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# **The Oxford medial unicompartmental knee replacement: the South African experience**

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**\*Abstract (Structured; 250 Words Maximum)**

**Title:** The Oxford medial unicompartmental knee replacement: the South African experience.

***Abstract***

*Background* The Oxford Unicompartmental Knee Replacement (OUKR) is a successful treatment for end-stage, symptomatic anteromedial osteoarthritis. This study reports the results of a cohort of consecutive cemented and cementless medial OUKRs from an independent centre and aims to answer the following questions: what is the mid to long-term survival of OUKR in the hands of a non-designer surgeon? Are there any differences in the mid to long-term survival of cementless and cemented OUKR? Are the failure modes any different with the cementless and cemented OUKR?

*Methods* 1120 consecutive Oxford UKRs were implanted in a single centre for the recommended indications. Patients were prospectively identified and followed up. Survival of was calculated with revision as the end-point.

*Results* There were 522 cemented and 598 cementless implants. The mean follow-up was 8.3 years for cemented implants (range 0.5-17, SD 2.9) and 2.7 years (range 0.5-7, SD 1.8) for cementless implants. The OKS improved from a preoperative mean of 22 (SD 8.1) to 40 (SD 7.9) at the last follow-up ( $p < 0.001$ ). There were 59 failures requiring revision surgery, with a 5.3% cumulative revision rate. The most common reason for failure was progression of osteoarthritis in the lateral compartment, occurred in 26 cases (2.3%). The life table analysis showed a cumulative 10-year survival of 91% (95% CI 87.3 – 95.2).

*Conclusion* The results of this prospective, consecutive case series from the African continent demonstrated that excellent results are achievable with the OUKR in independent centres if the correct indications and surgical technique are used.

*Level of evidence* IV.

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17 reason for failure was progression of osteoarthritis in the lateral compartment, occurred in 26 cases (2.3%).  
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20 that excellent results are achievable with the OUkR in independent centres if the correct indications and  
21 surgical technique are used.

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23

24

25 **Keywords:** Unicompartmental knee replacement, UKR, Cementless

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34 **Introduction**

35 The Oxford Unicompartmental Knee Replacement (OUKR) is a successful treatment for end-stage,  
36 symptomatic anteromedial osteoarthritis of the knee (AMOA). Compared to total knee replacement (TKR),  
37 UKR is associated with significantly lower morbidity and mortality [1]. In addition, patients regain better  
38 range of movement, superior function and more natural feel of the knee [2,3]. However, data from the  
39 National Joint Registry of England and Wales reports a higher revision rate [1]. This contrasts with the  
40 results reported in several studies, which showed excellent long-term survival and clinical outcome [2,4-9].  
41 Multiple factors hypothetically contribute to this discrepancy, including the susceptibility of UKR to  
42 revision, the use of heterogeneous indications and the unsuitability of survival as a comparison term between  
43 UKR and TKR [10]. A deeper analysis of registry data has revealed how usage, intended as the proportion of  
44 cases that are UKR in a surgeon's practice, influence the outcome of the procedure. Surgeons performing  
45 UKR in more than 20% of their knee arthroplasties achieve acceptable revision rates, and those who are  
46 around 50% achieve optimal results. In contrast, a usage below 20% results in a high revision rate [12]. This  
47 can explain the good results reported in big cohort studies and randomised controlled trials and their  
48 discrepancy with those reported in National Registries. However, most of this studies are from the designers  
49 and some authors have expressed concern regarding the reproducibility of such results in non-designer  
50 centres[11].

51

52 The OUKR has recently reached the 40<sup>th</sup> anniversary of its introduction in the clinical practice and is  
53 nowadays the most implanted partial knee replacement all over the world. The design underwent some  
54 modifications since is introduction. The Phase 3 represents the most recent version of the implant, which is  
55 still based on the same principles and key design features of the original implant without any changes made  
56 to the articular surfaces. Compared to the Phase 2, the Phase 3 had a new, less invasive instrumentation /  
57 surgical technique (minimally invasive surgical approach without patella eversion and without dislocating  
58 the tibio-femoral joint thereby preserving the extensor mechanism) and an increased range of component  
59 sizes. Cementation has been the only option for many years, before the introduction of a cementless version  
60 of the OUKR in 2004. Cementless fixation aimed to reduce the incidence of radiolucent lines, avoid  
61 cementation errors and introduce biological fixation [14,15], eventually reducing the discrepancy between  
62 the revision rate of National Joint Registries and high volume centres.

63 The most common failure modes of cemented OUKR include bearing dislocation, progression of  
64 osteoarthritis in the retained compartment and component loosening [16].

65 In spite of the perceived advantages of cementless OUKRs, there are some unique problems associated with  
66 their use such as valgus subsidence and higher fracture risk [17,18]. These need to be looked at in a big  
67 cohort and ideally the data should be compared with those of the cemented OUKRs to see if the overall  
68 implant survival and complications differ in cemented and cementless OUKR.

69 The designers have published the results of a RCT comparing the cemented with cementless OUKRs with 5-  
70 year follow-up. The study demonstrated no significant difference in any outcome measure, except for a

71 superior Knee Society functional score in the cementless group and a reduced incidence of radiolucent lines  
72 in cementless implants. There was no difference in complications among groups [3]. However, the sample  
73 size was small and the study was primarily set up to show equivalence in implant survival.

74 No long-term follow up data on large cohorts comparing cemented OUKRs with cementless OUKRs exist.

75

76 This study reports about a large, consecutive cohort of medial OUKRs from an independent centre from the  
77 African continent with the purpose of assessing the mid- to long-term clinical results in non-designer hands.

78 It includes consecutive cohorts of both the cemented as well as cementless OUKRs and aims to answer the  
79 following questions: 1. What is the mid to long-term survival of OUKR in the hands of a non-designer  
80 surgeon? 2. Are there any differences in the mid to long-term survival of cementless OUKR as compared to  
81 cemented OUKR? 3. Are the failure modes any different with the cementless OUKR as compared to  
82 cemented OUKR in the hands of a non-designer surgeon?

83

#### 84 **Materials and methods**

85 Between 2000 and 2016, 1120 Oxford UKRs were implanted in a single centre. All the procedures were  
86 cemented OUKRs until 2009, when the cementless fixation was progressively introduced. Between 2009 and  
87 2013, both cemented and cementless OUKRs were implanted. The same indications were used for both  
88 fixation methods, and the decision between cemented and cementless did not rely on specific criteria.  
89 Cementation was discontinued after 2013. Overall, 522 implants were cemented and 598 were cementless.

90

91 The cementless OUKR is a modified version of the cemented implant [19]. The cement pockets on both  
92 components are filled with porous titanium and the surfaces that are in contact with bone are coated with  
93 calcium hydroxyapatite (HA). The femoral component has two HA-coated cylindrical pegs for press-fit  
94 fixation and to confer rotational stability. The slot for the tibial keel is narrower than the cemented in order to  
95 provide press-fit fixation and ensure primary stability.

96

97 All the cases fulfilled the recommended indications by Goodfellow et al. [20]; osteoarthritis was the most  
98 common primary diagnosis (1088 cases), followed by avascular necrosis (32 cases – 24 in the cemented  
99 group and 8 in the cementless group). Age, level of activity, BMI, chondrocalcinosis or presence of patello-  
100 femoral OA (except for severe grade OA of lateral facet with bone loss or grooving) were not considered  
101 contraindications [21]. Patients who had either friable fragmented or absent anterior cruciate ligament (ACL)  
102 or had undergone previous/simultaneous ACL reconstruction or previous high tibial osteotomy were  
103 excluded from the study.

104 All procedures were performed through a minimally invasive approach, as previously described[22].

105 All patients were treated with a standard rehabilitation protocol. Patients were allowed to fully weight-bear  
106 and early mobilisation was encouraged. Patients were prospectively identified and independently followed-  
107 up in dedicated clinics. All patients were consented to be involved in the study prior to their inclusion in the

108 study. The study was approved by the local Human Research Ethics Committee of the University of the  
109 Witwatersrand - Johannesburg (Protocol no: M1704114).

110

111 The clinical outcome was measured using the Oxford knee score (OKS), a validated patient-based  
112 questionnaire to assess function and pain after knee replacement surgery. The OKS ranges from 0 (worst  
113 outcome) to 48 (best outcome) [23].

114

115 Any complications encountered during or after surgery or further surgeries were recorded at each follow-up  
116 appointment.

117

### 118 **Statistics**

119 Mann-Whitney U tests were performed to compare the pre-operative and post-operative (most recent) OKS  
120 scores. Fisher's test was used to compare the incidence of component loosening between cemented and  
121 cementless implants. Statistical significance was set at  $p < 0.05$ .

122 The log rank test was used to compare the survival curves of cemented and cementless implants. All analyses  
123 were carried out using SPSS version 22.0 for Windows (SPSS Inc., Chicago, USA).

124 Revision was defined as exchange or addition of a new component in the knee. A life table analysis was  
125 performed to estimate the survival. The 95% confidence intervals (CI) were calculated using the method  
126 described by Peto et al. [24].

127

### 128 **Results**

129 Of the 1120 consecutive OUKRs included in this series, 522 were cemented and 598 were cementless. The  
130 mean age at the time of the operation was 65 years (range 31-94, SD 9). There were 573 males (51%), 232 in  
131 the cemented group and 341 in the cementless group.

132

133 The mean follow-up was 5.3 years (range 0.5 -17, SD 3.7), with 569 patients having a minimum follow-up  
134 of 5 years and 171 patients having a minimum follow-up of 10 years. The mean follow-up was 8.3 years for  
135 the cemented implants (range 0.5-17, SD 2.9) and 2.7 years (range 0.5-7, SD 1.8) for the cementless  
136 implants. The OKS improved from a preoperative mean of 22 (SD 8.1) to 40 (SD 7.9) at the last follow-up ( $p$   
137  $< 0.001$ ).

138

139 There were 59 failures requiring revision surgery (40 in cemented implants and 19 in cementless implants),  
140 with a 5.3% cumulative revision rate. The most common reason for failure was progression of osteoarthritis  
141 in the lateral compartment, occurred in 26 (2.3%) cases. Four of these cases were treated with revision to  
142 total knee replacement, and the remaining with the addition of a lateral domed UKR. The second commonest  
143 cause of failure was bearing dislocation, occurred in 9 patients (0.8%). Six patients (0.5%) had a tibial  
144 plateau fracture, which was treated by open reduction and internal fixation in 4 cases and with revision to

145 TKR in two cases. All these cases were cementless UKRs and in women. Six other patients developed  
146 component loosening, 5 femoral (all in cemented cohort) and one tibial. Out of these 6 cases of component  
147 loosening, 3 were revised to TKR whilst in the remaining three cases the components were replaced by a  
148 cemented UKR component. Ten cases had a revision for other causes, as reported in Table 1. Two further  
149 cases were revised to TKR in other institutions for unknown reason. There were no revisions for infection or  
150 wear of the polyethylene.

151

152 There were additional 46 operations (25 in cemented implants and 21 in cementless implants) that were not  
153 considered revisions, since there was no addition or exchange of the existing prosthetic components. Thirty-  
154 eight of these reoperations were arthroscopies for lateral meniscal tear (n =20), debridement of the lateral  
155 compartment for lateral degeneration (n=8), haemarthrosis (n=2), large haematoma (n=2), synovitis (n=2),  
156 removal of a loose body (n=2, both cemented), removal of impingement (n=2) and washout of suspected  
157 infection (n=1). The remaining reoperations were manipulations under anaesthesia for postoperative stiffness  
158 (n=7).

159

160 The life table analysis showed a cumulative 10-year survival of 91% (95% CI 87.3 – 95.2) [Table 2].

161 There was no statistically significant difference between the 5-year survival of cemented and cementless  
162 components, which was 95.1 and 95.8, respectively (p=0.97) (Figure 1).

163

## 164 **Discussion**

165 The purpose of this prospective, consecutive case series was to evaluate the mid- to long-term results of  
166 medial OUKR in an independent centre. The results confirmed that good clinical outcome and survival can  
167 be achieved with the OUKR by a non-designer surgeon. These are the first results from the African continent  
168 and highlight the importance of proper patient selection and optimal surgical technique to achieve implant  
169 survival rates similar to the designer series. There was no difference in survival between the cemented and  
170 cementless versions of the implant. None of the failures were secondary to infection or wear of the  
171 polyethylene.

172

173 Several studies demonstrated that unicompartmental knee replacement is a successful treatment for  
174 symptomatic, end-stage anteromedial OA [2,4-9]. However, either these do not provide 10-year survival  
175 and/or number of cases in the cohort are relatively small. In addition, we are not aware of any other study  
176 which compares the survival of large cohorts of cemented and cementless OUKRs implanted by a non-  
177 designer surgeon.

178

179 The clinical results of UKRs and TKRs are comparable, with more excellent results (OKS >41) obtained  
180 with UKR even in multi-surgeon series as confirmed from the analyses of the Joint Registry data from New  
181 Zealand [25]. Furthermore, a study on over 100.000 matched patients from the National Joint Registry of



182 England and Wales has demonstrated that the incidence of severe medical complications and mortality is  
183 significantly lower in UKRs than TKRs [1]. Consequently, UKR is an advantageous procedure for patients  
184 meeting the recommended indications. It has been estimated that about 50% of patients requiring knee  
185 replacement surgery could be candidate to UKR [21,22]; on average, less than 10% of these patients are  
186 treated with partial knee replacement in current clinical practice across most of the countries. In our hands,  
187 we try and offer a patient a UKR whenever possible due to its safety and clinical effectiveness. No case of  
188 infection, implant survival not dissimilar to TKR, very low manipulation rates and low morbidity and  
189 mortality are key advantages of UKR in our clinical practice. Despite the excellent results reported by  
190 several studies, the NJR data show that the revision and re-operation rates are up to three times higher for  
191 UKRs than TKRs, also when patients are matched. According to this data, if 100 patients receiving TKR  
192 received UKR instead, there would be about one fewer death and three more reoperations in the first 4 years  
193 after surgery [1]. The discrepancy in the survival rates between the NJR and high volume centres is  
194 controversial. It has been argued that the revision is not an objective measure when comparing UKR and  
195 TKR because of the higher susceptibility of UKR to revision [10]. On the other hand, some surgeons claim  
196 that the good results achieved in designer centres are not generally reproducible.

197

198 The results of this prospective, consecutive case series from the African subcontinent highlights following  
199 key messages. Implant survival of 91% at 10 years for all-cause revision is similar to other published large-  
200 data series. The 5-year survival was similar in cemented and cementless implants. No particular assessment  
201 technique was used to confirm the suitability of a patient for a cementless UKR. As primarily the forces  
202 transmitted are compressive, the implant works well with the cementless fixation and bone density or  
203 patient's age do not matter in the success or failure of a cementless fixation. Recent evidence suggests that  
204 the results of cementless and cemented OUKR are similar in high volume centres [3,26], in which technical  
205 errors, inappropriate indications and misinterpretations of RLs are uncommon. However, the 2015 report  
206 from the New Zealand Joint Registry reported a revision rate of 0.67 per 100 component years (95% CI 0.49  
207 – 0.90) and 1.33 per 100 component years (95% CI 1.23 – 1.44) for cementless and cemented OUKR,  
208 respectively [25]. These results are encouraging and suggest that the cementless fixation is succeeding in its  
209 intended purpose.

210

211 The cumulative failure rate in this cohort was higher to that reported in a designer series of cemented  
212 OUKRs with similar follow-up (5.3% vs 2.9%). However, it was similar to that of mixed designer and  
213 independent cohorts studies with comparable follow-up [16]. The most common causes of failure were  
214 progression of OA in the retained compartments and bearing dislocation occurring in 2.3% and 0.8% of  
215 cases, respectively. Progression of arthritis in the retained lateral compartment is well documented after  
216 UKR. Overall the risk is low and no exact aetiology has been identified other than MCL damage at the time  
217 of primary UKR.

218

219 In this cohort there were no failures caused by infection. Only one patient in the cemented group required an  
220 arthroscopic debridement for suspected infection one month after the operation. The patient subsequently did  
221 well and is now in the tenth year of follow-up without any evidence of residual infection or impending  
222 implant failure.

223

224 In this series, there were 5 revisions caused by a failure of fixation. There were five cases of femoral  
225 component loosening, all in cemented implants, and one tibial component loosening in a cementless implant.  
226 The incidence of femoral loosening was significantly higher in the cemented group ( $p = 0.03$ ). This data are  
227 consistent with those previously reported on single-peg cemented femur, which may provide a limited  
228 rotational stability. The introduction of twin peg femoral components resulted in a significant reduction of  
229 loosening [27]. In contrast, there was no significant difference in the incidence of tibial loosening between  
230 cemented and cementless fixation ( $p = 0.4$ ), suggesting that cementless fixation is as reliable as cemented on  
231 the tibial side, providing better fixation on the femoral component. Further biomechanical research is needed  
232 to compare the component micromotion and rotational stability of cemented and cementless UKRs.

233

234 There were six tibial plateau fractures, all occurred in cementless implants and all in women. Medial tibial  
235 condyle fracture is a rare but recognised complication of cemented and cementless UKRs [28,29]. The  
236 aetiology of medial tibial plateau fractures is likely to be multifactorial. Several risk factors have been  
237 described for cemented UKRs [22,30,31], including a deep resection, damage to the posterior cortical bone, a  
238 medial vertical cut, more than one pin hole, and excessive impaction during implantation. A cadaver study  
239 has suggested a reduced fracture load in cementless UKR compared to cemented tibial components [18].  
240 However, a systematic review on cementless fixation in UKR did not reveal an increased incidence of  
241 fractures in cementless implants. The instrumentation and surgical technique of the cementless OUKR are  
242 the same of the cemented version except for the fixation, which is ensured by interference fit in the  
243 cementless implant. All the risk factors and technical precautions described for the cemented OUKR are  
244 therefore applicable to the cementless OUKR. However, the interference fit can represent an additional risk  
245 factor, causing trabecular bone damage and possibly initiating a fracture, making the cementless OUKR less  
246 forgiving to technical errors. It has been suggested that the strict adherence to the surgical technique should  
247 limit the incidence of this complication [32].

248

249 This study has some limitations. First, the lack of the radiographic analysis, which may cause an  
250 underestimation of specific complications such as the progression of OA in the retained compartments.  
251 Although all symptomatic patients were assessed, silent progression of lateral OA is a possibility and future  
252 failures may occur with time. Second, it is not a randomised controlled trial but a comparison of consecutive  
253 cohorts. Although this is the case, the number of cases available for FU are sufficiently large to draw  
254 meaningful conclusions.

255

256 One of the key strengths of this study is that it includes a consecutive series of large cohorts of both  
257 cemented and cementless OUQR, both performed with the same indications and recommended surgical  
258 technique by the same non-designer surgeon. The introduction of the cementless version of the OUQR aimed  
259 to reduce the incidence of radiolucent lines and avoid cementation errors [7], theoretically reducing the  
260 revision rate in National Joint Registries. Partial or complete radiolucencies are present in two thirds of  
261 cemented OUQRs [3]. The presence of “physiological” radiolucency does not affect the outcome or correlate  
262 with loosening or failure [33]. However, radiolucencies can be misinterpreted and lead to “unnecessary”  
263 revisions. Excess cement, presence of loose fragments or inadequate cement penetration can cause  
264 impingement, unexplained pain, loosening and accelerated wear. In our hands, we have seen significant  
265 reduction in the incidence of component loosening with the use of cementless implants. Although the  
266 fracture rates are significantly higher, we believe these should reduce in the coming years as we have learnt  
267 the nuances of the cementless system. All the fractures occurred in women and the tibial components were  
268 typically smaller. Ensuring the use of largest tibial size, avoidance of large hammer and accepting  
269 incomplete seating of the tibial component are key lessons for a surgeon when embarking on using the  
270 cementless implants.

271 Further research is needed to assess the potential long-term benefits of cementless fixation, as well as RCT to  
272 detect possible differences in the clinical outcome of cemented and cementless OUQRs. Commonest failure  
273 mode is progression of arthritis although the incidence is low. It will be useful to assess the factors  
274 contributing to progression of arthritis and establish mechanisms to rule out inflammatory osteoarthritis  
275 using pre-operative tests which can be reliably carried out.

276 In conclusion, the results of this prospective, consecutive case series from the African continent  
277 demonstrated that excellent results are achievable with the OUQR in independent centres if the correct  
278 indications and surgical technique are used.

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280

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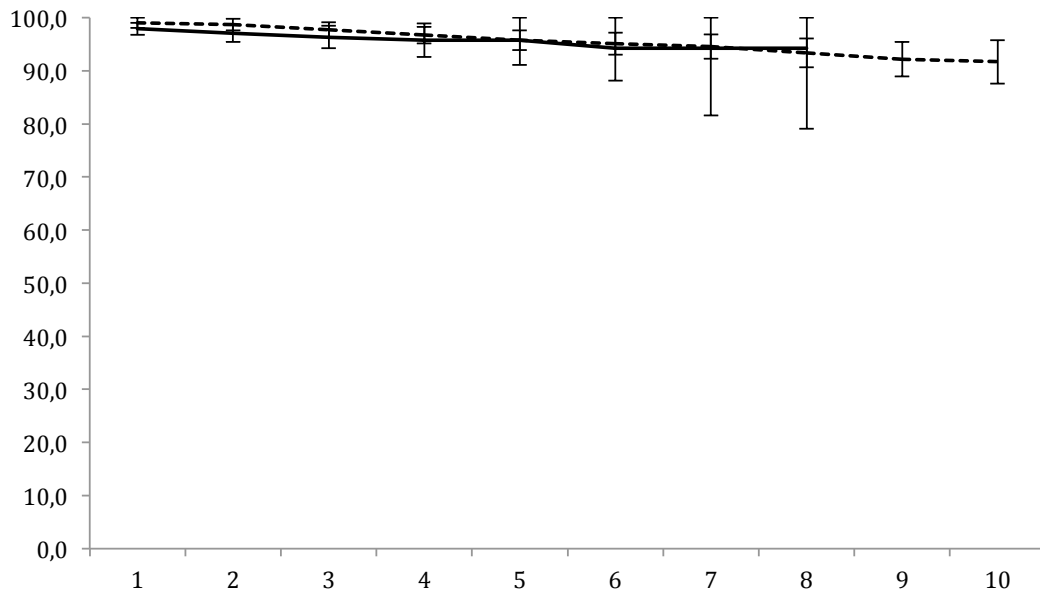
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Figures (Number each one)

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**Figure 1.** Survival curve of the cemented (dotted) and cementless (solid) OUKR

**Tables (Number each one)**

**Table 1.** Other causes of revision

Months since Op	Reason for Revision	Complication Resolved How?	Primary Fixation
5	Subsidence	Bearing upsize	Cementless
8	Synovitis secondary to inflammatory OA	Arthrotomy, synovectomy & bearing exchange	Cementless
9	AVN	Revision to TKR	Cemented
14	AVN Lateral	Addition of domed UKR	Cementless
25	Synovitis & Rheumatoid Arthritis	Arthrotomy, synovectomy and bearing exchange	Cemented
29	Traumatic Peri-prosthetic femoral fracture	Revision to TKR	Cemented
30	Bearing Subluxation & Anterior Impingement	Removal of impingement and bearing exchange	Cementless
39	Unexplained pain	PFJ replacement and removal of impingement	Cementless
41	Subsidence	Bearing upsize	Cemented
104	Trauma and lateral compartment progression	Addition of domed UKR	Cemented

**Table 2.** Life table analysis

Follow Up (Yrs)	Number at start	Revised	Withdrawn	Lost to FU	Deceased	At Risk	Annual Failure	Annual Success	Survival	95% CI	95% CI
0 to 1	1120	16	104	1	0	1068	0,015	0,985	98,5	97,8	99,2
1 to 2	1000	6	133	14	0	934	0,006	0,994	97,9	97,0	98,8
2 to 3	861	7	122	20	0	800	0,009	0,991	97,0	95,9	98,2
3 to 4	732	6	100	9	0	682	0,009	0,991	96,2	94,7	97,6
4 to 5	626	5	90	10	3	581	0,009	0,991	95,3	93,7	97,0
5 to 6	531	4	88	6	0	487	0,008	0,992	94,5	92,6	96,5
6 to 7	439	2	72	14	1	403	0,005	0,995	94,1	91,8	96,3
7 to 8	365	4	75	6	1	328	0,012	0,988	92,9	90,3	95,6
8 to 9	286	3	81	3	2	246	0,012	0,988	91,8	88,5	95,1
9 to 10	202	1	49	3	0	178	0,006	0,994	91,3	87,3	95,2
10 to 11	152	2	55	1	1	125	0,016	0,984	89,8	84,8	94,8