# Supplementary material

## List of authors, included in the systematic search.

| Author                  | Study (meniscal states, ligaments, interventions) | Test setup            | Knee flexion angle | Motion | Load          | Muscle simulation | Pressure measurement |
|-------------------------|---------------------------------------------------|-----------------------|--------------------|--------|---------------|-------------------|----------------------|
| 1. Agneskirchen et al. (2007) | HighTibialOsteotomy (HTO), valgus alignment       | material testing machine | 0°                 | N.A.   | 1000 N (axial) | N.A.              | Tekscan              |
| 2. Ahmed et al. (1983)   | intact, meniscectomy                              | desktop machine       | 0°, 30°, 60°, 90°  | N.A.   | 2668 N (axial) | N.A.              | Transducer           |
| 3. Alhalki et al. (2000) | intact, meniscectomy, autograph, allograph        | horizontal rig        | 0°, 15°, 30°, 45°  | N.A.   | 1000 N (axial) | N.A.              | Fuji Film            |
| 4. Allaire et al. (2008) | intact, root tear, repair, meniscectomy           | modified material testing machine | 0°, 30°, 60°, 90°  | N.A.   | 1000 N (axial) | N.A.              | Fuji film            |
| 5. Amadi et al. (2008)   | meniscofemoral ligaments                         | material testing machine | 0°                 | N.A.   | 700 N (4 DOF) | N.A.              | Fuji film            |
|                          |                                                   |                       |                    |        |               |                   |                      |
| 6. Andrish et al. (2001) | intact                                            | modified material testing machine | N.A.               | 15° to 75° | N.A.        | Quadriiceps, VL (45 N), VM (45 N), Hamstring (45 N) | Force Sensing Technology |
| 7. Arno et al. (2015)    | intact, posterior horn horizontal cleavage lesion | desktop machine       | N.A.               | −5° to 135° | 500 N (axial), 100 N P shear, 2.5 Nm torque | Quadriiceps                  | Tekscan              |
| 8. Baratz et al. (1986)  | tear, repair, partial meniscectomy                | material testing machine | 0°, 30°            | N.A.   | 1800 N (axial) | N.A.              | Fuji Film            |
| 9. Beamer et al. (2017)  | intact, horizontal cleavage tear, repair, partial (subtotal) meniscectomy | modified material testing machine | 0°, 10°, 20°       | N.A.   | 2437 N (axial) | N.A.              | Tekscan              |
| 10. Becher et al. (2011) | intact, with articular resurfacing device         | Oxford Rig            | N.A.               | 5° to 45° | 700 N (GRF)  | Quadriiceps                  | Tekscan              |
Menisci significantly influence tibiofemoral contact

|   | Authors (Year) | Condition | Simulator/Equipment | Joint Angle Range | Force Load | Forces \(N\) (Acting Direction) | Measurement System |
|---|----------------|-----------|----------------------|-------------------|------------|-------------------------------|------------------|
|11 | Becker et al. (2005) | repair of bucket-handle tear | modified material testing machine | 10° to 90° | 1400 N (axial) | Tekscan |
|12 | Bedi et al. (2012) | intact, radial tear, repair, partial meniscectomy | wear simulator | gait cycle | 2100 N (axial), A-P force, rotation torque | Tekscan |
|13 | Beidokhti et al. (2017) | intact | horizontal rig | 0°, 30°, 60°, 90° | 5.2 Nm torque, 12 Nm, 106 N (axial), 100 N A force | Tekscan |
|14 | Bode et al. (2017) | CP after HTO and absorbing device | biomechanical simulator | 120° to 0° | 31 Nm, physiological loading | Tekscan |
|15 | Breitn et al. (2011) | neutral position, malrotation femur | experimental setup with entire lower limb | gait cycle | half-bodyweight force due to one leg | Tekscan |
|16 | Brial et al. (2019) | intact, bone plug meniscal allograft, fixation techniques, meniscectomy | multidirectional dynamic simulator | gait cycle | physiological loads | Tekscan |
|17 | Brown et al. (2016) | horizontal tear, meniscectomy | material testing machine | 0° | 1800 N (axial) | Tekscan |
|18 | Bruns et al. (1993) | meniscal repair, meniscectomy | experimental apparatus | 0° | 500 N (axial) | Fuji Prescale Film |
|19 | Bryant et al. (2014) | TKA; normal and valgus | experimental apparatus | 0°, 30°, 60° | 450 N (muscle load) | Fuji Prescale Film |
|20 | Chen et al. (2016) | intact, tear, ACL rupture | wear simulator | gait cycle | 2100 N (axial), A-P force, rotation torque | Tekscan |
|21 | Chen et al. (2020) | intact, mattress suture repair | material testing machine | 0°, 30°, 60°, 90° | 1000 N 5 N-intert rotation, 134 N-anterior tibial translation | Fuji film |
|22 | Chen M. et al. (1996) | meniscectomy, transplantation (different horn fixations) | desktop machine | 0° | 310 N (axial) | Inteqe Resources Corp. |
Menisci significantly influence tibiofemoral contact

|   | Authors             | Conditions                              | Testing Device | Materials | Loads and Setups |
|---|---------------------|-----------------------------------------|----------------|-----------|-----------------|
|23 | Dienst et al. (2007)| intact, meniscectomy, allografts        | material testing machine | 0°, 30°   | N.A. 1000 N (axial) | N.A. Fuji film |
|24 | Du et al. (2017)    | osteochondral allograft (OCA)           | test setup     | N.A.      | N.A. Extension moment 0 Nm, 4 Nm, 6 Nm, 8 Nm | N.A. Load cell |
|25 | Dugas et al. (2015) | meniscocapsular separation, repair      | modified material testing machine | 0°  | N.A. 1500 N (axial) | N.A. Tekscan |
|26 | Flemming et al. (2008)| intact, ACL-reconstruction               | horizontal fixation test setup | 0°  | N.A. Passive motion | N.A. Tekscan |
|27 | Forkel et al. (2014)| lateral posterior root release, transsection MFL, refixation posterior root (2 different techniques) | material testing machine | 0°  | N.A. 100 N (axial) | N.A. Novel approach |
|28 | Fukubayashi et al. (1980)| intact, meniscectomy                    | modified material testing machine | 0°  | N.A. 1000 N (axial) | N.A. Fuji film |
|29 | Geeslin et al. (2016)| lateral posterior root avulsion, deficient MFLs, ACL tear, ACL reconstruction, root repair | material testing machine | 0°, 30°, 45°, 60°, 90° | N.A. 1000 N (axial) | N.A. Tekscan |
|30 | Gilbert et al. (2014)| intact                                    | wear simulator  | N.A.      | N.A. gait cycle, stair climbing, 2100 N (axial), A-P force, rotation torque | N.A. Tekscan |
|31 | Goss et al. (1997)  | anterior cruciate ligament (ACL)        | experimental apparatus | 0°, 30°, 60°, 90°, 120° | N.A. 0–200 N | N.A. N.A. |
|32 | Goyal et al. (2014) | short (extended) vertical tear, partial (subtotal) meniscectomy | modified material testing machine | 0°, 30°, 60° | N.A. 350 N (axial) | N.A. Quadriceps (311 N), Hamstring (156 N) Fuji film |
|33 | Guettler et al. (2007)| normal, 3°, 6°, 9° varus direction, osteochondral defects | modified material testing machine | 30° | N.A. 687 N (axial) | N.A. Tekscan |
|34 | Hofer et al. (2012) | kneeling on TKA                          | custom knee testing system | 90°, 105°, 120°, 135° | N.A. 339 N / 678 N (single stand kneeling) | N.A. Tekscan |
Menisci significantly influence tibiofemoral contact

|   | Authors                  | Treatment Description                                                                 | Force-Measuring Equipment | Force (N)(axial) | Other | Pressure-Measuring Equipment |
|---|-------------------------|---------------------------------------------------------------------------------------|---------------------------|-----------------|------|------------------------------|
| 35. | Huang et al. (2002)    | autograft, allograft, horizontal Rig                                                   | N.A.                      | 1200            | N.A. | Fuji film                    |
| 36. | Ihn et al. (1993)      | intact, partial (total) meniscectomy, material testing machine                          | 0°                        | N.A. 3000       | N.A. | Sensor                      |
| 37. | Inaba et al. (1990)    | varus-valgus instability, experimental apparatus                                       | 0°                        | N.A. 2700       | N.A. | pressure transducers, Bourdon tube |
| 38. | Kolosky et al. (2004)  | uninjured knee pressure pattern → intraoperative pressure                              | N.A. 90°–0° = 90°        | N.A.            | N.A. | Tekscan                     |
| 39. | Kenawy et al. (2011)   | intact, rotational alignment, specimen lying on table + foot plate                     | N.A. 350                 | N.A.            | N.A. | Tekscan                     |
| 40. | Kim et al. (2015)      | root tear, repair, total meniscectomy, allograft, MCL release, modified material testing machine | 0°,30°,60°,90°           | N.A. 300        | N.A. | Novel approach              |
| 41. | Koh et al. (2016)      | intact, horizontal cleavage tear, repair, leaf resection, resection of both leaves    | 0°,60°                    | N.A. 800        | N.A. | Tekscan                     |
| 42. | Kurosawa et al. (1980) | total meniscectomy, desktop machine                                                    | 0°,30°,60°,90°           | N.A. 1500       | N.A. | Silicone rubber             |
| 43. | LaPrade et al. (2015)  | root tear, anatomical (nonanatomical) transstibial pull-out repair, modified material testing machine | 0°,30°,60°,90°           | N.A. 1000       | N.A. | Tekscan                     |
| 44. | Lee et al. (2006)      | radial tear, total meniscectomy, desktop machine                                       | 0°,30°,60°               | N.A. 1800       | N.A. | Tekscan                     |
| 45. | Li et al. (2002)       | PCL deficiency, robotic machine                                                        | 0–120°                   | N.A.            | N.A. | Quadriceps 400 N, Hamstring 200 N |
| 46. | Linder-Ganz et al. (2010)| intact, total meniscectomy, implant, modified material testing machine               | 0°                        | N.A. 1200       | N.A. | Tekscan                     |
| 47. | Marchetti et al. (2017) | intact, MCL tear and repair, bucket-handle tear, inside-out repair, all-inside repair, modified material testing machine | 0°,30°,45°,60°,90°       | N.A. 1000       | N.A. | Tekscan                     |
| 48. | Marzo et al. (2009)    | meniscal horn tear, repair, material testing machine                                   | 0°                        | N.A. 1800       | N.A. | Tekscan                     |

This is a provisional file, not the final typeset article
Menisci significantly influence tibiofemoral contact

|   | Study                                      | Conditions                          | Testing Machine | Flexion-Extension Cycle | Quadriceps (218 N), hamstring (80 N) | Tekscan |
|---|--------------------------------------------|-------------------------------------|-----------------|-------------------------|--------------------------------------|---------|
| 49. | McCulloch et al. (2016)                    | intact, transplant, autograft       | Oxford-rig      | 0°, 30°, 90°, 115°      | 267 N (axial – GRF)                  |         |
| 50. | McDermott et al. (2008)                    | intact, meniscectomy, allograft (bone block, suture) | modified material testing machine | 0° | N.A. | 700 N (axial) |         |
| 51. | MacDonald et al. (1996)                    | posterior cruciate deficient knee   | material testing system machine | 0°, 30°, 60° | N.A. | 1500 N | Tekscan |
| 52. | Meyer et al. (2008)                        | test to failure, ACI rupture due to ex compressive loading | modified material testing machine | 30° | N.A. | up to 5.5 kN | Fuji Prescale film |
| 53. | Mina et al. (2008)                         | HTO for unloading osteochondral defect | material testing machine | 30° flexion + 12° varus to 10° varus (stepwise 2°). | N.A. | 200 N | Tekscan |
| 54. | Muriuki et al. (2011)                      | intact, tear, medial meniscal tear, repair, total meniscectomy | modified material testing machine | 0°, 30°, 60°, 90° | N.A. | 1000 N (axial) | Fuji film |
| 55. | Nakayama et al. (2005)                     | diff. TKA designs by posterior force | parallel-link six-axis actuator | 9°, 120°, 150° | N.A. | posterior load 500 N | Tekscan |
| 56. | Ode et al. (2012)                          | intact, radial tear, repair, total meniscectomy | modified material testing machine | 0°, 60° | N.A. | 800 N (axial) | Tekscan |
| 57. | Ostermeier et al. (2006)                   | TKA and tibiofemoral slope          | knee simulator (isokinetic) | N.A. | 120° – 0° | passive | Hamstring 200 N, Quadriceps 31 Nm | Tekscan |
| 58. | Paci et al. (2009)                         | intact, after release Anterior Intermeniscal Ligament | modified material testing machine | N.A. | 0° to 60° | 1000 N (axial) | Tekscan |
| 59. | Padalecki et al. (2014)                    | root avulsion, repair, radial tear, in situ repair | modified material testing machine | 0°, 30°, 45°, 60°, 90° | N.A. | 1000 N (axial) | Tekscan |
| 60. | Paletta et al. (1997)                      | intact, meniscectomy, allograft, release of anterior/posterior horn attachments of allograft | material testing machine | 0°, 30°, 60° | N.A. | 1800 N (axial) | Fuji film |
| 61. | Perez-Blanca et al. (2016)                 | posterior root avulsion, repair, total meniscectomy | desktop machine | 0°, 30°, 60°, 90° | N.A. | 1000 N (axial) | Tekscan |
| No. | Authors          | Description                                                                 | Material Testing Machine | Angle(s) | Load (N)         | Type                      | Notes          |
|-----|------------------|------------------------------------------------------------------------------|--------------------------|----------|-----------------|----------------------------|----------------|
| 62  | Poh et al. (2012) | intact, after sectioning anterior intermeniscal ligament                    | modified material testing machine | 0°       | 1800 N (axial)  | N.A.                       | Tekscan        |
| 63  | Prince et al. (2014) | intact, lateral anterior horn tear, repair, meniscectomy                  | material testing machine   | 0°, 30°  | N.A.            | 1000 N (axial)             | N.A. Tekscan   |
| 64  | Rodner et al. (2006) | HTO, tibial slope                                                           | material testing machine   | 0°, 30°  | N.A.            | 500 N                      | N.A. Tekscan   |
| 65  | Schall et al. (2019) | Proof-of-Concept: Novel Knee Joint Simulator                                | knee joint simulator, Oxford rig | N.A.     | gait cycle      | GGF: over 800 N             | Tekscan        |
| 66  | Schillhammer et al. (2012) | posterior horn detachment, repair                                           | modified material testing machine | N.A.     | gait cycle      | 2000 N (axial), A-P force, rotation torque | N.A. Tekscan   |
| 67  | Seitz et al. (2012) | intact, partial (total) meniscectomy                                        | modified material testing machine | 0°, 30°, 60° | N.A.          | 1000 N (axial)             | N.A. Tekscan   |
| 68  | Seitz et al. (2019) | open-wedge high tibial osteotomy (5°, 10°)                                  | load-application system    | 0°, 30°  | N.A.            | 1000 N (axial)             | N.A. Tekscan   |
| 69  | Sekaran et al. (2002) | nonanatomic location (autolog. PCL)                                        | load-application system    | 0°, 15°, 30°, 45° | N.A.      | 1200 N (axial)            | N.A. Fuji film |
| 70  | Shimakawa et al. (2019) | intact, ACL reconstruction, partial- + subtotal meniscectomy               | load-application system    | 0°, 30°, 60°, 90° | N.A.     | 735 N                      | N.A. Tekscan   |
| 71  | Shiramića et al. (2009) | high flexion knee designs                                                  | mechanical testing machine | 0, 30, 60, 90, 110, 135, 155° | N.A.    | 3600 N                     | N.A. Tekscan   |
| 72  | Stein et al. (2019) | partial medial meniscectomy, partial meniscal replacement                  | mechanical testing machine | N.A.     | flexion cycle, squat, 0° to 100° | 200 N                      | N.A. Tekscan   |
| 73  | Steinbruck et al. (2016) | TKA posterior-stabilized vs. medial-stabilized design                      | Oxford rig                 | N.A.     | active deep knee flexion from 20° to 120° | N.A. Quadriceps Hamstring | Tekscan        |
Menisci significantly influence tibiofemoral contact

| Study Reference | Test Conditions | Apparatus/Setup | Contact Angle | Axial Load | Shear Force | Torque | Result Notes | Machine |
|-----------------|-----------------|-----------------|---------------|------------|-------------|--------|--------------|---------|
| 74.  | intact, before and after total knee arthroplasty (TKA) | knee simulator (horizontal) | 120° – 0° | N.A. | N.A. | 31 Nm ext. moment | Tekscan |
| 75.  | intact, before and after total knee arthroplasty (TKA) | knee simulator (horizontal) | 120° – 0° | N.A. | N.A. | 31 Nm ext. moment | Tekscan |
| 76.  | contact stresses at both compartments | 6-DOF holding apparatus | 15.5° flexion and slight varus angle 2° | N.A. | 1144 N | N.A. | Tekscan |
| 77.  | intact, horizontal cleavage tear, flap removal | desktop machine | −5° to 135° | 500 N (axial) | 100 N P shear | 2.5 Nm torque | Quadriceps | Tekscan |
| 78.  | HTO, MCL release | test setup | 0° | N.A. | N.A. | N.A. | Tekscan |
| 79.  | total meniscectomy, transplant | material testing machine | 0° | N.A. | 800 N (axial) | N.A. | Tekscan |
| 80.  | meniscectomy, transplant | material testing machine | 0°, 30° | N.A. | 1000 N (axial) | N.A. | Tekscan |
| 81.  | intact, implant, total meniscectomy, allograft | Horizontal Rig | 0° to 90° | 1000 N (axial), 76 N (A-P force), 3.4 Nm (rotation torque) | Quadriceps (190 N), RF (250 N) | Tekscan |
| 82.  | intact | test setup | 0°, 30°, 60°, 90° | N.A. | 0 N, 1000 N, 1500 N | N.A. | Miniature contact pressure transducer |
| 83.  | intact | Horizontal Rig | −5° to 135° | 500 N (axial) + 100 N a.-p. shear | N.A. | Tekscan |
| 84.  | intact, meniscectomy, autograft transplantation | modified load-controlled knee simulator | gait cycle | N.A. | N.A. | N.A. | Tekscan |
| 85.  | neutral, varus/valgus malalignment | modified material testing machine | 0° flexion | 10%, 20% varus/valgus | N.A. | 750 N | N.A. | Tekscan |
|   | Authors and Year       | Procedure Description                                                                 | Setup                                                                 | Angle | Load   | Load   | Instrument   |
|---|------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-------|--------|--------|--------------|
| 86 | Willinger et al. (2020)| sequential medial meniscus resection, intersect the tibia plateau at 30%, 40%, 50%, 60%, 70% | universal testing machine                                             | 0°    | N.A.   | 750 N  | N.A. Tekscan |
| 87 | Yazdi et al. (2014)    | intact, tibial rotation                                                               | lower limb loading apparatus                                         | 0°    | N.A.   | Half BW of each specimen | N.A. Fuji film |
| 88 | Yazdi et al. (2016)    | intact, partial fibulectomy                                                           | lower limb loading apparatus                                         | 0°    | N.A.   | Half BW of each specimen | N.A. Fuji film |
| 89 | Zhang et al. (2015)    | intact, repair, meniscectomy                                                          | modified material testing machine                                    | 0°, 8°, 15°, 30° | N.A.   | 250 N, 500 N, 1000 N | N.A. Tekscan   |