# Assessment of an Abbreviated Rabbit Knee Model of Arthrofibrosis

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**Disclosures:** Kareme D. Alder (N), Mason F. Carstens (N), Cole E. Bothun (N), Oliver B. Dilger (N), Ashley N. Payne (N), Roman Thaler (N), Mark E. Morrey (Elsevier), Joaquin Sanchez-Sotelo (Acumed LLC, Elsevier, Exactech Inc, JSES, Oxford University Press, Precision OS, PSI, Stryker), Daniel J. Berry (Bodycad, DePuy, Elsevier, Wolters Kluwer), Amel Dudakovic (N), Matthew P. Abdel (OsteoRemedies, Springer, Stryker)

**INTRODUCTION:** Arthrofibrosis is a common complication following total joint arthroplasty, joint arthroscopy, and traumatic joint injury. Animal models may be used to replicate the phenotype found in humans and elucidate the pathologic mechanisms of the disease. Experimental analyses of knee arthrofibrosis have traditionally utilized a six-month rabbit model as the gold-standard; however, this time frame is resource-intensive and costly. The purpose of this study was to develop an abbreviated rabbit model of knee contracture and compare it a current gold-standard model to determine if equivalent knee stiffness could be achieved.

**METHODS:** Following approval by our Institutional Animal Care and Use Committee, twenty female New Zealand White rabbits were divided into two equal groups and prospectively studied to assess knee passive extension angles (PEA) and terminal posterior capsular stiffness. The right-side experimental (Exp) knees of each rabbit underwent a surgical procedure including disruption of the posterior capsule, creation of an intraarticular hematoma, and Kirschner-wire immobilization as previously described: right knees were immobilized in maximal flexion utilizing a Kirschner-wire passed retrograde through tibiae and into femora. Experimental knees were immobilized for either four weeks (n=10) with a remobilization period of eight weeks in the abbreviated model (i.e., 3 months, 3M) or immobilized for eight weeks (n=10) with a remobilization period of sixteen weeks in the gold-standard model (i.e., 6 months, 6M). PEAs were assessed at remobilization, one week, four weeks, and eight weeks in the abbreviated model and at remobilization and two weeks, eight weeks, and sixteen weeks in the gold-standard model at torques of 20, 30, 40, and 50 Ncm. A low passive extension angle indicates a larger flexion contracture (i.e. greater stiffness). At sacrifice, terminal biomechanical data were collected to assess posterior capsular stiffness utilizing a dynamic load cell device that applied a maximum torque of 20 Ncm at a rate of 1° per second to the experimental and non-operative limb.

**RESULTS:** No animals suffered any adverse event during this study. Analysis of PEAs at each torque value and time-point demonstrated larger PEAs in the 3M abbreviated model as compared to the 6M gold-standard model (**Figure 1** and **Table 1**). At sacrifice, terminal biomechanical analysis of posterior capsular stiffness (**Figure 2**) demonstrated significant differences between the Exp and contralateral (Contra) posterior capsular stiffness in the three-month abbreviated (2.4 vs. 0.05 Ncm/deg, p<0.0001) and six-month gold-standard (4.7 vs. 0.05 Ncm/deg, p<0.0001) models. Comparison of the posterior capsular stiffness between the three-month and six-month models demonstrated significantly increased stiffness in the six-month model (2.4 vs. 4.7 Ncm/deg, p<0.0001).

**DISCUSSION:** The present study established that the three-month abbreviated model of rabbit knee arthrofibrosis and six-month gold-standard model are not equivalent. While there was no difference between PEA throughout the study at increased torques, terminal posterior capsular stiffness was significantly higher in the six-month model.

**SIGNIFICANCE/CLINICAL RELEVANCE:** Our study suggests that the six-month gold-standard rabbit knee model (6M) of arthrofibrosis should continue to be used in the laboratory assessment of arthrofibrosis; however, the abbreviated model (3M) may be beneficial under certain experimental conditions.

**IMAGES AND TABLES:**

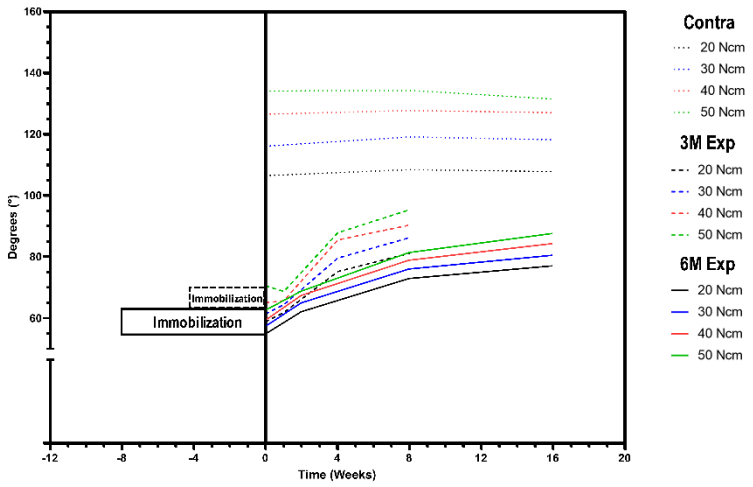


**Figure 1 (above): Passive extension angles.** Line graph demonstrating the change in knee passive extension angles from remobilization until sacrifice at 20, 30, 40, and 50 Ncm in the abbreviated 3M model and the gold-standard 6M model.

**Table 1: Passive extension angles (below).** Tabulated passive extension angles for 3M and 6M models at 20, 30, 40, and 50 Ncm.

| Group | Time after Remobilization (Weeks) | Angles (Mean±SD) | | | |
|---|---|---|---|---|---|
| | | 20Ncm | 30Ncm | 40Ncm | 50Ncm |
| 3M | 0 | 58.9 ± 5.8 | 61.3 ± 7.4 | 64.9 ± 9.2 | 70.5 ± 12.8 |
| | 1 | 61.8 ± 4.1 | 64.3 ± 4.2 | 65.7 ± 5.3 | 68.7 ± 6.0 |
| | 4 | 75.2 ± 3.8 | 79.6 ± 3.8 | 86.6 ± 4.7 | 87.9 ± 5.7 |
| | 8 | 81.2 ± 5.2 | 86.3 ± 7.1 | 90.4 ± 7.9 | 85.4 ± 8.0 |
| 6M | 0 | 54.7 ± 9.1 | 57.2 ± 8.2 | 59.2 ± 7.3 | 62.5 ± 8.3 |
| | 2 | 62.0 ± 7.0 | 64.9 ± 9.3 | 67.3 ± 10.4 | 68.7 ± 10.3 |
| | 8 | 72.9 ± 3.2 | 76.0 ± 4.3 | 78.8 ± 4.2 | 81.3 ± 5.1 |
| | 16 | 77.0 ± 4.3 | 80.4 ± 4.7 | 84.2 ± 6.2 | 87.6 ± 5.8 |

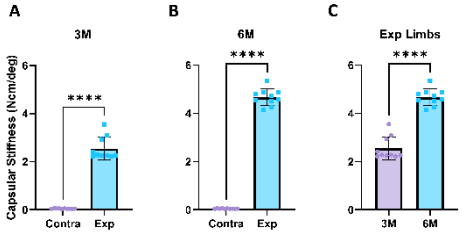


**Figure 2 (above): Posterior capsular stiffness.** Analysis of posterior capsular stiffness in the 3M model (**A**), the 6M model (**B**), and a direct comparison of Exp knees between 3M and 6M models (**C**). ****p<0.0001.