlier materials and implant designs persist. In addition, deformity correction had rarely been addressed in early studies and inappropriate candidates were receiving first MPJ replace-
Inclusion and Exclusion Criteria

Inclusion criteria for this meta-analysis included those studies with adults (≥18 years old) who received a first MPJ implant for any cause. Study designs could have been experimental (randomized or not), observational, or case series. All studies in English and German were included, as investigators were able to translate these languages.

Studies were excluded if there were less than 10 procedures or less than 1 year of mean follow-up. Because of concerns for industry conflicts of interest, abstracts from scientific meetings were not considered and journals must have been peer reviewed. Other excluded study designs included review articles, nonhuman studies, and studies in which the necessary data could not be extracted from the published work. Corresponding authors were contacted in the event data could have been misinterpreted or data needed further clarification. In addition, because of the evolution of implant designs and implant indications, studies before 1990 were not included. Finally, multiple publications identified on the same patient population were pooled to avoid double counting of patients, and the study with the longest follow-up was chosen for the meta-analysis.

Search Strategy

The following electronic databases were systematically searched: MEDLINE, EMBASE, Google Scholar, Cochrane library, and clinicaltrials.gov for relevant articles from January 1990 to September 2008. Both medical subject heading (MeSH) and exploding terms aided in the initial search strategy to help ensure capture of all articles. The use of “NOT” terms was used as necessary to avoid excessive capture. Initially, the following key words were used: Hallux OR Big Toe OR First Toe OR Great Toe OR Metatars* OR MPJ OR MTPJ OR Bunion OR Hallux Abductovalgus OR Hallux Valgus OR Hallux Rigidus OR Hallux Limitus OR Keller OR arthroplasty OR Arthritis AND Replacement OR Implant OR Prosthesis OR Endoprosthesis OR Arthroplasty OR Hemi* OR total.

In addition to the above electronic database searches, relevant journals were hand searched from 1990 to current, including Journal of Foot and Ankle Surgery, Foot and Ankle Specialist, Foot and Ankle International, Journal of the American Podiatric Medical Association, and Journal of Bone and Joint Surgery American and British.

Data Extraction

Two readers who are both foot and ankle specialists evaluated whether or not studies fulfilled the selection criteria based on title and abstract. If both of these readers did not agree with any English articles throughout the entire data extraction process, discrepancies were resolved by a third independent person. This person was blinded to the study objectives, as well as the study titles, authors, and location.

The primary outcome measure or metameter was the proportion of patients who were satisfied with the surgical procedure. Because of the variability in the way satisfaction was reported, dichotomization was necessary to reduce bias and to maintain consistency across all studies. In the case of 4 categories of satisfaction, the 2 highest categories and the 2 lowest categories were merged. In case of 3 categories, the 2 highest categories were merged. There were no cases of more than 4 categories reported. Data extraction included the following variables: study name, year of publication, country of origin, language, study design, proportion of patients satisfied and dissatisfied, mean age with ranges, number of patients and procedures, gender, percentage of patients lost to follow-up, surgical indications, study exclusions, mean follow-up, implant material, and implant design.
Data Analysis

All data were analyzed with Comprehensive Meta-Analysis (Version 2.2.046, Biostat, Englewood, NJ, 2007) and Statistical Analysis Software, (Version 9.1.3R33, SAS Inc., Cary, NC). Both a fixed effect model and a random effect model were first used in analyzing overall results. Determination of the appropriate model was chosen based on the amount of heterogeneity present. It was expected that heterogeneity would be high because of variations in type and material of implant, follow-up time, proportion of patients lost to follow-up, age, presence of rheumatoid arthritis, and study quality.

Separate subanalyses, sensitivity analyses, analysis of variance (ANOVA), and meta-regression were used to help identify and control for potential confounders. The Q-statistic for heterogeneity, the I²-statistic, and the Tau-squared statistic were calculated for each analysis. The differences between subgroups were tested for significance with the ANOVA technique.

Results

Study attrition is detailed in Figure 1. Following review of citation titles, abstracts, and identification of duplications or obvious study exclusions, 112 articles were then retrieved and evaluated. A total of 47 publications met all inclusion and exclusion criteria and were therefore entered into this analysis. Individual study references and study demographics are included in Appendices 1 and 2.

There were a total of 3049 procedures, with an overall mean age of 54.98 ± 4.82 years and a mean follow-up of 61.48 ± 45.03 months. Overall, 31.91% of the studies were prospective. No randomized controlled clinical trials were identified that assessed comparisons of first MPJ implant arthroplasty subtypes. There was one randomized clinical trial in which implants were compared with another procedure, but was determined to have a Jadad score of one. Most studies were conducted either in the United States or United Kingdom, but also included Canada, Germany, Switzerland, Finland, and Australia. Interobserver reliability of the extracted materials was 95.8%, K = 0.83.

The complete implant cohort was first assessed for patient satisfaction following first MPJ implant arthroplasty. The proportion of patients satisfied for each study was determined. Overall results are presented in Figure 2, ordered by publication date. Within the studies that met selection criteria, the crude overall mean patient satisfaction following first MPJ implant arthroplasty was found to be 85.7% (95% confidence interval: 82.5%–88.3%). (All ranges reported are the 95% confidence interval unless otherwise stated throughout this study.) Both a cumulative meta-analysis and one-study-removed analysis were performed, without evidence of concerning trends or that any one study was overly influential (Figure 3, A and B).

As anticipated, heterogeneity was found to be quite high ($Q = 184.615, I^2 = 75.083$) (Table 1). A random effect model was therefore used throughout the entire meta-analysis because of this heterogeneity. The previous a priori sources of heterogeneity were therefore further explored, as anticipated, in a systematic manner to assist in interpretation of results.

Implant Material and Design

The three major types of implant materials identified were: silicone, metal, and ceramic. Within metal implants, there were titanium, cobalt chromium, stainless steel, and mixtures of various alloys. There were also 2 major implant...

FIGURE 1 Flow chart of study selection.
designs: hemi and total. Total implants could further be identified as either constrained or nonconstrained. All silicone total implants were constrained and all metal and ceramic total implants were nonconstrained.

Analysis of variance was used to assess for differences between implant materials and designs. No significant difference was found between the various implant materials ($P = .259$) with minimal improvement of heterogeneity ($Q = 167.633, I^2 = 73.156$): ceramic: 80.5% (71.5%–87.1%), metal: 85.0% (78.2%–90.0%), and silicone: 87.1% (83.1%–90.2%). In regard to implant design, there was also no significant difference found ($P = .531, Q = 152.25$).

When combining implant design and material together, silicone hemi had a significantly lower satisfaction outcome than the other 4 groups ($P = .007, Q = 152.25$) (Table 2).

Patient Characteristics

An additional source of heterogeneity selected a priori was the patient populations of the different studies. Two characteristics believed to be important regarding first MPJ implant arthroplasty outcomes include age and indications for the procedure. Implant survival analyses have found that younger ages may predict implant failure. Using the median age as the point of reference, studies were divided into older than and younger than 55 years old for comparison. The comparison showed a statistically insignificant difference between the age groups ($P = .495$).

The presence of inflammatory joint diseases, specifically in younger patient populations, is another indication for joint implant arthroplasty. Therefore, studies that included rheumatoid arthritis (RA) were compared with those that did not, and no difference was found ($P = .17$). In studies where the lower boundary of the age range was younger than 40 years old, the authors compared the satisfaction ratings in studies that included rheumatoid arthritis patients with those studies that did not. Although studies without RA had a lower satisfaction (84.4%, 76.4%–90.0%) in this younger population, the difference was not statistically significant ($P = .373$).
FIGURE 3  (A) One-study-removed.  (B) Cumulative meta-analysis.
Study Quality

Given the observational nature of most of the studies that met the inclusion criteria, the quality of each study had the potential to greatly influence the data collected and analyzed. Factors that were considered important to address this potentially large source of heterogeneity were percentage of patients lost to follow-up (LTFU), length of follow-up, and prospective versus retrospective study design.

To evaluate if there was a relationship between the percentage of patients lost to follow-up and satisfaction, a meta-regression was performed (Figure 4). There was a significant negative relationship found \((P = .021)\), with a median percentage lost to follow-up of 23.1% across all studies.

Follow-up length was then compared across studies. Studies with 5 years or more of follow-up were considered long. No significant difference was found in satisfaction between studies with greater (86.6% [81.1%–90.6%]) or less than (84.8% [80.8%–88.1%]) 5 years of follow-up \((P = .577, Q = 184)\). Finally, prospective studies tended to have higher satisfaction (89.6% [84.6%–93.1%]) than retrospective studies (83.9% [79.9%–87.3%]), although this was statistically insignificant \((P = .063, Q = 184)\).

Given the a priori heterogeneity assumptions, the highest quality studies were considered to be prospective, have the longest follow-up (greater than 5 years), and have the least proportion of patients lost to follow-up (less than the median). It was found that evaluating the studies that met this inclusion criteria remarkably reduced heterogeneity (crude \(Q = 184.6\), high-quality studies \(Q = 2.053\)). Patient satisfaction was found to be 94.5% (89.6%–97.2%) in the highest-quality studies.

Discussion

The primary aim of this meta-analysis was to provide readers with the most objective information available to determine the efficacy of first MPJ implant arthroplasty in regard to patient satisfaction. When including all potential confounders and effect modifiers, patient satisfaction following first MPJ implant arthroplasty was found to be 85.7% (95% confidence interval: 82.5%–88.3%). When sources of heterogeneity (variability across studies) were reduced by means of evaluation of the highest-quality studies, patient satisfaction increased to 94.5% (95% confidence interval 89.6%–97.2%).

By approaching quality assessment of all the studies in a systematic way, a significant reduction in heterogeneity was achieved. Prospective studies were considered higher quality than retrospective studies. Length of follow-up was also an important consideration. The authors realize that 5 years of mean follow-up would be considered an intermediate follow-up by some, but for the purposes of avoiding a high percentage of patients lost, studies with greater than 5 years of mean follow-up were used to assign study quality. Finally, meta-regression was used to determine if the implants responded to percentage of patients lost to follow-up. A statistically significant negative relationship was found \((P = .021)\), indicating that studies with the greatest percentage of patients lost to follow-up had the lowest satisfaction outcomes. This implies that the most satisfied patients tend not to return for evaluation in many studies. Because of this significant relationship, studies containing less than the me-
dian percentage of patients lost to follow-up were considered higher quality. In addition, if studies where the percentage of lost to follow-up exceeds the magnitude of effect were included as higher-quality studies, a degree of uncertainty is present, because those patients missing from the study may have significantly added or subtracted from the outcome measure.

When compared with all other implant material and design combinations (silicone total, metallic total, ceramic total, metallic hemi), silicone hemi implants were found to have lower patient satisfaction \( (P = .007) \). Because the Q statistic reduced by only 17.5%, it is believed that there are many more factors to consider besides implant material and design alone. Furthermore, there may be more sensitive metameters to identify differences between implant material and design.

Most foot and ankle surgeons agree that patient characteristics are an important consideration in the success of first MPJ implants arthroplasty. Implant arthroplasty is more frequently used in patients with lower functional demands. In regard to age, Papagelopoulos and colleagues (Appendix 1, #33) confirmed with survival analysis that age is a major predictor of implant survivorship. They found that overall survivorship of implants is 86% at 10 years and 82% at 15 years. Moreover, Bankes et al dichotomized patients by age and found that the younger group’s implant survivorship was 82% while that of the older group was 90% \( (P = .03) \). They also compared inflammatory joint disease to other indications and found no significant impact on survivorship. Bankes and colleagues (Appendix 1, #2) similarly concluded implant survival to be 94% at 10 years, but failed to make comparisons by age or indication. Moreover, Bankes et al did not identify any particular patient characteristics that significantly impacted the outcome. Therefore, other metameters may be more sensitive in identification of ideal patient characteristics.

The results of this meta-analysis compare favorably with other joint replacement outcomes in the literature. Bullens et al (17) conducted a study of 100 total knee replacements where one of the primary outcomes was patient satisfaction. Mean satisfaction was 80% \( \pm 28\% \), with 32% of respondents reporting less than the mean. The National Institutes of Health 2003 consensus statement concluded that 85% of patients are satisfied following total knee replacement surgery (18).

In regard to comparing first MPJ implant arthroplasty to other first MPJ procedures, it is felt that each procedure has its own unique indications and ideal patient populations. There are advantages and disadvantages to each procedure. The goal is to choose the best procedure to improve symptoms and quality of life in a particular patient. Because it is believed that there are different patient populations for each procedure, logical comparisons of different surgical procedures are challenging to successfully conduct. Furthermore, this lack of equipoise does not allow the ability to perform randomized trials. This is why carefully constructed studies of a particular procedure are very useful, and combining studies in a meaningful way can help provide insight and guidance in regard to continuous improvement in the understanding of implant design, ideal procedure indications, and patient characteristics.

Innovation has produced several implants that have come and gone since the 1950s. To help categorize the history and the various implants available for future study, one may consider categorizing them into 4 generations, as follows:

- **1st generation:** material—silicone, design—hemi and total
- **2nd generation:** material—improved silicone, design—hemi and total implants with grommets
- **3rd generation:** material—metallic, design—hemi and total implants that are press fit
- **4th generation:** material—metallic, design—hemi and total implants that have a threaded stem

Because data do not exist on the 4th generation of first MPJ implants, comparison of outcomes data of the first 3 generations should provide insight for future consideration in implant design and most importantly patient care.

The results of this meta-analysis represent the collective best effort of the authors to analyze and present the data in an ethical and logical fashion. Despite these efforts, the data presented highlights associations that do not necessarily represent causation. Even in comparisons where statistical significance is found, the results should be carefully considered by the readership given the high degree of heterogeneity among the studies that contributed to any particular finding. Adoption of standardized outcome measures for future studies would improve the accuracy of pooled data.

In conclusion, implant arthroplasty for first MPJ end-stage degenerative joint disease appears to be effective in improving patient satisfaction. The overall quantitative level of satisfaction is difficult to report with certainty based on numerous confounding factors. Despite this, our study suggests that metallic hemi, silicone total, metallic total, and ceramic total may result in higher patient satisfaction than silicone hemi implants. Variation in study quality was felt to significantly impact the results of this investigation. By accounting for study quality, heterogeneity decreased and the outcome measurement increased.

### Acknowledgments

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References (In addition to studies included in the meta-analysis as listed in Appendix 1)


APPENDIX 1

Studies included in this meta-analysis

APPENDIX 2  Study demographics

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>Country</th>
<th>Study Design</th>
<th>No. Surgeries</th>
<th>Mean Age</th>
<th>Mean f/u, mo</th>
<th>Surgical Indications</th>
<th>Study Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashford RL</td>
<td>2000</td>
<td>UK</td>
<td>Retrospective</td>
<td>16</td>
<td>61</td>
<td>33</td>
<td>HR n = 19, Revisions n = 3</td>
<td>&lt;20 yo, very active</td>
</tr>
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<td>Bankes MJK</td>
<td>1999</td>
<td>UK</td>
<td>Retrospective</td>
<td>56</td>
<td>57</td>
<td>84</td>
<td>HAV n = 25, HR n = 18, RA n = 9, Revisions n = 10</td>
<td>&lt;5 yrs f/u, DM, PVD, h/o local infection</td>
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<tr>
<td>Barwick TW</td>
<td>2008</td>
<td>UK</td>
<td>Retrospective</td>
<td>24</td>
<td>54.5</td>
<td>26</td>
<td>All had DJD grade 1,2,3; [mild HAV n = 5, Revisions n = 6, 2nd MHR for Freiberg's dz n = 1]</td>
<td>RA, revision from silicone arthroplasty</td>
</tr>
<tr>
<td>Bommer R</td>
<td>2003</td>
<td>UK</td>
<td>Retrospective</td>
<td>42</td>
<td>64</td>
<td>96</td>
<td>DJD n = 25, HAV with OA n = 17</td>
<td>RA, high functional demands</td>
</tr>
<tr>
<td>Bonet J</td>
<td>1998</td>
<td>USA</td>
<td>Retrospective</td>
<td>40</td>
<td>63</td>
<td>99</td>
<td>Geriatric HAV n = 16, RA n = 7, Hallux rigidus n = 4 and all had DJD</td>
<td>None</td>
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<tr>
<td>Clayton ML</td>
<td>1997</td>
<td>USA</td>
<td>Retrospective comparative</td>
<td>49</td>
<td>56</td>
<td>75.8</td>
<td>RA</td>
<td>Non-RA patients</td>
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</table>

<table>
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<tr>
<th>First Author</th>
<th>Year</th>
<th>Country</th>
<th>Study Design</th>
<th>No. Surgeries</th>
<th>Mean Age</th>
<th>Mean f/u, mo</th>
<th>Surgical Indications</th>
<th>Study Exclusion Criteria</th>
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<td>Cracchiolo, A 3rd</td>
<td>1992</td>
<td>USA</td>
<td>Prospective</td>
<td>86</td>
<td>52.8</td>
<td>69.6</td>
<td>RA n = 49, DJD n = 8, HR n = 8, Revision n = 21</td>
<td>Bad skin, PVD, DM, neuropathy, osteopenia, prior infection, desire to run, tennis or wear heel &gt;2 in</td>
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<td>Ess P</td>
<td>2002</td>
<td>Finland</td>
<td>Prospective</td>
<td>10</td>
<td>53</td>
<td>24</td>
<td>HR [Etiology: OA n = 7, RA n = 2, trauma n = 1]</td>
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<td>Gibson JNA</td>
<td>2005</td>
<td>UK</td>
<td>RCT - Jadad score 1</td>
<td>36</td>
<td>55.5</td>
<td>24</td>
<td>HR</td>
<td>H/o systemic jt dz, prior MPJ sx, IPJ arthritis</td>
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<td>Granberry WM</td>
<td>1991</td>
<td>USA</td>
<td>Retrospective</td>
<td>90</td>
<td>55</td>
<td>36</td>
<td>HR n = 14, RA n = 21, Post-traumatic n = 2, Revisions n = 53</td>
<td>None</td>
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<td>Gupta S</td>
<td>2008</td>
<td>UK</td>
<td>Prospective</td>
<td>21</td>
<td>57</td>
<td>12.2</td>
<td>DJD</td>
<td>None</td>
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<td>Hanyu T</td>
<td>2001</td>
<td>Japan</td>
<td>Retrospective</td>
<td>60</td>
<td>52</td>
<td>144</td>
<td>RA</td>
<td>None</td>
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<td>2003</td>
<td>UK</td>
<td>Retrospective</td>
<td>20</td>
<td>50.5</td>
<td>217</td>
<td>HAV n = 8, HR n = 13</td>
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<td>UK</td>
<td>Retrospective</td>
<td>18</td>
<td>56</td>
<td>18</td>
<td>Pain &amp; HR</td>
<td>Prior foot infxn, DM, Loss of 2-pt discrimination</td>
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<td>USA</td>
<td>Retrospective</td>
<td>25</td>
<td>51</td>
<td>20</td>
<td>HR with DJD</td>
<td>Non-HR, inadequate bone stock, neuropathy, metal sensitivity, infxn</td>
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<td>Germany</td>
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<td>115</td>
<td>12</td>
<td></td>
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<td>60</td>
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<td>Connective tissue disorder n = 36, DJD n = 136, Revisions n = 29</td>
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<td>70.8</td>
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<td>11</td>
<td>58</td>
<td>17</td>
<td>HR</td>
<td>NR</td>
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<td>USA</td>
<td>Prospective</td>
<td>18</td>
<td>55.47</td>
<td>18</td>
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<td>None</td>
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<td>Konkel KF</td>
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<td>USA</td>
<td>Retrospective</td>
<td>13</td>
<td>53</td>
<td>66</td>
<td>HR, OA (4 revision surgeries)</td>
<td>DM</td>
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<td>Konkel KF</td>
<td>2008</td>
<td>USA</td>
<td>Retrospective</td>
<td>13</td>
<td>59</td>
<td>97</td>
<td>DJD &amp; HR</td>
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<td>Germany</td>
<td>Retrospective</td>
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<td>57.5</td>
<td>88.8</td>
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<td>None</td>
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<td>Retrospective</td>
<td>228</td>
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<td>48</td>
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<td>Ledermann T</td>
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<td>Switzerland</td>
<td>Retrospective</td>
<td>65</td>
<td>45</td>
<td>156</td>
<td>HAV &amp; OA n = 48, HR n = 13</td>
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<td>Lemon B</td>
<td>1997</td>
<td>USA</td>
<td>Retrospective</td>
<td>66</td>
<td>55.1</td>
<td>160.8</td>
<td>DJD in all: HR n = 10, HAV n = 33, RA n = 2, Gout n = 1, Reiter’s syndrome n = 1</td>
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<td>McAuliffe TB</td>
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<td>UK</td>
<td>Retrospective</td>
<td>111</td>
<td>58</td>
<td>33</td>
<td>Hallux rigidus n = 43, HAV n = 68</td>
<td>Non-DJD</td>
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<td>Moeckel BH</td>
<td>1992</td>
<td>USA</td>
<td>Retrospective</td>
<td>67</td>
<td>56</td>
<td>72</td>
<td>RA with PMHR</td>
<td>Non-RA or No PMHR</td>
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<td>Neumann R</td>
<td>1996</td>
<td>Germany</td>
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<td>430</td>
<td>55</td>
<td>48</td>
<td>RA or DJD</td>
<td>NR</td>
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<td>Notni A</td>
<td>2001</td>
<td>Germany</td>
<td>Prospective</td>
<td>26</td>
<td>52</td>
<td>28</td>
<td>HR with OA, HAV n = 2, Revisions n = 4</td>
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<td>Olms K</td>
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<td>21</td>
<td>58.8</td>
<td>24</td>
<td>HR n = 16; Revisions n = 5</td>
<td>&lt;24 mos f/u</td>
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<td>14</td>
<td>49.79</td>
<td>12</td>
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<td>Papagelopoulos PJ</td>
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<td>USA</td>
<td>Retrospective</td>
<td>88</td>
<td>56</td>
<td>144</td>
<td>HR = 38, OA = 1, RA = 32, HAV = 22 (of which 24 were revisions)</td>
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<td>72</td>
<td>46</td>
<td>67</td>
<td>RA</td>
<td>Non-RA</td>
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<table>
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<tr>
<th>First Author</th>
<th>Year</th>
<th>Country</th>
<th>Study Design</th>
<th>No. Surgeries</th>
<th>Mean Age</th>
<th>Mean f/u, mo</th>
<th>Surgical Indications</th>
<th>Study Exclusion Criteria</th>
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<tr>
<td>Pulavarti RS</td>
<td>2005</td>
<td>UK</td>
<td>Prospective</td>
<td>36</td>
<td>57</td>
<td>47</td>
<td>HR n = 20, HAV &amp; OA</td>
<td>Infxn, PVD, neuropathy, poor skin condition, poor medical conditions, unwilling to consent</td>
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<td>Rahman H</td>
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<td>54</td>
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<td>HR n = 38, HAV n = 40</td>
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<td>Raikin SM</td>
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<td>USA</td>
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<td>21</td>
<td>59.7</td>
<td>79.2</td>
<td>OA grade 3+</td>
<td>RA, Charcot, prior infxn, instability of lesser MPJs</td>
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<td>USA</td>
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<td>57</td>
<td>51</td>
<td>RA &amp; DJD</td>
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<td>DJD n = 53, RA n = 5,</td>
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<td>Prospective</td>
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<td>HR n = 19 HAV n = 87</td>
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<td>40</td>
<td>54</td>
<td>110</td>
<td>All with DJD; Post-traumatic n = 5</td>
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<td>33.14</td>
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<td>279</td>
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<td>HR</td>
<td>NR</td>
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</table>

UK, United Kingdom; USA, United States of America; RCT, randomized controlled trial; No. surgeries, number of surgeries analyzed for satisfaction; mo, months; n, number surgeries; HR, hallux rigidus or limitus; HAV, hallux abducto valgus; DJD, degenerative joint disease; RA, rheumatoid arthritis; Revisions, Any revision surgery of the 1st metatarsophalangeal joint; MHR, metatarsal head resection; dz, disease; OA, osteoarthritis; NR, not reported; PMHR, pan metatarsal head resection; yo, year old; f/u, follow-up; DM, diabetes mellitus; PVD, peripheral vascular disease; h/o, history of; infxn, infection; MPJ, metatarsophalangeal joint; pts, patients.