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Does Implant Design Influence Failure Rate of Lateral Unicompartmental Knee Arthroplasty? A Meta-Analysis

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Title: “Does implant design influence failure rate of lateral unicompartmental knee arthroplasty? A meta-analysis.”

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1 **Does implant design influence failure rate of lateral unicompartmental knee arthroplasty? A**
2 **meta-analysis.**

3 **Abstract**

4 Background

5 Lateral unicompartmental knee arthroplasty (UKA) is a viable solution for isolated lateral
6 compartment arthritis. Several prosthetic designs are available such as Fixed Bearing Metal-Backed
7 (FB M-B), Fixed Bearing All Polyethylene (FB A-P), and Mobile Bearing Metal Backed (MB M-
8 B) implants. The purpose of this meta-analysis is to compare failure rates of different prosthetic
9 designs.

10 Methods

11 Preferred Reporting Items for Systematic Reviews and Meta-Analyses systematic review was
12 conducted using 4 databases (MEDLINE, EMBASE, Cochrane, and PubMed) to identify all studies
13 that investigate outcomes of lateral UKA. 21 studies met the inclusion criteria, and failure rates
14 were compared by implant type and follow-up time separately in order to assess potential
15 confounding factors. Two separate analyses have been performed among different implant designs
16 (FB M-B vs FB A-P vs MB M-B) and different follow-ups (less than 5 years, between 5 and 10
17 years, more than 10 years).

18 Results

19 The failure rate of FB M-B lateral UKA was significantly lower compared to other lateral
20 unicompartmental knee arthroplasty designs present on the market (0,8% vs 8,6% and 7,1% for FB
21 M-B, FB A-P and MB M-B, respectively). No significative difference among groups has been
22 detected when comparing all implants with regard to follow-up time.

23 Conclusion

24 Considering actual evidence, for a surgeon approaching lateral UKA, the Fixed Bearing Metal
25 Backed design is preferable, given the lower failure rates and subsequently a longer implant
26 survivorship.

27 **Keywords**

28 Lateral, Unicompartmental, Knee, Arthroplasty, Survivorship, Meta-analysis

29

30 **Background**

31 Lateral unicompartmental knee arthroplasty (UKA) is an appealing alternative to total knee
32 arthroplasty (TKA) for patients with isolated lateral compartment arthritis. Whilst degenerative

33 joint disease may affect any compartment of the knee, the isolated lateral compartment arthritis of
34 the knee is less common and much more challenging to treat. It is estimated that only less than 1%
35 of the total number of knee arthroplasty and only 5–10% of all unicompartmental knee
36 replacements are performed for lateral compartment disease[1,2]. This number might be artificially
37 low because the majority of surgeons prefer total rather than lateral unicompartmental knee arthroplasty
38 for the treatment of lateral compartment osteoarthritis[3]. Compared to TKA, UKA has several
39 potential advantages, which include a less invasive procedure, improved postoperative range of
40 motion, preservation of the cruciate ligaments, fat pad and bone stock, improved proprioception,
41 increased patient satisfaction, earlier return to activities, shorter hospital stay, and fewer
42 complications [4–9]. Moreover, it leaves the healthy contralateral tibiofemoral compartment intact.

43 Despite these benefits, lateral compartment knee arthroplasty is more difficult to perform than
44 medial compartment UKA due to its anatomic and biomechanical characteristics. The lateral
45 collateral ligament is looser than the medial ligament, and the lateral femoral condyle
46 anteroposterior translation is deeper than the medial side.[10] Moreover, the lateral tibial plateau is
47 rounder compared to the medial plateau, the lateral femoral condyle is smaller than the medial
48 condyle, and the screw-home mechanism is far more significant on the lateral side [11,12]. All
49 these anatomic and biomechanical characteristics lead to a technically challenging procedure, a
50 more difficult surgical approach, a significantly longer learning curve, therefore the need to perform
51 a large number of procedures to achieve the lowest reoperation rates, which have traditionally been
52 higher in UKA compared with TKA surgery[13,14].

53 Because of the infrequency of this procedure, few studies describe the survivorship and the causes
54 of failure in lateral UKA[15]. These studies mainly include case series that involve a small cohort
55 of patients, further comprised by mixed data including medial UKA[16]. Nevertheless, the scarce
56 evidence in literature has shown acceptable results for short and mid-term survivorship of lateral
57 UKA with remaining concerns on the long-term survivorship together with difficulties about
58 identifying the main reasons for failure. Hence it is fundamental to systematically examine failure
59 rates, evaluate the etiology and the mechanism of lateral UKA failure to improve the understanding
60 and the revision strategy of a failed lateral UKA.

61 Several prosthetic designs are commercially available, which differ concerning the bearing and the
62 materials. They can be divided into three groups: Fixed Bearing All-Polyethylene (FB A-P), Fixed
63 Bearing Metal-Backed (FB M-B), and Mobile Bearing Metal-Backed (MB M-B) implants.

64 To our knowledge, limited evidence is available in literature on survivorship in lateral UKA in
65 relation to implant design. Therefore, we performed a systematic review and metanalysis, pooling
66 failure rates of studies that reported lateral UKA survivorship. The aim of this study was to assess
67 the different rates of lateral UKA failures with regard to implant design.

68

69 **Material and Methods**

70 Article Identification and Selection

71 This study was conducted in accordance with the 2009 Preferred Reporting Items for Systematic
72 Reviews and Meta-Analyses (PRISMA) statement[17] (Fig.1). A systematic review of the literature
73 regarding the existing evidence for survivorship and clinical outcomes of Lateral Unicompartmental
74 Knee Arthroplasty (UKA) was performed using the Cochrane Central Register of Controlled Trials,
75 PubMed, MEDLINE (2011-2021), and EMBASE. The queries were performed in April 2021. The
76 literature search strategy included the following: (lateral[All Fields] AND ("arthroplasty,
77 replacement, knee"[MeSH Terms] OR ("arthroplasty"[All Fields] AND "replacement"[All Fields]
78 AND "knee"[All Fields]) OR "knee replacement arthroplasty"[All Fields] OR
79 ("unicompartmental"[All Fields] AND "knee"[All Fields] AND "arthroplasty"[All Fields]) OR
80 "unicompartmental knee arthroplasty"[All Fields])) AND ("2011/01/01"[PDat] :
81 "2021/04/28"[PDat]).

82 Inclusion criteria were as follows: survivorship and/or failure rates stated for lateral
83 unicompartmental knee arthroplasty, English language, minimum follow-up of 2 years for all
84 patients in the cohort, minimum of 20 patients in each study cohort, study published within the last
85 10 years, same implant used for all patients in each cohort, and human studies. We excluded
86 cadaveric studies, animal studies, biomechanical reports, basic science articles, editorial articles,
87 case reports, literature reviews, surgical technique descriptions, instructional courses, and tumors.

88 Two independent reviewers (S.F., A.M.) performed a review of the abstracts from all identified
89 articles. Full-text articles were obtained for review, if necessary, to allow for a further assessment of
90 inclusion and exclusion criteria. Additionally, all references from the included studies were
91 reviewed and reconciled to verify that no relevant articles were missing from the systematic review.

92 Data Collection and Processing

93 The level of evidence of the studies was assigned according to the classification system specified by
94 Wright et al.[18] Data were abstracted from the full text of all eligible articles using standardized
95 data collection forms. Abstracted and recorded data included patient demographics, the follow-up
96 period, the type of implant used, failure rates and/or survivorship rates. For continuous variables
97 (e.g. age, follow-up), the means, SDs, interquartile ranges, and ranges were collected (if reported).
98 Data were recorded into a custom spreadsheet using a modified information extraction table.

99 Literature Quality Evaluation

100 Two reviewers (S.F., A.M.) used a modified version of the Coleman methodology score (mCMS) to
101 assess the methodological quality of each study. The 2-part mCMS grades cartilage-related studies
102 based on 10 criteria. Part A includes the study size, mean follow-up, number of different surgical
103 procedures, type of study, description of the surgical procedure, postoperative rehabilitation,
104 participants' magnetic resonance imaging outcome, and participants' histological outcome. Part B
105 includes the outcome criteria, procedure for assessing clinical outcomes, and description of the
106 participant selection process. The maximum mCMS is 100, which indicates a study that largely
107 avoids chance, biases, and confounding factors.

108 Statistical Analysis

109 The primary outcome of the meta-analysis was the difference in failure rate among the three groups
110 of implants evaluated (FB A-P, FB M-B, and MB M-B). The statistical analysis and the forest plot
111 was carried out according to Neyeloff et al. using Microsoft Excel (release 2103 16.0.13901.20400 /
112 April 13, 2021).[19] The Mantel-Haenszel method was used to evaluate the expected value[20];
113 Wilson's confidence intervals were preferred because of data sparsity, either in terms of event rates
114 being low or study size being small; therefore the standard error estimates using inverse variance
115 methods were considered inadequate.[21] With no heterogeneity, the estimation of the expected
116 value and its 95% confidence interval (CI) was based on fixed-effect analysis of variance; the
117 random effect model was used otherwise. Statistical heterogeneity was evaluated by the I-square
118 statistic and Cochrane's Q.[22] The comparisons among groups were based on the z-score

119 transformation of the difference. The rationale is that, under a normal-distribution assumption, a
120 95% CI is 2×1.96 standard error's (SE) wide; therefore it is possible to estimate the SE for each
121 group from the CI around each expected value. Then, the SE for the difference between the two
122 groups can be calculated as $SE(B - A) = \sqrt{SE(B)^2 + SE(A)^2}$ and $Z = \frac{(B-A)}{SE(B-A)}$. The p -value of the
123 difference can be carried out from the normal standard distribution and then corrected with the
124 Bonferroni method for multiple comparisons. Two investigators independently assessed the risks of
125 bias (low, high or unclear). Publication bias was also assessed using a funnel plot (Fig. 2).
126 Subgroup analyses based on differences in the follow-up period were also performed to explore a
127 potential source of heterogeneity. Three subgroups were accordingly created in each group: short-
128 term (<5 years), midterm (5–10 years), and long-term (>10 years) follow-up.

129

130 **Results**

131 A total of 2215 studies were selected for the analysis. After a review of the titles, abstracts, full
132 titles, and excluding the unrelated studies, 21 articles were selected as eligible for the final meta-
133 analysis.[23–43] Four of the 21 studies were prospective trials, while the others were retrospective
134 analyses. The mean follow-up period ranged from 3 to 14.2 years. Additional details about study
135 characteristics and patient demographics can be found in Table 1.

136 Within the selected studies, the FB A-P implants were from two manufacturers: HLS Uni Evolution
137 (Tournier) and AMC Uniglide (Corin); the FB M-B implants were from five manufacturers:
138 Restoris MCK (Stryker), Sled UKA (Waldemar Link), Unicompartmental High Flex Knee
139 (Zimmer), Miller-Galante Unicompartmental Knee (Zimmer), iUni G1 (Conformis), Respicci II
140 UKA (Biomet), Vanguard M UKA (Biomet); the MB M-B implants were from two manufacturers:
141 Oxford Doomed Lateral UKR (Zimmer Biomet), Preservation UKA (DePuy).

142 Failure rates analysis by implant design

143 A total of 3378 knees were examined, and 219 experienced failure and subsequent revision. The
144 total failure rate was 5,0% (95% C.I. 3,1%-6,9%). I^2 was 85% showing substantial heterogeneity;

145 therefore random effect was applied.[22] The FB A-P group showed a failure rate of 8,6% (95%
146 C.I. 3,2%-14,1%) with an $I^2=54\%$; therefore random effect was applied. The FB M-B group
147 showed a failure rate of 0,8% (95% C.I. 0,0%-1,6%) with no heterogeneity; therefore fixed effect
148 was applied. The MB M-B group showed a failure rate of 7,1% (95% C.I. 5,3%-8,9%) with an
149 $I^2=52\%$, therefore random effect was applied. Data are summarized in Table 2 and Figure 3.

150 Meta-analysis evaluation showed a statistically significant difference among groups FB M-B and
151 FB A-P ($p=0,024$) and among groups FB M-B and MB M-B ($p<0,01$). No significative difference
152 has been noted among FB A-P and MB M-B groups ($p>0,99$). Bonferroni correction has been
153 applied due to the comparison among the three groups. Data are summarized in Table 3.

154 Failure rates analysis by mean follow-up

155 Twelve of the 21 studies had a mean follow-up between 3 and 5 years [24–26,29–
156 32,35,36,38,41,43], six had a mean follow-up between 5 and 10 years[23,27,33,34,40,42] and three
157 had a follow-up longer than 10 years [28,37,39]. The shortest follow-up group showed a failure rate
158 of 3,9% (95% C.I. 1,6%-6,3%) with an $I^2=87\%$; therefore random effect was applied. The 5-to-10
159 years follow-up group showed a failure rate of 7,0% (95% C.I. 2,6%-11,4%) with an $I^2=82\%$;
160 therefore random effect was applied. Lastly, the longest follow-up group showed a failure rate of
161 8,9% (95% C.I. 0%-18,7%) with an $I^2=83\%$, and again random effect was applied. Data are
162 summarized in Table 4 and Figure 4.

163 Meta-analysis evaluation did now show any statistically significant difference among groups. Data
164 are shown in Table 5.

165 Reoperation and Failure

166 Reoperation and failure results were reported in all the studies included in the present analysis. Data
167 is summarized in Appendix.

168 **Discussion**

169 The most important finding of the present meta-analysis was that the failure rate of Metal-Backed
170 Fixed Bearing lateral unicompartmental arthroplasty was significantly lower compared to other
171 lateral unicompartmental knee arthroplasty designs present on the market (0,8% vs 8,6% and 7,1%
172 for FB M-B, FB A-P and MB M-B respectively).

173 A recent systematic review and meta-analysis evaluating mobile vs fixed bearing UKAs found
174 better survival rates for fixed bearing implants. The mobile bearing implants showed an
175 approximately four times higher risk of revision than fixed bearing designs when used for lateral
176 UKA.[44]

177 Burger et al. found similar observations in their work and stated that revision risk is lower with FB
178 implants than MB ones in lateral UKAs. According to them the annual revision rate was 2.16 (95%
179 CI 1,54-3,04), 1.81 (95% CI 0,98-3,34) and 0.94 (95% CI 0,66-1,33) for MB, domed MB and FB
180 designs respectively.[45] A study from Dutch arthroplasty registry data also reported similar results
181 where the use of Mobile Bearing lateral UKA was associated with increased revision rate.[46]

182 The lateral knee compartment shows a different behavior with regard to the medial side. During
183 knee flexion, while the medial condyle remains relatively static on the anteroposterior (AP) plane
184 with approximatively 1,5mm of translation, the lateral side presents an inherent instability and has a
185 greater degree of freedom with an AP translation from 9 to 15mm.[47,48]

186 The less constrain on the lateral knee condyle increases the underlying risk of bearing dislocation
187 for MB implants. A fixed bearing construct reduces the system complexity and the bearing
188 instability, providing a simpler and stronger construct.

189 To decrease bearing dislocation incidences, domed mobile bearing tibial implants were introduced
190 in order to require more distractive force before the polyethylene insert dislocates. Those implants
191 have a convex tibial component augmented with biconcave bearings, compared to previous designs,
192 which featured a flat tibial component. Although by using domed implants the dislocation rate was
193 significantly decreased with respect to non-domed implants, it does not eliminate the chance of
194 bearing dislocation. Therefore, various modifications have been introduced to address this issue,
195 such as placing a screw in the intercondylar notch, even if further increasing the system
196 complexity.[25,30,49]

197 When analyzing failures based on the type of implant used, it can be found that bearing dislocation
198 is the main responsible for failure when mobile bearing implants are used, whereas osteoarthritis
199 progression is responsible for most failures in fixed bearing implants. Polyethylene wear is not the
200 main determinant for survivorship, presumably thanks to improvement in polyethylene
201 manufacturing, processing, design, sterilization, and storage which significantly improved over the
202 last few years. [16,50]

203 When evaluating Metal-Backed and All-Polyethylene designs, a very scarce bibliography can be
204 found on lateral UKAs. Studies based on medial UKAs show superiority of Metal-Backed tibial
205 implants over All-Polyethylene designs.[51,52] It has to be noted, however, that the biomechanics
206 of the medial side, as previously discussed, is different with regard to the lateral side, and those
207 benefits may or may be not noted in lateral UKAs.

208 Based on the few studies on Metal-Backed *vs* All-Polyethylene lateral UKAs, no significant
209 differences has been noted [23,53,54], while an increased risk of bearing dislocation has been
210 described. Another study by Gunther et al. using Mobile Bearing lateral UKAs showed a 10% rate
211 of inlay dislocations.[55] This effect is most likely due to greater AP translation of the lateral side
212 during knee flexion.[56] While this behavior can be cause for concerns, it has not been noted in
213 more recent studies included in this analysis. [35]

214 The present study has some limitations. Studies available in literature are often of poor quality, with
215 few patients and incomplete data. However, a complete literature search has been performed with
216 the aim of providing a complete analysis.

217 Lateral UKAs are less implanted than medial UKAs and have strict indications, despite comparable
218 survivorships being shown at short, medium and long follow-up. [57] The surgeon experience and
219 the number of lateral UKA performed play an essential role in outcomes and failures. For this
220 reason, the same studies have been evaluated with regard to follow-up time as well, mixing all the
221 designs together for assessing a potential confounding factor. No significative differences have been
222 noted when evaluating failure rates by follow-up, confirming that the simpler implant design
223 provides the lowest failure rates.

224 As things stand today, for a surgeon approaching lateral UKA, Fixed Bearing Metal-Backed design
225 is preferable, given the lower failure rates and subsequently longer implant survivorship.

226 **Conclusion**

227 Considering actual evidence, for a surgeon approaching lateral UKA, the Fixed Bearing Metal-
228 Backed design is preferable, given the lower failure rates and subsequently longer implant
229 survivorship.

230

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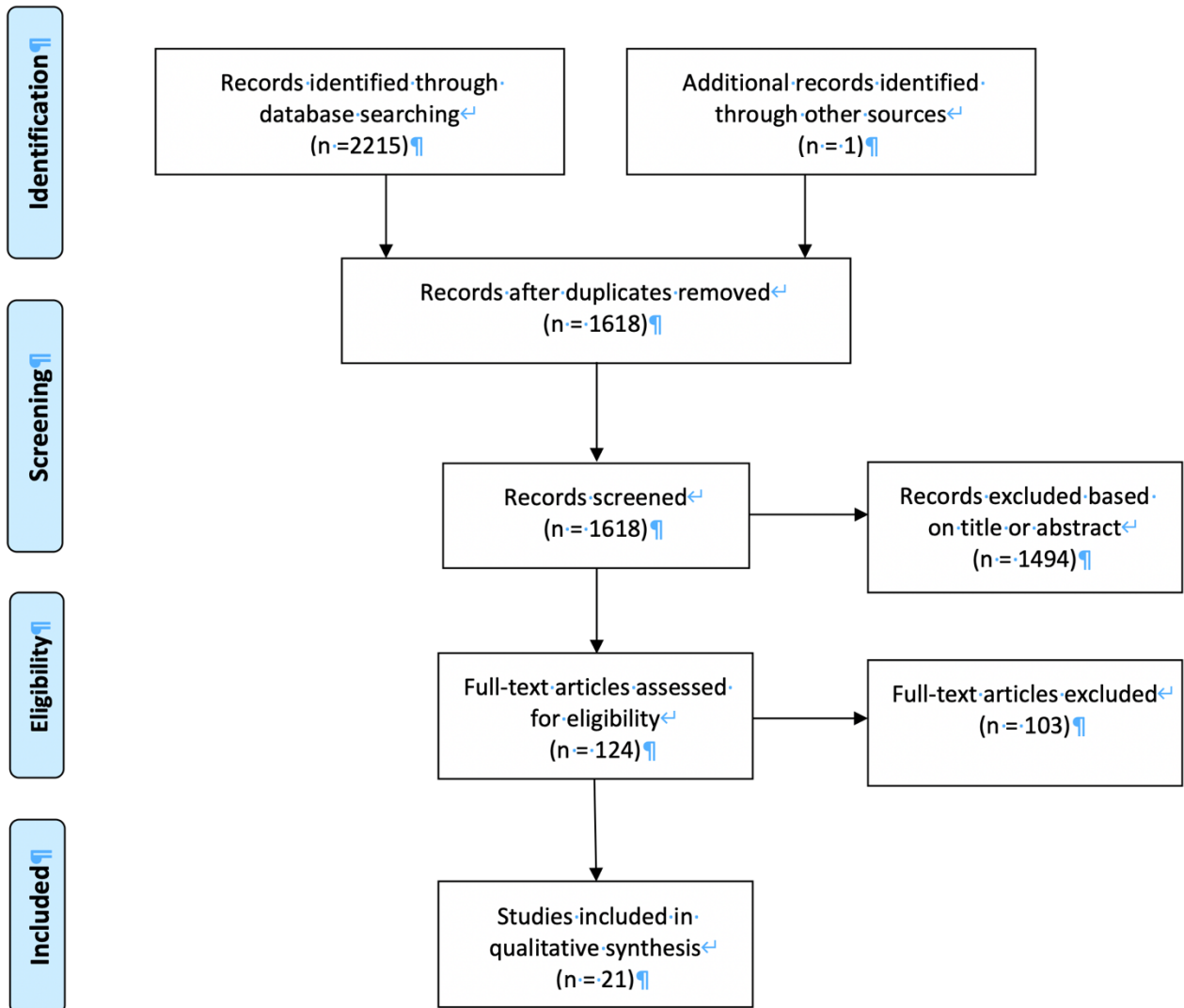
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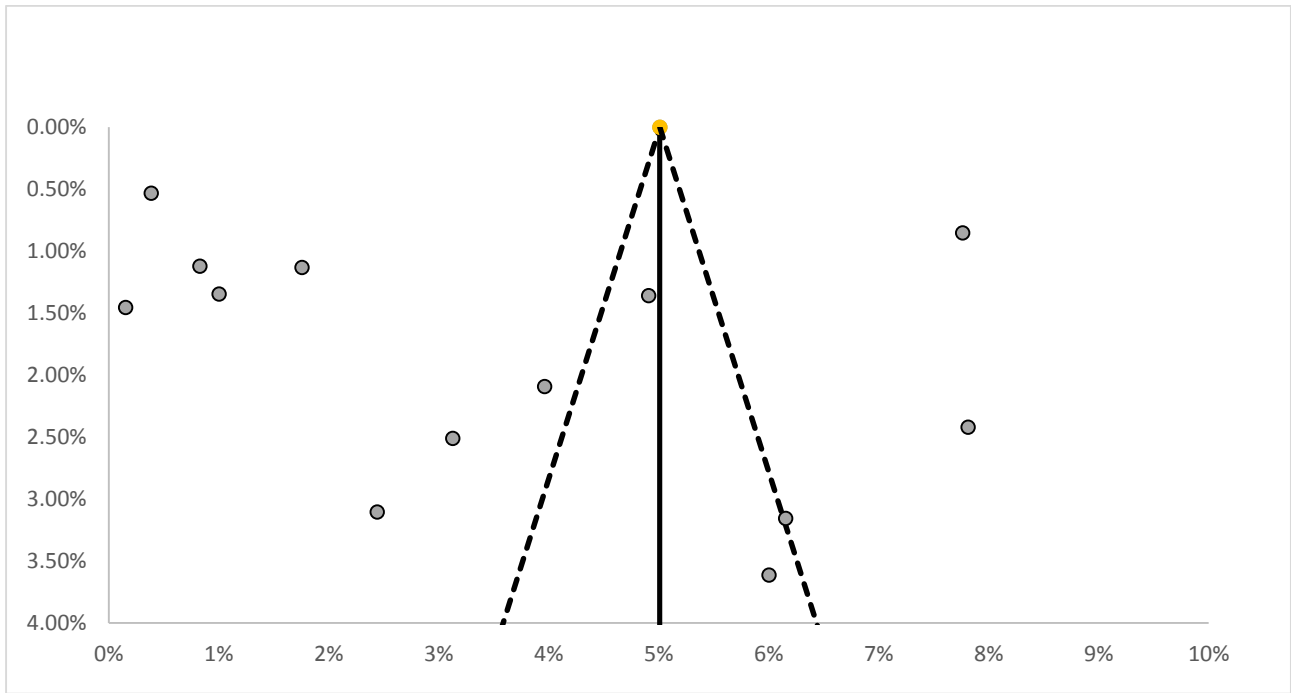
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409



412 **Fig.1** Overview of screening and selection process for the systematic review.



413

414 **Fig. 2** Funnel plot assessing potential publication bias from failure rates. Thirteen studies were analyzed, the abscissa
 415 axis showed the failure rates, and the vertical axis showed the standard error.

416

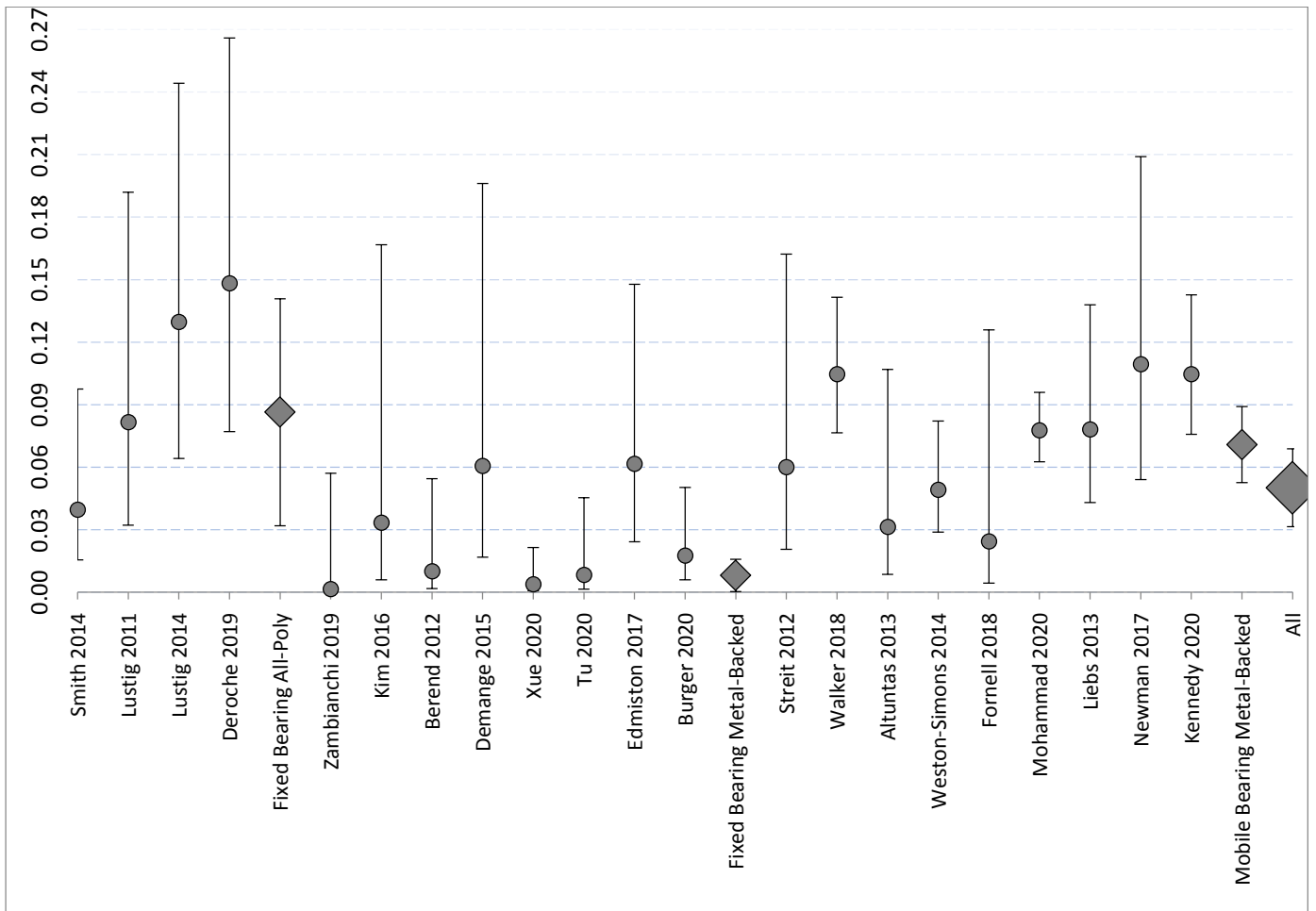
Author	Year	LOE	Type of Study	No. Of Patients (Knees)	Age, Mean \pm SD (Range), y	Male Sex, n (%)	Type of Implant	Implant	Follow-up, Mean \pm SD (Range), y	Quality score (mCS)
Burger et al.	2020	IV	Retrospective	NA (171)	64.4 \pm 11 (NA)	69 (40.4)	FB M-B	Stryker Restoris MCK	4.3 \pm 1.7 (NA)	65
Kennedy et al.	2020	II	Prospective	300 (325)	64.9 \pm 11 (39-90)	96 (37)	MB M-B	Zimmer Biomet Oxford Doomed Lateral UKR	7 \pm 2,7 (3-14)	70
Mohammad et al.	2020	II	Retrospective	NA (992)	64.5 \pm 12,5 (NA)	351 (35.4)	MB M-B	Zimmer Biomet Oxford Doomed Lateral UKR	5 \pm 3.0 (NA)	41
Tu et al.	2020	II	Prospective	121 (121)	70.2 \pm 8.8 (NA)	38 (31.4)	FB M-B	Waldemar Link Sled UKA	5.3 \pm 2.5 (2-12.4)	84
Xue et al.	2020	IV	Retrospective	248 (260)	70.6 \pm 8.5 (NA)	56 (28.3)	FB M-B	Waldemar Link Sled UKA	4.7 \pm 1.1 (NA)	61
Deroche et al.	2019	IV	Retrospective	52 (54)	65.4 \pm 11 (25-79)	6 (15.4)	FB A-P	NA, two different implants	17.9 \pm 2 (15-23)	66
Zambianchi et al.	2019	IV	Retrospective	66 (67)	62.1 \pm 9.5 (NA)	16 (24.2%)	FB M-B	Stryker Restoris MCK	3.0 \pm NA (NA)	51
Fornell et al.	2018	IV	Retrospective	41 (41)	63 \pm 10.8 (38-81)	10 (24.4)	MB M-B	Zimmer Biomet Oxford Doomed Lateral UKR	4.1 \pm 1.2 (2.1-7)	62
Walker et al.	2018	IV	Retrospective	327 (344)	65 \pm 13 (36-88)	90 (27.5)	MB M-B	Zimmer Biomet Oxford Doomed Lateral UKR	3.1 \pm 1.7 (1-7.8)	64
Edmiston et al.	2017	IV	Retrospective	65 (65)	61.3 \pm 11.2 (NA)	22 (34)	FB M-B	Zimmer Unicompartmental High Flex Knee, Zimmer Miller-Galante Unicompartmental Knee	6.6 \pm 3.1 (NA)	48
Newman et al.	2017	IV	Retrospective	58 (64)	71 \pm 12 (44-92)	17 (29.3)	MB M-B	Zimmer Biomet Oxford Doomed Lateral UKR	6.7 \pm 2.0 (2-9.9)	72
Kim et al.	2016	IV	Retrospective	27 (30)	63.3 \pm 8 (48-80)	15 (50)	FB M-B	Zimmer Unicompartmental High Flex Knee	3.2 \pm 0.5 (2-4)	61
Demange et al.	2015	IV	Retrospective	32 (33)	57.5 \pm 8.9 (36-88)	20 (39.2)	FB M-B	ConforMIS iUni G1 (1st gen) Zimmer Miller-Galante Unicompartmental Knee	4.7 \pm 1.2 (2-9.1)	66
Lustig et al.	2014	IV	Retrospective	52 (54)	72.2 \pm 15.2 (25-85)	7 (15.9)	FB A-P	Tornier HLS Uni Evolution	14.2 \pm 1.95 (10.2-18)	66
Smith et al.	2014	IV	Retrospective	100 (101)	64.8 \pm 13.8 (36-91)	32 (32)	FB A-P	Corin AMC Uniglide	5.0 \pm 0.0 (5-5)	82
Weston-Simons et al.	2014	II	Prospective	258 (265)	64 \pm 14.5 (32-90)	91 (35.3)	MB M-B	Zimmer Biomet Oxford Doomed Lateral UKR	4.0 \pm 2.2 (0.5-8.3)	72
Altuntas et al.	2013	IV	Retrospective	58 (64)	71 \pm 12 (44-92)	17 (29.3)	MB M-B	Zimmer Biomet Oxford Doomed Lateral UKR	3.2 \pm 0.8 (2-5.1)	59
Liebs et al.	2013	IV	Retrospective	128 (128)	73.6 \pm 11.8 (44-91)	NA (33)	MB M-B	DePuy Preservation UKA	6.0 \pm 1.9 (2.1-9.8)	75
Berend et al.	2012	IV	Retrospective	97 (100)	68.8 \pm 14 (NA)	38 (30)	FB M-B	Biomet Respicci II UKA Biomet Vanguard M UKA	3.3 \pm 1.2 (2-6.8)	59
Streit et al.	2012	II	Prospective	50 (50)	60 \pm 11.3 (36-81)	20 (40)	MB M-B	Zimmer Biomet Oxford Doomed Lateral UKR	3 \pm 0.6 (2-4.3)	71
Lustig et al.	2011	IV	Retrospective	47 (49)	72.2 \pm 3 (25-88)	8 (17)	FB A-P	Tornier HLS Uni Evolution	8.4 \pm 2.6 (5.3-15.8)	60

417 **Tab. 1** Study characteristics and patients demographics. FB, Fixed Bearing; MB, Mobile Bearing; A-P, All Polyethylene; M-B, Metal Backed; NA, Non Available

	Failure Rate	95% CI Lower Limit	95%CI Upper Limit
FB A-P	8,6%	3,2%	14,1%
FB M-B	0,8%	0,0%	1,6%
MB M-B	7,1%	5,3%	8,9%
All	5,0%	3,1%	6,9%

418 **Tab. 2** Failure rates by implant design

419



420

421 **Fig. 3** Results of aggregate analysis for comparison of failure rates between patients with FB A-P, FB M-B and MB M-
 422 B implants. Y-axis shows failure rate, X-axis shows examined studies.

423

424

Implant design (comparison)	Mean Failure Rate	95% CI Lower Limit	95% CI Upper Limit	p-value
FB A-P	9%	3%	14%	0,024
FB F-B	1%	0%	2%	
FB A-P	9%	3%	14%	>0,999
MB M-B	7%	5%	9%	
FB M-B	1%	0%	2%	0,000
MB M-B	7%	5%	9%	

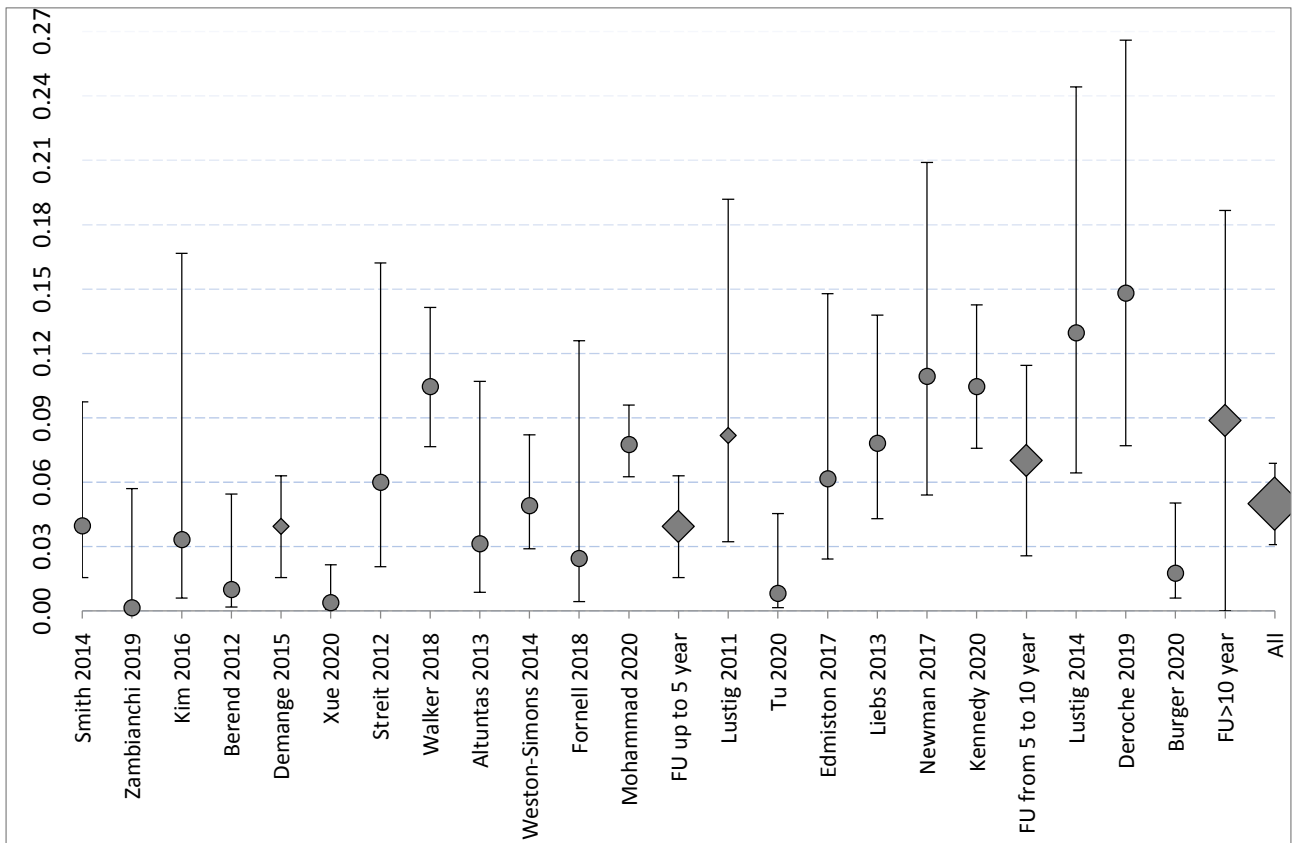
425 **Tab. 3** Comparison of failure rates among groups by implant designs.

426

	Failure Rate	95% CI Lower Limit	95%CI Upper Limit
FU < 5y	3,9%	1,6%	6,3%
5y <FU < 10y	7,0%	2,6%	11,4%
FU > 10y	8,9%	0,0%	18,7%
All	5,0%	3,1%	6,9%

427 **Tab. 4** Failure rates by follow-up time

428



429

430 **Fig. 4** Results of aggregate analysis for comparison of failure rates between patients with a follow-up less than 5 years,
 431 between 5 and 10 years, and more than 10 years. Y-axis shows failure rate, X-axis shows examined studies.

432

Follow-up (comparison)	Mean Failure Rate	95% CI Lower Limit	95% CI Upper Limit	p-value
FU < 5y	4%	2%	6%	0,582
5y <FU < 10y	7%	3%	11%	
FU < 5y	4%	2%	6%	0,754
FU > 10y	9%	0%	19%	
5y <FU < 10y	7%	3%	11%	>0,999
FU > 10y	9%	0%	19%	

433 **Tab. 5** Comparison of failure rates among groups by follow-up time.

Author	Reoperations	Failure, n (%)	Survivorship
Lustig 2011	4 cases were revised 1 TKA	NA	98.08% at 10 years; end-point removal of the prosthesis
Berend 2012	3 revisions for UKA in the medial compartment 3 patients had reoperations 1 ORIF for fracture 1 arthroscopy for a medial meniscal tear	NA	NA
Streit 2012	1TKA revision for pain 3 patients had revision 2 TKA due to dislocation 1 TKA due to MRSA infection	3 cases (6.2%) Dislocation at 3 years.	94% at 3 years, end-point revision for any reason
Altuntas 2013	4 patients had reoperation 2 had re-operations unrelated to the implant 2 required revision of prosthesis [Instability (1); Medial OA (1)]	3.1% failure rate of prosthesis no case of bearing dislocation	97% at 38 months; end point revision of implant
Liebs 2013	14 patient had revision 6 Aseptic loosening 2 Medial OA 2 Fracture 1 Patellofemoral pain 1 Internal fixation with screws, no change of implant components 1 Impingement 1 Arthroscopy, without change of components	NA	83% at 9 years; end-point prosthesis survival
Lustig 2014	7 patient had undergone a second operation 3 were revised to TKA 3 had medial UKAs for medial OA 1 TKA for tibial tray malpositioning	NA	91.4% at 15 years ,end-point removal of the prosthesis
Smith 2014	4 knees had revision 1 Medial OA 1 Tibial loosening 1 Infection 1 Unknown	NA	95.5% at 5 year; end-point removal of the prosthesis
Weston-Simons 2014	13 knees (4.9%) had re-operations 4 dislocation 3 Medial OA 3 Infection 3 Ongoing pain	NA	92.1% at 8 years; end point any revision
Demange 2015	In custom implant group 2 revision 1 infection so two-stage re-implantation with custom implant 1 prosthesis failure so TKA In the standard implant group, 3 implants failed 1 Infection 2 progression of disease	NA	97% at average 37 months, in custom implant group 85% at an average of 33 months in the standard implant group
Kim 2016	Revision to TKA in 1 case due to ongoing pain	3.3 % failure rate of prosthesis	96.7% at 38 months, end point removal of prosthesis
Edmiston 2017	4 patient had revision surgery 1 ongoing pain 1 posttraumatic wound dehiscence 1 medial OA 1 patellofemoral arthritis	5% failure in in lateral approach 7% failure in medial approach	94% at a mean of 82 months; end point revision surgery
Newman 2017	2 patient revised into TKA (1 Medial OA, 1 ongoing pain) 6 patient had further surgery without prosthesis removal 1 exchange of bearing due to instability 1 arthroscopic lavage for haematoma 1 ACL reconstruction with bearing exchange 2 medial UKRs for medial OA 1 exchange of bearing due to instability	7% knee revised 13% was reoperation rate	87% at 80.6 months; end point re-operation
Fornell 2018	1 patient revised to TKA due to ongoing pain 1 arthroscopic reduction of dislocation	2.4% revision 2.4% dislocation	97.5% at 5 years; endpoint revision for any reason
Walker 2018	36 knees had revision surgery (in 6 patient more than 1 procedure) 3 infection 20 dislocation (19 revised while 1 had spontaneous repositioning) 18 patients revised into TKA (5 dislocation, 6 medial OA, 3 instability, 3 ongoing pain, 1 femoral component loosening)	10.5 % revision 8.5 % dislocation	85.0% at 5 years; end point revision surgery
Deroche 2019	8 knees had revision 3 medial uka for medial OA 4 TKA for medial and symptomatic patellofemoral OA	20.5 % revision	82.1% at 15 years and 79.4% at 20 years end point prosthesis removal and/or a second UKA for OA
Burger 2020	1TKA for aseptic loosening of the tibial component 3 revision to TKA 1 infection 1 Aseptic loosening 1 ongoing pain	NA	97.7% at 5 Year; end point revision surgery
Zambianchi 2019	Arthroscopy performed in 2 cases 1 for medial meniscus tear 1 for synovitis in medial compartment Radiological outcome was not reported	No revisions	100% at 3 years; revision as the endpoint 96.9% (CI 88.0–99.2%) at 3 years; reoperation as the endpoint
Kennedy 2020	7 bearing exchange alone 7 bearing exchange with screw augmentation	34 (10%) revisions 14 knees bearing dislocation	92.1% at 5 year; end-point revision for any reason 84.6% at 10 years, end-point revision for any reason

	<ul style="list-style-type: none"> 1 bearing exchange with debridement 1 bearing exchange with exploration for pain 1 bearing exchange with femoral component revision 11 single-stage TKA 5 addition of medial uKa 1 conversion to a fixed bearing tibial component 1 two-stage TKA Radiological outcome was not reported 	<ul style="list-style-type: none"> 12 knees progression of osteoarthritis 1 aseptic femoral loosening 1 deep infection 2 recurrent haemarthrosis 1 unrelated patellar fracture 3 bearing exchanged 	
Mohammad 2020	NA	77 knees (7.8%) revision surgery	92.4% (CI: 90.3-94.1) at 5 year; endpoint any revision surgery 88.6% (CI: 85.3-91.2) at 10 year; endpoint any revision surgery
	Radiological outcome was not reported	23 Dislocation subluxation revision	96.0% (CI: 91.4-98.2) at 5 year for normal weight
		15 Pain	92.3% (CI: 88.3-95.0) at 5 year for overweight
		14 Aseptic loosening	89.7% (CI: 84.8-93.1) at 5 year for obese
		12 OA progression	
		6 Component dissociation	86.0% (CI: 80.2-90.3) at 5 year for <55 year
		6 Infection	92.9% (CI: 88.4-95.7) at 5 year for 55-64 years
		3 Instability	94.9% (CI: 91.3-97.1) at 5 year for 65-74 year
		1 Periprosthetic fracture	95.6% (CI: 91.1-97.8) at 5 year for 75 and more
		1 Lysis	
		1 Wear	
		1 Stiffness	
		14 others	
Tu 2020	1 medial UKA for medial OA	NA	99.2%, at 5 years; revision for any reason as the end point
Xue 2020	1 medial UKA for medial OA	NA	99.5% at 5 years; endpoint revision of prosthesis

Reoperations and failures overview