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1 **New surgical instrumentation reduces the revision rate of**  
2 **Unicompartmental Knee Replacement: A propensity score**  
3 **matched comparison of 15,906 knees from the National Joint**  
4 **Registry**

5

6 Hasan R Mohammad, Gulraj S Matharu, Andrew Judge, David W Murray

7

8 **Qualifications, appointments and roles of the authors**

9 <sup>1,2</sup> Mr Hasan R Mohammad - MBChB, MRCS, MRes (Dist). Clinical Research Fellow in  
10 Orthopaedics.

11 <sup>1,2</sup> Mr Gulraj S Matharu – BSc (Hons), MRCS, MRes, DPhil. Clinical Lecturer in Trauma  
12 and Orthopaedic Surgery.

13 <sup>1,2</sup> Professor Andrew Judge – BSc, MSc, PhD. Professor of Translational Statistics.

14 <sup>1</sup> Professor David W Murray – MD, FRCS. Consultant Orthopaedic Surgeon and Professor of  
15 Orthopaedic Surgery.

16

17

18 **Institutional address**

19 1. Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences  
20 University of Oxford, Nuffield Orthopaedic Centre, Oxford, OX3 7LD, United Kingdom

21 2. Musculoskeletal Research Unit, Bristol Medical School, University of Bristol, Level 1  
22 Learning and Research Building, Southmead Hospital, Westbury-on-Trym, Bristol, BS10  
23 5NB, United Kingdom.

24

25 **Corresponding author:**

26 Name: Mr Hasan Raza Mohammad

27 Email: [hasanmohammad@doctors.org.uk](mailto:hasanmohammad@doctors.org.uk)

28 Tel: +44 (0) 7841 873 244

29 Corresponding Author Address: The Botnar Research Centre, Old Road, Oxford, OX3 7LD.

30 **Word count (including abstract): 2836 words**

31 **ABSTRACT**

32 **Background:** Unicompartmental knee replacement (UKR) offers advantages over total knee  
33 replacement but has higher revision rates. New instrumentation known as Microplasty was  
34 introduced to address this. The aim was to compare the revision rates of UKRs implanted  
35 with Microplasty and traditional instrumentation (Non-Microplasty).

36  
37 **Methods:** National Joint Registry (NJR) data was used to propensity score match 15,906  
38 UKRs (7,953 Microplasty and 7,953 Non-Microplasty) for important patient, implant and  
39 surgical factors. Implant survival rates were determined using the Kaplan-Meier method and  
40 compared using Cox regression models in a multilevel model.

41  
42 **Results:** The 5 year implant survival for Microplasty and Non-Microplasty UKRs were  
43 96.7% (95% CI 96.0%-97.2%) and 94.5% (CI 93.8-95.1%) respectively. The revision rate for  
44 Microplasty UKR was significantly lower than that of Non-Microplasty UKRs (Hazard ratio  
45 (HR)=0.77, p=0.008). Compared with Non-Microplasty UKRs, the revision rate of  
46 Microplasty UKRs implanted during the year after introduction of Microplasty was lower but  
47 the difference was not significant (HR 0.86, CI 0.67-1.10, p=0.23), whereas for those  
48 implanted more than a year after introduction the difference was significant (HR 0.69, CI  
49 0.54-0.89, p=0.004).

50  
51 **Conclusion:** The use of Microplasty instrumentation has resulted in an improved 5 year UKR  
52 survival. Microplasty UKR implanted during the first year after introduction had a small,  
53 non-significant decrease in revision rate. As the revision rate did not increase this suggests  
54 that there is no adverse learning curve effect. Microplasty UKRs implanted after this  
55 transition period had a revision rate 31% lower than the Non-Microplasty group.

56  
57 Level of evidence: II

58 Key words: Microplasty, Non Microplasty, Unicompartmental Knee Arthroplasty

59 Abstract word count: 245 words

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## 65 1. INTRODUCTION

66

67 Total and Unicompartmental knee replacement (TKR, UKR) are the two main treatments for  
68 knee osteoarthritis which has failed to respond to conservative therapy, with evidence that  
69 UKR is appropriate in up to 50% of cases [1]. Although UKR is more cost effective [2] and  
70 results in better functional outcomes [3], revision rates remain significantly higher in joint  
71 registries [4-6]. This is not the case in specialist centres with high volume surgeons who  
72 achieve similar revision rates to TKR [7-9].

73

74 The high revision rate of UKR may, in part, be a result of poor positioning of the implant or  
75 other technical problems with the operation, which is made particularly difficult with  
76 minimally invasive approaches where intra-operative visualisation is restricted [10, 11]. This  
77 is relevant given the most commonly used UKR is the Phase 3 Oxford UKR [4], which is  
78 implanted using a minimally invasive approach. Phase 3 instrumentation, which was  
79 introduced over 20 years ago, is difficult to use: For example the operating surgeon has to  
80 judge by eye the height of the tibial cut and the orientation of the femoral component, making  
81 inexperienced surgeons susceptible to errors.

82

83 New instrumentation known as Microplasty was introduced to make the operation simpler,  
84 more reproducible and more reliable. The use of Microplasty instrumentation has been  
85 steadily increasing. The instrumentation includes a stylus system for selecting tibial resection  
86 level, a femoral drill guide linked to an intramedullary rod to help femoral component  
87 positioning, slotted saw guides and instruments to protect the medial collateral ligament and  
88 avoid impingement [12] (Figure 1). Although the Microplasty instrumentation has been  
89 shown to improve implant positioning [13-16] it is currently unknown whether it makes any  
90 difference to the revision rate. Additionally, as Microplasty instrumentation is more complex  
91 than the Phase 3 instrumentation (Non-Microplasty), there is a concern that the outcome  
92 might be worse when it is first used due to learning curve issues.

93

94 The National Joint Registry for England, Wales, Northern Ireland and Isle of Man (NJR) is  
95 the world's largest arthroplasty register [4]. NJR data was utilised to compare the revision  
96 rates following Microplasty and Non-Microplasty Oxford UKRs. The null hypothesis was  
97 that there would be no difference in UKR implant survival between groups. To ensure that  
98 any difference in implant performance was due to the instrumentation rather than other

99 factors, Microplasty and Non-Microplasty cases were matched on patient, surgeon (including  
100 caseload) and implant factors.

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## 133 2. MATERIALS AND METHODS

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135 A retrospective observational study was performed using NJR data [4]. The NJR database  
136 includes information on patient factors (including age, sex, body mass index), implant factors  
137 (including component design and size) and surgical factors (surgical indication, operating  
138 surgeon grade) for each procedure. The database is linked to mortality data from the Office of  
139 National Statistics.

140

141 The dates at which Microplasty Instrumentation was introduced to each UK hospital  
142 (changeover date) were obtained and supplied to the NJR. Prior to this date, or if there was no  
143 date, the hospital was assumed to be using the Non-Microplasty instrumentation. After this  
144 date it was assumed they were using Microplasty Instrumentation. During the first year after  
145 the changeover date it was assumed that there was a transition period which included the  
146 surgeon's learning curve and the changeover between systems. In Oxford, prototype  
147 Microplasty instruments have been used for many years and there was no exact date of their  
148 changeover to Microplasty, so all UKRs conducted in Oxford were excluded from this study.

149

150 Anonymised patient data were extracted from the NJR database which included all primary  
151 Oxford UKRs implanted between 1<sup>st</sup> January 2012 to 31<sup>st</sup> December 2017 (n=28,273), given  
152 Microplasty was first used outside Oxford in 2012. The NJR linked the changeover date to  
153 Microplasty to the patient data. After data cleaning there were 23,234 medial UKRs (11,024  
154 Microplasty and 12,210 Non Microplasty UKRs) eligible for study inclusion (Figure 2).

155

156 Given the potential for patient, implant and surgical factors [17-31] other than  
157 instrumentation to affect the revision rate, *a priori* matching for these factors between groups  
158 was conducted using propensity scores (Table 1 for full list). Surgical factors included  
159 surgeon caseload, which was defined as the average number of UKRs done per year and  
160 stratified into low (<10 cases/yr), medium (10 to <30 cases/yr) and high volume ( $\geq 30$   
161 cases/yr) as described previously [26].

162

163 A multilevel logistic regression model was used to generate a propensity score representing  
164 the probability that a patient received a Microplasty assisted UKR. This approach controlled  
165 for clustering at the hospital level. The specific variables patients were matched on were; age,  
166 gender, primary diagnosis, unilateral/bilateral UKRs, ASA grade, chemical

167 thromboprophylaxis, mechanical thrombopropylaxis, operating surgeon grade, surgeon  
168 caseload, surgical approach, operating technique and implant fixation (Table 1). Body mass  
169 index (BMI) was not used for matching given it had a large proportion of missing data, but  
170 was similar between groups both before and after matching.

171

172 One to one matching on the logit of the propensity score with a 0.02-SD calliper width was  
173 utilised. Greedy matching without replacement was used given its superior performance for  
174 estimating treatment effects [32]. Standardized mean differences (SMDs) were examined  
175 both before and after matching to assess for any covariate imbalance between the Microplasty  
176 and Non Microplasty UKRs, with SMDs of 10% or more considered suggestive of covariate  
177 imbalance [32]. After matching, 15,906 UKRs (7,953 Microplasty and 7,953 Non  
178 Microplasty UKRs) were included for analysis (Figure 2). Microplasty UKRs were divided  
179 into procedures conducted within the first year after Microplasty's introduction and after the  
180 first year to explore the learning curve effect.

181

## 182 **2.1 Statistical analysis**

183

184 Outcomes of interest were: (1) implant survival and revision rates (2) indications for revision  
185 surgery.

186

187 Cumulative implant survival was determined using the Kaplan-Meier method. The endpoint  
188 for implant survival was revision surgery (any component removed, exchanged or added).  
189 Cumulative implant revision rates were compared between groups, using Cox regression  
190 models. To account for clustering within the matched cohort a robust variance estimator was  
191 used in regression models. Univariable and adjusted models were also assessed. The adjusted  
192 models included covariates with residual imbalance after matching (SMD of 10% or more)  
193 [32].

194

195 A secondary analysis was undertaken based on the revision rate per 100 component years.  
196 This was calculated for both groups by dividing the number of revisions by the total number  
197 of observed component years (mean follow up multiplied by number of knees) as per the  
198 Australian Joint Registry [5]. 95% CI were calculated using the Clopper Pearson exact  
199 method. Revision rates between groups were compared using the chi squared proportional  
200 test.

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To compare the indications for revision surgery the revision rates per 100 component years for each revision indication were calculated. The proportional Chi-squared test with Yate's correction was used to test for differences between Microplasty and Non-Microplasty except when the observed frequencies were below 5 in which case the Fisher Exact Test was utilised.

All statistical analyses were performed using Stata (Version 15.1; Lakeway Drive TX) except propensity score matching which was performed using R (Version 3.4.0; R Foundation for Statistical Computing, Vienna, Austria). P-values of <0.05 were considered significant, with 95% confidence intervals (CI) presented.

## **2.2 Ethics approval and consent to participate**

The study was approved by the NJR Research Sub-Committee (RSC2017/17). As patients provide informed consent for inclusion of their data in the NJR for purposes including research, institutional review board approval was not required.



### 234 3. RESULTS

235

236 The matched cohort included 15,906 UKRs with 7,953 Microplasty UKRs and 7,953 Non-  
237 Microplasty UKRs. The mean age at surgery was 64.5 years (SD 9.5), with 7,235 females  
238 (45.5%) and 8,671 males (54.5%). The mean BMI was 30.4 kg/m<sup>2</sup> (SD 5.0) with the primary  
239 indication for surgery being osteoarthritis in 15,752 knees (99.0%).

240

241 Patient, surgical (including caseload) and implant characteristics were well balanced between  
242 the Microplasty and Non Microplasty groups after propensity score matching (Table 1). The  
243 only covariates with some residual imbalance were surgeon grade and surgeon caseload, which,  
244 when adjusted for in the regression models, did not change the findings.

245

246 In the matched cohort, the mean follow up for Microplasty and Non Microplasty UKRs were  
247 2.3 years (SD 1.3) and 3.3 years (SD 1.8) respectively. In total 451 knees underwent revision  
248 surgery. There were 160 (2.0%) revisions in the Microplasty group and 291 (3.7%) revisions  
249 in the Non Microplasty UKR group.

250

251 The 5-year cumulative implant survival rates were 96.7% (95% CI 96.0%-97.2%) for  
252 Microplasty and 94.5% (95% CI 93.8-95.1%) for Non-Microplasty UKRs (Figure 3).  
253 Microplasty UKRs had a significantly reduced revision rate compared with Non-Microplasty  
254 UKRs (HR=0.77, CI 0.64-0.94; p=0.008).

255

256 Subgroup analysis of Microplasty UKR inserted within a year of its introduction (n=2,424)  
257 and those inserted more than a year after its introduction (n=5,529) had 4 year implant  
258 survival rates of 96.2% (CI 95.3-97.0) and 96.8% (CI 95.6-97.8) respectively (Figure 4).  
259 Microplasty UKRs inserted within one year of its introduction had non-significantly reduced  
260 revision rates when compared to Non-Microplasty UKRs (HR 0.86, CI 0.67-1.10, p=0.23).  
261 Microplasty UKRs inserted more than a year after its introduction had significantly reduced  
262 revision rates compared to Non-Microplasty (HR 0.69, CI 0.54-0.89, p=0.004).

263

264 The revisions per 100 component years for Microplasty UKR (0.87, CI 0.75-1.02) were  
265 significantly lower (p=0.02) than for Non Microplasty (1.11, CI 0.99-1.24). Microplasty  
266 inserted within a year of its introduction (n=2,424) and those inserted more than a year and  
267 after its introduction (n=5,529) had revision rates per 100 component years of 0.98 (CI 0.78-

268 1.22) and 0.79 (CI 0.63-0.99) respectively. When compared to the Non-Microplasty group,  
269 the decrease in revision rates of Microplasty inserted within a year of its introduction was not  
270 significant (0.98 v 1.11, p=0.34). Microplasty inserted more than a year after its introduction  
271 had significantly lower (0.79 v 1.11, p=0.008) revision rates than Non-Microplasty.

272

273 The indications for revision with the highest revision rates per 100 component years in Non-  
274 Microplasty UKRs were osteoarthritis progression (0.31), aseptic loosening (0.26) and pain  
275 (0.19) (Table 2). In Microplasty UKRs the highest revision rates per 100 component years  
276 were osteoarthritis progression (0.21), aseptic loosening (0.19) and pain (0.12) (Table 2).  
277 Microplasty UKRs had a significantly reduced revision risk per 100 component years  
278 compared to Non-Microplasty UKRs for indications; osteoarthritis progression (p<0.05, 0.21  
279 vs 0.31) and “other reasons” (p=0.003, 0.08 vs 0.18). Microplasty assisted UKRs had a  
280 significantly increased risk of periprosthetic fracture (p=0.03, 0.09 vs 0.04). No other revision  
281 indications differed significantly between groups.

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#### 302 4. DISCUSSION

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304 This study demonstrates that Microplasty instrumentation improves the 5 year implant survival  
305 of the Oxford UKR compared to the Non-Microplasty instrumentation and decreases the  
306 overall revision rate by 23%. Although previous studies have demonstrated that Microplasty  
307 usage results in improvement in various surrogate measures such as implant positioning [13,  
308 14, 16], the need for tibial recuts [15] and tibial bone preservation [16], this is the first study  
309 which has investigated its effect on implant survival.

310

311 We found different effects on revision rate with time from Microplasty introduction.  
312 Microplasty UKRs inserted less than a year after its introduction to a hospital decreased the  
313 revision rate compared to Non Microplasty UKRs by 14%. However the difference was not  
314 statistically significant, partly because the numbers of cases was relatively small, so we do not  
315 know if there was a decrease in revision rate or not. In contrast Microplasty UKRs inserted  
316 more than a year after its introduction had a 31% reduction in revision rates compared to Non-  
317 Microplasty UKRs, which was highly statistically significant. The smaller decrease in revision  
318 rate during the first year after introduction is likely to be due, in part, to a delay in surgeons  
319 within a hospital changing to use Microplasty after the instruments had been supplied, as in  
320 many hospitals second and third Microplasty sets were introduced sometime after the first set.  
321 It may also, in part, be due to the learning curve. However as Microplasty, in the early period,  
322 did not increase the risk of revision relative to Non Microplasty the learning curve, if present,  
323 was not adverse as it was not associated with a temporary increase in implant failure rate.  
324 Furthermore the decrease in revision rate by one third (31%) seen later is likely to represent  
325 the true advantage of Microplasty.

326

327 It is difficult to interpret the analysis of the causes for revision primarily because the average  
328 follow-up of the Microplasty (2.3 years) and Non-Microplasty (3.3 years) UKR were different.  
329 A direct comparison of revision rates would be inappropriate because the numbers of revisions  
330 are related to the length of follow-up. The optimal method of comparison would be Kaplan  
331 Meier survival with Cox regression models, which we used for primary analysis of overall  
332 revision rate, as this is designed for the analysis of data from patients with different lengths of  
333 follow-up. However, as the number of revisions in each subgroup is low, this method is not  
334 appropriate. Another widely used approach is to use the revision rate per 100 component years,  
335 which is what we have used. However it is based on the assumption that the annual revision

336 rate is constant. This a reasonable assumption for the overall revision rate and the conclusions  
337 of the analysis over the overall revision rate using revisions per 100 component years and  
338 survival and cox regression were identical. However although is a reasonable assumption for  
339 many individual modes of failure it may not be for all. For example peri-prosthetic fractures  
340 tend to occur early so the group with a shorter follow up would be expected to have a higher  
341 revision rate. This may explain why Microplasty has a peri-prosthetic fracture rate that is just  
342 significantly higher than that of Non-Microplasty. Conversely arthritis progression tends to  
343 occur late so the group with a longer follow up would be expected to have a higher revision  
344 rate. This may explain why Non-Microplasty has an arthritis progression rate that is just  
345 significantly higher than that of Microplasty. The only other significant difference relates to  
346 “other reasons” for revision, so we don’t know what these are. We therefore have to conclude  
347 that it is not clear why Microplasty has a lower revision rate but it is probably a result of the  
348 numerous improvements in the instruments.

349

350 With the Non-Microplasty instrumentation surgeons judged the position of the tibial  
351 component and the orientation of the femoral component by eye. Microplasty includes a stylus  
352 system for selecting tibial resection level and a guide to control femoral component orientation.  
353 It has other advantages including slotted saw guides and instruments to protect the medial  
354 collateral ligament and avoid impingement. In addition, as the instrumentation guides  
355 component positioning the surgeon can focus on what really matters, which is restoration of  
356 normal ligament balance, tension and function. If these are accurately restored normal knee  
357 kinematics and function will also be restored. Previous studies have shown that the use of  
358 Microplasty does result in improved component positioning, with better tibial bone  
359 preservation, thinner bearings and avoidance of tibial recuts [13, 14, 16]. It has also resulted in  
360 improved patient reported outcome measures [15]. Furthermore Microplasty has made the  
361 operation more simple, logical, reliable and repeatable [13, 14]. These improvements probably  
362 explain the overall decrease in revision rate: For example improved component position and  
363 the avoidance of impingement should decrease revisions for loosening, pain and dislocation;  
364 and protection of the medial collateral ligament should prevent overcorrection and lateral  
365 arthritis.

366

367 The main strength of the study is that it is large enough to study revision as it included over  
368 15,000 knees. The study is also unbiased as it was based on NJR data, and data from the  
369 designer surgeons centre was not included in the analysis. The study is also long enough to

370 report the 5 year revision rate and showed that it was appreciably less with Microplasty than  
371 Non-Microplasty Instrumentation. But perhaps more importantly the 97% five-year survival of  
372 Microplasty UKR was not substantially worse than that achieved by TKR in National Registers  
373 [4, 6]. So the Microplasty instrumentation has gone a long way to addressing the main  
374 disadvantage of UKR, which is that it has a higher revision rate than TKR.

375

376 The main limitation of the study is that the precise date when individual surgeons changed  
377 from Non-Microplasty to Microplasty instrumentation is not known and the length of the  
378 learning curve is not known. As a result it was assumed that surgeons started using  
379 Microplasty as soon as it was introduced to their centre and that the transition period, which  
380 included the learning curve, lasted one year. Furthermore it is a possibility that some cases  
381 were done using other instrumentation, such as Patient Specific Instrumentation. However if  
382 other instrumentation was used the numbers would have been too small to influence the  
383 results. Another limitation is that the study is based on registry data and the only outcome  
384 assessed is revision. Furthermore the reasons for revision in the NJR are those recorded at the  
385 time of surgery even if this subsequently changed due to histopathology and microbiology  
386 data. Registries can under-report revisions [33] although there is no reason to believe this  
387 would differ between the groups, and it is not possible to confirm causality in registry based  
388 studies. Another limitation is that, despite propensity matching there is potential for residual  
389 confounding. The groups were not perfectly matched given there was imbalance in the  
390 operating surgeon grade and surgeon caseload. However there were no differences in findings  
391 when we adjusted for these parameters in the regression models. There was a substantial  
392 proportion of BMI data missing so we did not match on BMI. However, the BMI distribution  
393 between groups were the same both before and after propensity matching. The only way to  
394 achieve complete balance with respect to both known and unknown confounders is with a  
395 randomised trial. However to compare revision rates and causes for revision would require  
396 large numbers which would make a randomised study impractical.

397

398

## 399 **5. CONCLUSIONS**

400

401 In conclusion, this propensity matched registry based study observed that the five year  
402 survival of Microplasty assisted Oxford UKRs was 97%, which was significantly better than  
403 that of Non-Microplasty UKRs. Furthermore there was no adverse learning curve effect.

404 After the one-year transition period, the revision rate following Microplasty UKRs was about  
405 one third less than following Non Microplasty UKRs.

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430 **6. LIST OF TABLES**

431

432 **Table 1. Patient and surgical factors before and after propensity score matching.**

433 Abbreviations: ASA (American Society of Anesthesiologist score), BMI (Body mass index),

434 OA (Osteoarthritis), SD (Standard deviation), SMD (Standardised mean difference), UKR

435 (Unicompartmental knee replacement) VTE (Venous thromboembolism).

	Unmatched cohort				Matched cohort			
	All UKRs (n=23,234)	Non Microplasty UKRs (n=12,210, 52.6%)	Microplasty assisted UKRs (n=11,024, 47.4%)	SMD	All UKRs (n=15,906, 100%)	Non Microplasty UKRs (n=7953, 50%)	Microplasty assisted UKRs (n=7953, 50%)	SMD
<b>Covariate</b>								
<b>Gender</b>								
Female	10,453 (45.0%)	5,484 (44.9%)	4,969 (45.1%)	0.003	7,235 (45.5%)	3623 (45.6%)	3612 (45.4%)	0.003
Male	12,781 (55.0%)	6,726 (55.1%)	6,055 (54.9%)		8671 (54.5%)	4330 (54.4%)	4341 (54.6%)	
<b>Age at surgery (yr)</b>								
Mean (SD)	64.5 (SD 9.4)	64.3 (SD 9.4)	64.8 (SD 9.3)	0.06	64.5 (SD 9.5)	64.6 (SD 9.5)	64.5 (SD 9.4)	0.007
<b>BMI (kg/m<sup>2</sup>)*</b>								
Mean (SD)	30.3 (SD 5, n=18,802)	30.1 (SD 4.9, n=9,245)	30.5 (SD 5.1, n=9,557)	0.08	30.4 (SD 5, n=12,965)	30.1 (SD 4.9, n=6134)	30.6 (SD 5.1, n=6831)	0.08
<b>Primary diagnosis</b>								
Primary OA	23,014 (99.1%)	12,092 (99%)	10,922 (99.1%)	0.004	15,752 (99.0%)	7,864 (98.9%)	6,888 (99.2%)	0.03
<i>Other</i>	220 (1%)	118 (1%)	102 (0.9%)		154 (1.0%)	89 (1.1%)	65 (0.8%)	
<b>Bilateral UKRs</b>	739 (3.2%)	435 (3.6%)	304 (2.8%)	0.05	484 (3.0%)	287 (3.6%)	197 (2.5%)	0.066
<b>ASA grade</b>								
1	4,380 (18.9%)	2395 (19.6%)	1985 (18.0%)	0.06	2,979 (18.7%)	1,575 (19.8%)	1,404 (17.7%)	0.05
2	16,857	8,833	8024		11,534	5,684	5840	

3 or above	(72.6%) 1,997 (8.6%)	(72.3%) 982 (8.0%)	(72.8%) 1015 (9.2%)		(72.5%) 1,393 (8.8%)	(71.5%) 694 (8.7%)	(73.6%) 699 (8.8%)	
<b>VTE chemical</b>	–							
LMWH (+/- other)	13,912 (59.9%)	7,910 (64.8%)	6,002 (54.4%)	0.26	10,305 (64.8%)	5,081 (63.9%)	5,224 (65.7%)	0.05
Aspirin only	1,343 (5.8%)	676 (5.6%)	664 (6%)		1,022 (6.4%)	556 (7.0%)	466 (5.9%)	
Other	7,455 (32.1%)	3,259 (26.7%)	4,196 (38.1%)		4,286 (27.0%)	2,160 (27.2%)	2,126 (26.7%)	
None	524 (2.3%)	362 (3.0%)	162 (1.5%)		293 (1.8%)	156 (2.0%)	137 (1.7%)	
<b>VTE mechanical</b>	–							
Any	22,973 (98.9%)	12,065 (98.8%)	10,908 (99.0%)	0.01	15,721 (98.8%)	7,883 (99.1%)	7,838 (98.6%)	0.05
None	261 (1.1%)	145 (1.2%)	116 (1.0%)		185 (1.2%)	70 (0.9%)	115 (1.5%)	
<b>Surgeon grade</b>								
Consultant	21,840 (94.0%)	11,768 (96.4%)	10,072 (91.4%)	0.21	14,988 (94.2%)	7,676 (96.5%)	7,312 (91.9%)	0.19
Other	1,394 (6.0%)	442 (3.6%)	952 (8.6%)		918 (5.8%)	277 (3.5%)	641 (8.1%)	
<b>Surgeon caseload</b>								
<10 cases/year	7,446 (32.1%)	4780 (39.1%)	2666 (24.2%)	0.33	5,073 (31.9%)	2919 (36.7%)	2154 (27.1%)	0.21
10 to <30 cases/year	10,112 (43.5%)	4776 (39.1%)	5336 (48.4%)		7,086 (44.6%)	3267 (41.1%)	3819 (48.0%)	
≥30 cases/year	5,676 (24.4%)	2654 (21.7%)	3022 (27.4%)		3,747 (23.6%)	1767 (22.2%)	1980 (24.9%)	



<b>Surgical approach</b>								
Medial parapatellar	21,121 (90.9%)	11,219 (91.9%)	9,902 (89.8%)	0.07	14,631 (92.0%)	7,385 (92.9%)	7,246 (91.1%)	0.06
Other	2,113 (9.1%)	991 (8.1%)	1,122 (10.2%)		1,275 (8.0%)	568 (7.1%)	707 (8.9%)	
<b>Minimally invasive surgery</b>								
0	12,325 (53.0%)	6,141 (50.3%)	6,184 (56.1%)	0.12	8,507 (53.5%)	4,063 (51.1%)	4,444 (55.9%)	0.09
1	10,909 (47.0%)	6,069 (49.7%)	4,840 (43.9%)		7,399 (46.5%)	3,890 (48.9%)	3,509 (44.1%)	
<b>Fixation</b>								
Cemented	12,939 (55.7%)	8,570 (70.2%)	4,369 (39.6%)	0.65	8,696 (54.7%)	4,350 (54.7%)	4,346 (54.7%)	0.001
Cementless	10,295 (44.3%)	3,640 (29.8%)	6,655 (60.4%)		7,210 (45.3%)	3,603 (45.3%)	3,607 (45.4%)	
<b>Bone graft</b>								
None	23,146 (99.6%)	12,157 (99.6%)	10,989 (99.6%)	0.02	15,842 (99.6%)	7,912 (99.5%)	7,930 (99.7%)	0.04
Bone graft used	88 (0.4%)	53 (0.4%)	35 (0.3%)		64 (0.4%)	41 (0.5%)	23 (0.3%)	

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438 **Table 2. Reasons for revision in matched cohort.** Comparisons between were Microplasty  
439 and Non-Microplasty revisions per 100 component years were conducted using the Chi squared  
440 test. Abbreviations: OA (Osteoarthritis), UKR (Unicompartmental Knee Replacement).  
441 Significant p values are in bold and the indication for revision they correspond to are marked  
442 with \*.  
443

Reasons for revision	Matched cohort						
	Non Microplasty absolute number of revisions	Mean time to revision (Years)	Non Microplasty revisions per 100 component years	Microplasty absolute number of revisions	Mean time to revision (Years)	Microplasty revisions per 100 component years	Comparison of revisions per 100 component years (P value)
Aseptic loosening	69 (0.87%)	2.3 (SD 1.3)	0.26	35 (0.44%)	1.5 (SD 0.9)	0.19	P=0.13
OA progression*	82 (1.03%)	2.8 (SD 1.4)	0.31	39 (0.49%)	1.9 (SD 1.0)	0.21	<b>P=0.048</b>
Pain	49 (0.62%)	2.3 (SD 1.1)	0.19	22 (0.28%)	1.5 (SD 0.7)	0.12	P=0.08
Other*	48 (0.60%)	2.0 (SD 1.4)	0.18	14 (0.18%)	1.2 (SD 0.8)	0.08	<b>P=0.003</b>
Dislocation subluxation revision	17 (0.21%)	1.5 (SD 1.5)	0.06	22 (0.28%)	1.1 (SD 0.8)	0.12	P=0.052
Instability	26 (0.33%)	2.3 (SD 1.1)	0.10	10 (0.13%)	1.4 (SD 0.8)	0.05	P=0.11
Component dissociation	18 (0.23%)	1.4 (SD 1.1)	0.07	12 (0.15%)	1.0 (SD 0.9)	0.07	P=0.91
Malalignment	23 (0.29%)	2.0 (SD 1.4)	0.09	11 (0.14%)	1.2 (SD 1.5)	0.06	P=0.30
Infection	12 (0.15%)	0.9 (SD 1.0)	0.05	13 (0.16%)	0.9 (SD 0.7)	0.07	P=0.27

Periprosthetic fracture*	10 (0.13%)	0.5 (SD 0.3)	0.04	16 (0.20%)	0.5 (SD 0.6)	0.09	<b>P=0.03</b>
Lysis	8 (0.1%)	2.7 (SD 0.9)	0.03	4 (0.05%)	2.2 (SD 1.3)	0.02	P=0.77
Wear	7 (0.09%)	2.9 (SD 1.4)	0.03	5 (0.06%)	1.7 (SD 1.7)	0.03	P=0.97
Stiffness	5 (0.06%)	2.4 (SD 1.3)	0.02	6 (0.08%)	1.8 (SD 1.8)	0.03	P=0.36
Implant fracture	0 (0%)		N/A	0 (0%)		N/A	N/A
Patellar wear	0 (0%)		N/A	0 (0%)		N/A	N/A
Tibial wear	0 (0%)		N/A	0 (0%)		N/A	N/A
Incorrect sizing	0 (0%)		N/A	0 (0%)		N/A	N/A
Patella mal tracking	0 (0%)		N/A	0 (0%)		N/A	N/A

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447 **7. LIST OF FIGURES**

448 **Figure 1. Schematic of Microplasty instrumentation.** Adapted from [12].

449

450 **Figure 2. Data flowchart of NJR database cleaning.**

451

452 **Figure 3. Kaplan Meier implant survival rates for matched Microplasty assisted**

453 **(n=7,953) and Non Microplasty (n=7,953) UKR implants up to 5 years.**

454

455 **Figure 4. Kaplan Meier implant survival rates for Microplasty UKRs inserted < 1 year**

456 **of introduction (n=2,424), Microplasty UKRs  $\geq$  1 year after introduction (n=5,529) and**

457 **Non Microplasty UKRs (n=7,953) up to 5 years.**

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472 **8. DECLARATIONS**

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492

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494 HRM, GSM, AJ and DWM designed the study. HRM and GSM analysed the data with  
495 statistical support from AJ. HRM, GSM, AJ, and DWM helped with data interpretation.  
496 HRM wrote the initial manuscript draft which was then revised by all authors. All authors  
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