

1 **What are the indications for hinged implant in revision total knee replacement?**

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5 **Response/Recommendation:** The three most common indications for considering hinged-  
6 design implants in revision total knee arthroplasty are infection, instability, and aseptic  
7 loosening when severe bone loss and loss of integrity of collateral ligaments may be  
8 encountered.

9 **Strength of recommendation:** Moderate.

10 **Rationale**

11 A comprehensive systematic review was conducted to analyse the existing literature for the  
12 indications of hinged knee implant designs in revision total knee replacement (rTKA). Three  
13 databases (PubMed, Web of Science and Scopus) were searched from inception till 27 March  
14 2024 for original articles reporting the indication of using hinged implant designs in rTKA.  
15 Exclusion criteria were non-English language, case reports, studies with sample size <10  
16 patients, review articles, registry-based studies, studies with oncology cases, technique articles,  
17 non-human studies and studies not reporting implants use indications. PRISMA (Preferred  
18 Reporting Items for Systematic Review and Meta-Analysis) guidelines were strictly followed  
19 in the conduct and reporting of this review [1]. The initial search yielded 2349 articles. After  
20 deduplication and preliminary screening of titles and abstracts, 172 articles were selected for  
21 full-text screening. Ultimately, 58 articles met the inclusion criteria and were included for  
22 detailed analysis [2-59]. The majority of the included articles were retrospective studies and  
23 provided Level IV evidence. A total of 2,803 revision TKAs were included in this  
24 review. Hinged implants are increasingly being considered for rTKA in complex scenarios

25 (Table 1) . These scenarios can be complicated by significant instability and bone loss, which  
26 compromise the performance and longevity of standard implant designs [60]. The three most  
27 common indications for considering hinged-design implants in rTKA are infection, instability,  
28 and aseptic loosening when integrity of collateral ligaments may be compromised. Although  
29 rTKA for infection could be done in a single stage or two-stage revision, hinged design can be  
30 considered to compensate for the lack of stability after debridement. Apart from infection,  
31 instability either due to direct ligamentous frailty or due to the revision procedure, remains the  
32 next common indication followed by aseptic loosening. On a clinical perspective, the identified  
33 indications are not usually as distinctive, rather they present in a combined fashion thereby  
34 making hinged designs ideal. These high risk scenarios also call for an increased risk of  
35 reoperations and revisions. The common reasons for reoperation and revision following rTKA  
36 with hinged knee prosthesis are listed below in Table 2. The overall reported reoperation and  
37 revision rate in the included studies was around 13.9% and 14.2% respectively.

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39 With the increase in the modularity and next-generation rotating designs, hinged implants are  
40 now becoming an essential component in the arsenal of not only rTKA but also in select  
41 complex primary scenarios.

42 As with all systematic reviews, this study faced several limitations. There was significant  
43 heterogeneity among the included studies, and selection bias could not be entirely avoided  
44 given the nature of study design and data collection. Furthermore, the review was limited to  
45 articles published in English. Additionally, the inconsistency in reporting outcomes, such as  
46 radiological assessments, mortality rates, pre- and postoperative range of motion (ROM), and  
47 patient-reported outcome measures (PROMs), impeded a comprehensive quantitative analysis.

48 This inconsistency restricted our ability to conduct robust meta-analyses, often limiting our  
49 conclusions to qualitative descriptions.

50 Some studies did not provide detailed information on patient demographics and comorbidities,  
51 which are important factors that could influence outcomes. Additionally, variations in the  
52 follow-up durations across studies could affect the long-term assessment of outcomes and  
53 mortality rates. Moreover, the diversity in implant designs and the range of indications for their  
54 use could have influenced the observed outcomes, reoperation rates, and complication rates.  
55 These variations highlight the complexity of comparing results across different studies and  
56 underscore the need for standardized reporting in future research.

57 To conclude, in revision total knee arthroplasty, the main reasons for considering hinged-  
58 design implants are infection, instability, and aseptic loosening. These indications, however,  
59 are rarely encountered in isolation. More often, they are combined or accompanied by  
60 additional factors such as pain, stiffness/arthrofibrosis, periprosthetic fracture,  
61 dislocation/subluxation, malalignment/malposition, mechanical failure, bone loss, patellar  
62 issues, and the need to revise an existing hinged prosthesis.

### 63 **References**

- 64 1. Moher D, Liberati A, Tetzlaff J, Altman DG., (2009) PRISMA Group. Preferred  
65 reporting items for systematic reviews and meta-analyses: the PRISMA statement.  
66 PLoS Med. 6(7):e1000097. DOI: 10.1371/journal.pmed.1000097.
- 67 2. Minamoto STN, Mozella AP, Cossich VRA, Gavilão UF, Machado HS, Barretto JM.  
68 Comparative Functional and Isokinetic Analysis between Implants with Posterior  
69 Stabilization and Rotating Hinge Total Knee Arthroplasty. Rev Bras Ortop (Sao Paulo).  
70 2024 Mar 21;59(1):e68-e75. doi: 10.1055/s-0044-1779685.
- 71 3. Dzidzishvili L, Sáez D, Calvo E. Metaphyseal cones combined with diaphyseal  
72 impaction grafting provide good outcomes and survival in a complex revision total knee

- 73 arthroplasty: a matched comparative analysis. *Eur J Orthop Surg Traumatol.* 2024  
74 Jan;34(1):577-583. doi: 10.1007/s00590-023-03659-y.
- 75 4. Schlechter M, Theil C, Gosheger G, Moellenbeck B, Schwarze J, Puetzler J, Bockholt  
76 S. Good Mid-Term Implant Survival of a Novel Single-Design Rotating-Hinge Total  
77 Knee Arthroplasty. *J Clin Med.* 2023 Sep 22;12(19):6113. doi: 10.3390/jcm12196113.
- 78 5. Koch KA, Spranz DM, Westhauser F, Bruckner T, Lehner B, Alvand A, Merle C,  
79 Walker T. Impact of Comorbidities and Previous Surgery on Mid-Term Results of  
80 Revision Total Knee Arthroplasty for Periprosthetic Joint Infection. *J Clin Med.* 2023  
81 Aug 25;12(17):5542. doi: 10.3390/jcm12175542.
- 82 6. Hecker A, Pütz HA, Wangler S, Eberlein SC, Klenke FM. Indications, clinical outcome  
83 and survival of rotating hinge total knee arthroplasty in a retrospective study of 63  
84 primary and revision cases. *Eur J Orthop Surg Traumatol.* 2023 Jul;33(5):1885-1894.  
85 doi: 10.1007/s00590-022-03349-1.
- 86 7. Van Laarhoven SN, Te Molder MEM, Van Hellemond GG, Heesterbeek PJC.  
87 Acceptable migration of a fully cemented rotating hinge-type knee revision system  
88 measured in 20 patients with model-based RSA with a 2-year follow-up. *Acta Orthop.*  
89 2023 Apr 24;94:185-190. doi: 10.2340/17453674.2023.12305.
- 90 8. Matar HE, Bloch BV, James PJ. Satisfactory medium- to long-term outcomes of  
91 cemented rotating hinge prosthesis in revision total knee arthroplasty. *Bone Jt Open.*  
92 2023 Oct 16;4(10):776-781. doi: 10.1302/2633-1462.410.BJO-2022-0032.R1.
- 93 9. Miralles-Muñoz FA, Pineda-Salazar M, Rubio-Morales M, González-Parreño S, Ruiz-  
94 Lozano M, Lizaur-Utrilla A. Similar outcomes of constrained condylar knee and  
95 rotating hinge prosthesis in revision surgery for extension instability after primary total  
96 knee arthroplasty. *Orthop Traumatol Surg Res.* 2022 Dec;108(8):103265. doi:  
97 10.1016/j.otsr.2022.103265.

- 98 10. Özdemir M, Yaradılmış YU, Ateş A, Evren AT, Okkaoğlu MC , Altay2 M (2021)  
99 Hinged prosthesis in the knee revision surgery: Is there a great need? *Ann Clin Anal*  
100 *Med* 13(10):1061-1065. DOI: 10.4328/ACAM.20990.
- 101 11. Sanz-Ruiz P, León-Román VE, Matas-Diez JA, Villanueva-Martínez M, Vaquero J.  
102 Long-term outcomes of one single-design varus valgus constrained versus one single-  
103 design rotating hinge in revision knee arthroplasty after over 10-year follow-up. *J*  
104 *Orthop Surg Res.* 2022 Mar 4;17(1):135. doi: 10.1186/s13018-022-03026-3.
- 105 12. Neumann DR, Hofstaedter T, Dorn U. Follow-up of a modular rotating hinge knee  
106 system in salvage revision total knee arthroplasty. *J Arthroplasty.* 2012 May;27(5):814-  
107 9. doi: 10.1016/j.arth.2011.08.015.
- 108 13. Schnetz M, Hofmann L, Ewald L, Klug A, Hoffmann R, Gramlich Y. Midterm results  
109 of modular hinge total knee arthroplasty using cementless osseointegrating stems: low  
110 fixation associated complications and good functional outcome in primary and revision  
111 knee arthroplasty. *Arch Orthop Trauma Surg.* 2024 Feb;144(2):831-845. doi:  
112 10.1007/s00402-023-05148-7.
- 113 14. Vertesich K, Staats K, Böhler C, Koza R, Lass R, Giurea A. Long Term Results of a  
114 Rotating Hinge Total Knee Prosthesis With Carbon-Fiber Reinforced Poly-Ether-  
115 Ether-Ketone (CFR-PEEK) as Bearing Material. *Front Bioeng Biotechnol.* 2022 Mar  
116 4;10:845859. doi: 10.3389/fbioe.2022.845859.
- 117 15. Rajgopal A, Agrawal U. Long term results of rotating hinge total knee arthroplasty in  
118 complex primary and revision cases. *Acta Orthopædica Belgica, Vol. 86 - e-*  
119 *Supplement - 3 - 2021.*
- 120 16. Memon N, Iqbal F, Noor SS, Najjad KR, Sozera MF, Abro A, Khan N. Mid-term results  
121 and survival rates following a single-design rotating hinge knee arthroplasty in non-

- 122 tumor conditions in a Pakistani population. *Knee Surg Relat Res.* 2021 May 4;33(1):15.  
123 doi: 10.1186/s43019-021-00102-6.
- 124 17. Bourbotte-Salmon F, Ferry T, Cardinale M, Servien E, Rongieras F, Fessy MH, Bertani  
125 A, Laurent F, Buffe-Lidove M, Batailler C, Lustig S; Lyon Bone and Joint Infections  
126 Study Group. Rotating Hinge Knee Arthroplasty for Revision Prosthetic-Knee  
127 Infection: Good Functional Outcomes but a Crucial Need for Superinfection  
128 Prevention. *Front Surg.* 2021 Sep 20;8:551814. doi: 10.3389/fsurg.2021.551814.
- 129 18. Wignadasan W, Chang JS, Kayani B, Kontoghiorghe C, Haddad FS. Long-term results  
130 of revision total knee arthroplasty using a rotating hinge implant. *Knee.* 2021 Jan;28:72-  
131 80. doi: 10.1016/j.knee.2020.11.009.
- 132 19. Bingham JS, Bukowski BR, Wyles CC, Pareek A, Berry DJ, Abdel MP. Rotating-Hinge  
133 Revision Total Knee Arthroplasty for Treatment of Severe Arthrofibrosis. *J*  
134 *Arthroplasty.* 2019 Jul;34(7S):S271-S276. doi: 10.1016/j.arth.2019.01.072.
- 135 20. on Hintze J, Niemeläinen M, Sintonen H, Nieminen J, Eskelinen A. Outcomes of the  
136 rotating hinge knee in revision total knee arthroplasty with a median follow-up of  
137 6.2 years. *BMC Musculoskelet Disord.* 2021 Apr 7;22(1):336. doi: 10.1186/s12891-  
138 021-04205-9.
- 139 21. Arnholdt J, Boelch SP, Dogan F, Hoberg M, Holzapfel BM, Rudert M. Revision  
140 arthroplasty with rotating hinge systems for total knee arthroplasty instability. *Oper*  
141 *Orthop Traumatol.* 2020 Aug;32(4):298-308. English. doi: 10.1007/s00064-020-  
142 00663-x.
- 143 22. Brown LR, Clement ND, MacDonald DJ, Breusch SJ. The survivorship of the link  
144 endo-rotational hinge total knee arthroplasty: 5-12-year follow-up of 100 patients. *Arch*  
145 *Orthop Trauma Surg.* 2019 Jan;139(1):107-112. doi: 10.1007/s00402-018-3064-0.

- 146 23. van Rensch PJH, Heesterbeek PJC, Hannink G, van Hellemond GG, Wymenga AB.  
147 Improved clinical outcomes after revision arthroplasty with a hinged implant for  
148 severely stiff total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc.* 2019  
149 Apr;27(4):1043-1048. doi: 10.1007/s00167-018-5235-5.
- 150 24. Lim JBT, Pang HN, Tay KJD, Chia SL, Lo NN, Yeo SJ. Increased constraint of rotating  
151 hinge knee prosthesis is associated with poorer clinical outcomes as compared to  
152 constrained condylar knee prosthesis in total knee arthroplasty. *Eur J Orthop Surg*  
153 *Traumatol.* 20;30(3):529-535. doi: 10.1007/s00590-019-02598-x.
- 154 25. Böhler C, Kolbitsch P, Schuh R, Lass R, Kubista B, Giurea A. Midterm Results of a  
155 New Rotating Hinge Knee Implant: A 5-Year Follow-Up. *Biomed Res Int.*  
156 2017;2017:7532745. doi: 10.1155/2017/7532745.
- 157 26. Abdelaziz H, Biewald P, Anastasiadis Z, Haasper C, Gehrke T, Hawi N, Citak M.  
158 Midterm Results After Tantalum Cones in 1-Stage Knee Exchange for Periprosthetic  
159 Joint Infection: A Single-Center Study. *J Arthroplasty.* 2020 Apr;35(4):1084-1089. doi:  
160 10.1016/j.arth.2019.11.016.
- 161 27. Kearns SM, Culp BM, Bohl DD, Sporer SM, Della Valle CJ, Levine BR. Rotating  
162 Hinge Implants for Complex Primary and Revision Total Knee Arthroplasty. *J*  
163 *Arthroplasty.* 2018 Mar;33(3):766-770. doi: 10.1016/j.arth.2017.10.009.
- 164 28. Chen MJ, Hung JF, Chang CH, Lee SH, Shih HN, Chang YH. Periprosthetic knee  
165 infection reconstruction with a hinged prosthesis: Implant survival and risk factors for  
166 treatment failure. *Knee.* 2020 Jun;27(3):1035-1042. doi: 10.1016/j.knee.2020.03.004.
- 167 29. Rouquette L, Batailler C, Muller B, Neyret P, Servien E, Lustig S. Early complications  
168 and causes of revision after rotating-hinge TKA. *Arch Orthop Trauma Surg.* 2020  
169 Jan;140(1):109-119. doi: 10.1007/s00402-019-03290-9.

- 170 30. Hermans K, Vandenuecker H, Truijen J, Oosterbosch J, Bellemans J. Hinged versus  
171 CCK revision arthroplasty for the stiff total knee. *Knee*. 2019 Jan;26(1):222-227. doi:  
172 10.1016/j.knee.2018.10.012.
- 173 31. van Laarhoven SN, van Eerden AHJ, van Hellemond GG, Schreurs BW, Wymenga  
174 AB, Heesterbeek PJC. Superior Survival of Fully Cemented Fixation Compared to  
175 Hybrid Fixation in a Single Design Rotating Hinge Knee Implant. *J Arthroplasty*. 2022  
176 Mar;37(3):482-487. doi: 10.1016/j.arth.2021.11.037.
- 177 32. León-Román VE, García-Mato D, López-Torres II, Vaquero-Martín J, Calvo-Haro JA,  
178 Pascau J, Sanz-Ruíz P. Is a greater degree of constraint really harmful? Clinical  
179 biomechanical comparative study between condylar constrained knee and rotating  
180 hinge prosthesis. *Clin Biomech (Bristol, Avon)*. 2024 Jan;111:106149. doi:  
181 10.1016/j.clinbiomech.2023.106149.
- 182 33. Schneider AM, Rice SJ, Lancaster N, McGraw M, Farid Y, Finn HA. Low-Dose  
183 Irradiation and Rotating-Hinge Revision for the Treatment of Severe Idiopathic  
184 Arthrofibrosis Following Total Knee Arthroplasty: A Review of 60 Patients With a  
185 Mean 6-Year Follow-Up. *J Arthroplasty*. 2024 Apr;39(4):1075-1082. doi:  
186 10.1016/j.arth.2023.10.021.
- 187 34. Pradhan NR, Bale L, Kay P, Porter ML. Salvage revision total knee replacement using  
188 the Endo-Model rotating hinge prosthesis. *Knee*. 2004 Dec;11(6):469-73. doi:  
189 10.1016/j.knee.2004.03.001.
- 190 35. Hernández-Vaquero D, Sandoval-García MA. Hinged total knee arthroplasty in the  
191 presence of ligamentous deficiency. *Clin Orthop Relat Res*. 2010 May;468(5):1248-53.  
192 doi: 10.1007/s11999-009-1226-7.



- 193 36. Gudnason A, Milbrink J, Hailer NP. Implant survival and outcome after rotating-hinge  
194 total knee revision arthroplasty: a minimum 6-year follow-up. *Arch Orthop Trauma*  
195 *Surg.* 2011 Nov;131(11):1601-7. doi: 10.1007/s00402-011-1330-5.
- 196 37. Jones RE, Skedros JG, Chan AJ, Beauchamp DH, Harkins PC. Total knee arthroplasty  
197 using the S-ROM mobile-bearing hinge prosthesis. *J Arthroplasty.* 2001  
198 Apr;16(3):279-87. doi: 10.1054/arth.2001.21498.
- 199 38. Ochs BG, Schreiner AJ, de Zwart PM, Stöckle U, Gonser CE. Computer-assisted  
200 navigation is beneficial both in primary and revision surgery with modular rotating-  
201 hinge knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc.* 2016 Jan;24(1):64-73.  
202 doi: 10.1007/s00167-014-3316-7.
- 203 39. Shen C, Lichstein PM, Austin MS, Sharkey PF, Parvizi J. Revision knee arthroplasty  
204 for bone loss: choosing the right degree of constraint. *J Arthroplasty.* 2014  
205 Jan;29(1):127-31. doi: 10.1016/j.arth.2013.04.042.
- 206 40. Baier C, Lüring C, Schaumburger J, Köck F, Beckmann J, Tingart M, Zeman F, Grifka  
207 J, Springorum HR. Assessing patient-oriented results after revision total knee  
208 arthroplasty. *J Orthop Sci.* 2013 Nov;18(6):955-61. doi: 10.1007/s00776-013-0467-1.
- 209 41. Utting MR, Newman JH. Customised hinged knee replacements as a salvage procedure  
210 for failed total knee arthroplasty. *Knee.* 2004 Dec;11(6):475-9. doi:  
211 10.1016/j.knee.2003.12.007.
- 212 42. Back DL, David L, Hilton A, Blunn G, Briggs TW, Cannon SR. The SMILES  
213 prosthesis in salvage revision knee surgery. *Knee.* 2008 Jan;15(1):40-4. doi:  
214 10.1016/j.knee.2007.09.002.
- 215 43. Neumann DR, Hofstaedter T, Dorn U. Follow-up of a modular rotating hinge knee  
216 system in salvage revision total knee arthroplasty. *J Arthroplasty.* 2012 May;27(5):814-  
217 9. doi: 10.1016/j.arth.2011.08.015.

- 218 44. Farid YR, Thakral R, Finn HA. Intermediate-Term Results of 142 Single-Design,  
219 Rotating-Hinge Implants: Frequent Complications May Not Preclude Salvage of  
220 Severely Affected Knees. *J Arthroplasty*. 2015 Dec;30(12):2173-80. doi:  
221 10.1016/j.arth.2015.06.033.
- 222 45. Barrack RL, Lyons TR, Ingraham RQ, Johnson JC. The use of a modular rotating hinge  
223 component in salvage revision total knee arthroplasty. *J Arthroplasty*. 2000  
224 Oct;15(7):858-66. doi: 10.1054/arth.2000.9056.
- 225 46. Zahar A, Kendoff DO, Klatte TO, Gehrke TA. Can Good Infection Control Be Obtained  
226 in One-stage Exchange of the Infected TKA to a Rotating Hinge Design? 10-year  
227 Results. *Clin Orthop Relat Res*. 2016 Jan;474(1):81-7. doi: 10.1007/s11999-015-4408-  
228 5.
- 229 47. Rodríguez-Merchán EC, Gómez-Cardero P, Martínez-Lloreda Á. Revision knee  
230 arthroplasty with a rotating-hinge design in elderly patients with instability following  
231 total knee arthroplasty. *J Clin Orthop Trauma*. 2015 Mar;6(1):19-23. doi:  
232 10.1016/j.jcot.2014.11.001.
- 233 48. Singer J, Merz A, Frommelt L, Fink B. High rate of infection control with one-stage  
234 revision of septic knee prostheses excluding MRSA and MRSE. *Clin Orthop Relat Res*.  
235 2012 May;470(5):1461-71. doi: 10.1007/s11999-011-2174-6.
- 236 49. Inglis AE, Walker PS. Revision of failed knee replacements using fixed-axis hinges. *J*  
237 *Bone Joint Surg Br*. 1991 Sep;73(5):757-61. doi: 10.1302/0301-620X.73B5.1894661.

- 238 50. Efe T, Roessler PP, Heyse TJ, Hauk C, Pahrman C, Getgood A, Schmitt J. Mid-term  
239 results after implantation of rotating-hinge knee prostheses: primary versus revision.  
240 Orthop Rev (Pavia). 2012 Dec 11;4(4):e35. doi: 10.4081/or.2012.e35.
- 241 51. Bistolfi A, Massazza G, Rosso F, Crova M. Rotating-hinge total knee for revision total  
242 knee arthroplasty. Orthopedics. 2012 Mar 7;35(3):e325-30. doi: 10.3928/01477447-  
243 20120222-34.
- 244 52. Streitbuerger A, Harges J, Gosheger G, Dieckmann R, Hoell S. Knee salvage in revision  
245 arthroplasty after massive bone loss of the femur condyles ( $\geq$ Engl III) with a single-  
246 modular-hinged knee revision implant. Arch Orthop Trauma Surg. 2016  
247 Aug;136(8):1077-83. doi: 10.1007/s00402-016-2491-z.
- 248 53. Joshi N, Navarro-Quilis A. Is there a place for rotating-hinge arthroplasty in knee  
249 revision surgery for aseptic loosening? J Arthroplasty. 2008 Dec;23(8):1204-11. doi:  
250 10.1016/j.arth.2007.10.016.
- 251 54. Luttjeboer JS, Bénard MR, Defoort KC, van Hellemond GG, Wymenga AB. Revision  
252 Total Knee Arthroplasty for Instability-Outcome for Different Types of Instability and  
253 Implants. J Arthroplasty. 2016 Dec;31(12):2672-2676. doi:  
254 10.1016/j.arth.2016.06.062.
- 255 55. Angelini FJ, Helito CP, Veronesi BA, Guimarães TM, Pécora JR, Demange MK.  
256 KNEE ARTHROPLASTY REVISION WITH A CONSTRAINED IMPLANT USING  
257 HINGE AND ROTATING TIBIAL BASIS. Acta Ortop Bras. 2016 Jan-Feb;24(1):22-  
258 6. doi: 10.1590/1413-785220162401153984. Sanguineti F, Mangano T, Formica M,  
259 Franchin F. Total knee arthroplasty with rotating-hinge Endo-Model prosthesis: clinical  
260 results in complex primary and revision surgery. Arch Orthop Trauma Surg. 2014  
261 Nov;134(11):1601-7. doi: 10.1007/s00402-014-2061-1.

262 56. Sanguineti F, Mangano T, Formica M, Franchin F. Total knee arthroplasty with  
 263 rotating-hinge Endo-Model prosthesis: clinical results in complex primary and revision  
 264 surgery. *Arch Orthop Trauma Surg.* 2014 Nov;134(11):1601-7. doi: 10.1007/s00402-  
 265 014-2061-1.

266 57. Hwang SC, Kong JY, Nam DC, Kim DH, Park HB, Jeong ST, Cho SH. Revision total  
 267 knee arthroplasty with a cemented posterior stabilized, condylar constrained or fully  
 268 constrained prosthesis: a minimum 2-year follow-up analysis. *Clin Orthop Surg.* 2010  
 269 Jun;2(2):112-20. doi: 10.4055/cios.2010.2.2.112.

270 58. Steens W, Loehr JF, Wodtke J, Katzer A. Morselized bone grafting in revision  
 271 arthroplasty of the knee: a retrospective analysis of 34 reconstructions after 2-9 years.  
 272 *Acta Orthop.* 2008 Oct;79(5):683-8. doi: 10.1080/17453670810016713.

273 59. Fuchs S, Sandmann C, Gerdemann G, Skwara A, Tibesku CO, Bottner F. Quality of  
 274 life and clinical outcome in salvage revision total knee replacement: hinged vs total  
 275 condylar design. *Knee Surg Sports Traumatol Arthrosc.* 2004 Mar;12(2):140-3. doi:  
 276 10.1007/s00167-003-0401-8.

277 60. Salari P, Baldini A. Revision knee surgery: the practical approach. *EFORT Open Rev.*  
 278 2021;6(6):495-500. doi:10.1302/2058-5241.6.210018

279 **Figures:**

280 **Table 1.** Indications of hinged implant designs in rTKA

Indication	n	%
Infection	781	27.86
Instability	671	23.94
Aseptic loosening	665	23.72
Stiffness / Arthrofibrosis	228	8.13

Multiple reasons	128	4.57
Periprosthetic fracture	110	3.92
Dislocation / Subluxation	41	1.46
Malalignment / Malposition	40	1.43
Mechanical Failure	32	1.14
Bone loss	27	0.96
Patellar complications	24	0.86
Pain	17	0.61
Others	17	0.61
Revision of hinged as only indication	15	0.54
Not specified	7	0.25

281

282 **Table 2.** The common reasons for reoperation and revision following rTKA with hinged knee  
283 prosthesis.

<b>Reoperation Causes</b>	<b>n</b>	<b>%</b>	<b>Revision Causes</b>	<b>n</b>	<b>%</b>
Infection	98	32.78	Infection	90	36.29
Aseptic Loosening	66	22.07	Periprosthetic Fracture	33	13.31
Patellar Complications	27	9.03	Wound complication	26	10.48
Wound complication	22	7.36	Patellar Complications	25	10.08
Arthrofibrosis	20	6.69	Arthrofibrosis	20	8.06
Implant Failure	19	6.35	Aseptic Loosening	19	7.66
Periprosthetic Fracture	17	5.69	Extensor Mechanism Failure	8	3.23
Chronic Pain	9	3.01	Dislocation	7	2.82
Dislocation	8	2.68	Poly wear	7	2.82

Extensor Mechanism Failure	6	2.01	Implant Failure	5	2.02
Recurrent Instability	4	1.34	Instability	4	1.61
Cement Complication	1	0.33	Chronic Pain	3	1.21
Nerve Palsy	1	0.33	Metallosis	1	0.40
Vascular Injury	1	0.33			
Total	299	100.00	Total	248	100.00