Knee Surg Sports Traumatol Arthrosc (2014) 22:475–477
DOI 10.1007/s00167-014-2860-5

EDITORIAL

The importance of the third knee compartment on outcome following total knee arthroplasty

Roland Becker · Jon Karlsson

Published online: 31 January 2014
© Springer-Verlag Berlin Heidelberg 2014

The third compartment, the patellofemoral joint, appears to have been neglected somehow when discussing optimal knee kinematics in total knee arthroplasty (TKA). How much impact will good function of the patellofemoral joint have on the clinical outcome after TKA?

There is an extensive amount of discussion on whether or not the patella should be resurfaced in TKA. Some surgeons resurface the patella routinely, some never and some selectively, depending on the shape of the patella. A meta-analysis of all randomized studies until 2009 showed no difference between resurfacing or not of the patella in terms of postsurgical rate of anterior knee pain, knee pain score and quality of life [10].

The overall incidence of anterior knee pain after TKA without patella resurfacing ranged between 12 and 87 % [14, 20]. Anterior knee pain has been shown to impair patient's quality of life.

The literature review about anterior knee pain after TKA published in the current issue shows that there is more than one reason for patellofemoral pain [21].

Variables, which may directly influence patellofemoral loading, appear to show an impact on clinical and functional outcome. In conclusion, correct kinematic seems to be important.

Biomechanical studies have proven that patella kinematic during knee flexion is very complex because of the combination of rotation, flexion and mediolateral shift. Considering the amount of patellofemoral forces of more than 3 times body weight, minor changes of patella tracking may cause significant impact on the loading condition [16]. In vivo fluoroscopy data were used, and patellofemoral force was calculated using a 3D mathematical model. Interestingly, patellofemoral contact did not differ between normal, cruciate retaining and posterior stabilized total knee arthroplasty. The data were in contrast to the biomechanical findings reported by others. It has been shown that patellofemoral pressure increases up to 1.5–2.5 times after TKA in comparison with the natural knee [13]. Studies have also reported about the impact of the component design on femoropatella pressure [4]. Of course, it depends on the components shape of both the patella and the trochlea groove. Six different patella designs are most commonly used in TKA: the dome, offset dome, modified dome, anatomic mobile bearing, anatomical and cylindrical type of patella [15].

The design of the patella component significantly influences patella tracking also. The dome-shaped patella shows a more internal and external rotation for instance, compared with a more anatomical component [7].

Anatomical studies have shown that the morphology of the femur, tibia and patella varies tremendously. How much of the anatomy do we restore when performing TKA? Do we require a more patient-specific trochlea design? There seems to be a direct relation between the shape of the trochlea and patella kinematic and pain [9]. The articular cartilage depth, the length of the trochlea groove and the height of the patella significantly influence patella tracking.

It is well known that femoral component malrotation will affect the femoropatella joint [5, 11]. Increased internal rotation will cause overstuffing of the lateral facet.

R. Becker (✉)
Department of Orthopaedics and Traumatology, Hochstrasse 26, 14770 Brandenburg/Havel, Germany
e-mail: roland_becker@yahoo.de

J. Karlsson
Department of Orthopaedics, Sahlgrenska University Hospital, Molndal, Sweden
e-mail: jon.kssta@gmail.com

Malposition of the patella component also affects the patellofemoral kinematic. Medialization of the patella component shifts and tilts the patella laterally [2]. In conclusion, abnormal tension might occur in the medial or lateral retinaculum. Under- or overstuffing of the patellofemoral compartment ends with stretching or slacking of the medial patellofemoral ligament [8]. Scott Dye performed a mapping of pain sensation of his own knee [6]. No pain was provoked behind the patella but moderate to severe localized pain was identified at the medial and lateral retinaculum. The soft tissue of the knee seems to play an important role regarding knee pain, because this is the site of nociception. It raises the question whether or not surgeons balance the patella as meticulously as they do with the femorotibial joint?

The impact of component placement in term of rotation on both sites the femur and tibia component is well known. However, considering the huge variety of femoral component designs, there will be significant differences in patella tracking. Perhaps, one or the other component designs might be more forgiving, which is not known yet. Most femoral components rely primarily on the anteroposterior and mediolateral dimension of the distal femur. The comparison of different femoral component designs has shown that a larger more anatomical component will differ in stair climbing from components having a smaller radius of the trochlea [1].

Anthropometric studies have shown a wide variation in size and shape of the patella. The thickness at the central ridge seems to range from 17 to 26 mm and the mediolateral width between 32 and 64 mm [3, 12]. The patella is larger in size in male than in female patients. There are remarkable variations in the configuration of the medial and lateral facet of the patella as described first by Wiberg [23].

Not only the patella but also the trochlea as the anatomical counterpart shows a wide variation in shape, depth and angulation [18]. One may question whether the currently available implants take all these aspects into consideration. The “patella friendly” femoral component design was developed showing an extended anterior flange, a deeper and wider trochlea groove. This will engage the patella earlier during flexion, decrease patella mobility and increase the patellofemoral contact area. One study reported a significantly decrease in complications when using a “patella friendly” design [19]. However, the review by van Jonbergen showed that the “patella friendliness” design did not reduce the rate of anterior knee pain [21]. Why does the patella friendly design fail to improve the clinical outcome? It might be both the bony morphology and the surrounding soft tissue.

The medial and lateral collateral ligament act almost isometric throughout the range of knee motion showing a maximal strain of less than 2 % [22]. The mean length of the medial patellofemoral ligament increases in length up to 30° of knee flexion and shortens continuously until full flexion with approximations of changing its insertion site of 0.25 mm/10° of knee flexion. In case we are unable to restore the minor changes in soft tissue strain, the performance of the total knee prosthesis is compromised.

How much stretching of the soft tissue envelope is allowed? We know that the closure of the knee after TKA in flexion improves the range of motion and less initial physiotherapy is required [17]. Such a small difference in our surgical technique provides already a significant impact on the early clinical or functional outcome.

The most difficult part in total knee arthroplasty is the restoration of the harmony of all three compartments. It does not rely solely on the bony geometry. The surrounding soft tissue seems to play a much more important role. We all know that excellent results in component placement show on radiography yet patients appear less satisfied, but the converse may also be true.

Despite the long history of TKA, there are many questions still unsolved. However, it explains the permanent development of new concepts in TKA.

References

1. Andriacchi TP, Yoder D, Conley A, Rosenberg A, Sum J, Galante JO (1997) Patellofemoral design influences function following total knee arthroplasty. J Arthroplasty 12:243–249
2. Anglin C, Brimacombe JM, Wilson DR, Masri BA, Greidanus NV, Tonetti J, Hodgson AJ (2010) Biomechanical consequences of patellar component medialization in total knee arthroplasty. J Arthroplasty 25:793–802
3. Baldwin JL, House CK (2005) Anatomic dimensions of the patella measured during total knee arthroplasty. J Arthroplasty 20:250–257
4. Becher C, Heyse TJ, Kron N, Ostermeier S, Hurschler C, Schofer MD, Fuchs-Winkelmann S, Tibesku CO (2009) Posterior stabilized TKA reduce patellofemoral contact pressure compared with cruciate retaining TKA in vitro. Knee Surg Sports Traumatol Arthrosc 17:1159–1165
5. Colwell CW, Chen PC, D’Lima D (2011) Extensor malalignment arising from femoral component malrotation in knee arthroplasty: effect of rotating-bearing. Clin Biomech 26:52–57
6. Dye SF, Vaupel GL, Dye CC (1998) Conscious neurosensory mapping of the internal structures of the human knee without intraarticular anaesthesia. Am J Sports Med 26:773–777
7. Fitzpatrick CK, Baldwin MA, Clary CW, Wright A, Laz PJ, Rullkoetter PJ (2012) Identifying alignment parameters affecting implanted patellofemoral mechanics. J Orthop Res 30:1167–1175
8. Ghosh KM, Merican AM, Iranpour F, Deehan DJ, Amis AA (2009) The effect of overstuffing the patellofemoral joint on the extensor retinaculum of the knee. Knee Surg Sports Traumatol Arthrosc Ger 17:1211–1216
9. Harbaugh CM, Wilson NA, Sheehan FT (2010) Correlating femoral shape with patellar kinematics in patients with patellofemoral pain. J Orthop Res 28:865–872

10. He JY, Jiang LS, Dai LY (2011) Is patellar resurfacing superior than nonresurfacing in total knee arthroplasty? A meta-analysis of randomized trials. Knee 18:137–144
11. Kessler O, Patil S, Colwell CW, D'Lima DD (2008) The effect of femoral component malrotation on patellar biomechanics. J Biomech 41:3332–3339
12. Kim TK, Chung BJ, Kang YG, Chang CB, Seong SC (2009) Clinical implications of anthropometric patellar dimensions for TKA in Asians. Clin Orthop Relat Res 467:1007–1014
13. Leichtle UG, Wünschel M, Leichtle CI, Müller O, Kohler P, Wülker N, Lorenz A (2013) Increased patellofemoral pressure after TKA: an in vitro study. Knee Surg Sports Traumatol Arthrosc. doi:10.1007/s00167-013-2372-8
14. Pulavarti RS, Raut VV, McLauchlan GJ (2013) Patella denervation in primary total knee arthroplasty—a randomized controlled trial with 2 years of follow-up. J Arthroplasty. doi:10.1016/j.arth.2013.10.017
15. Schindler OS (2012) The controversy of patellar resurfacing in total knee arthroplasty: ibisne in medio tutissimus? Knee Surg Sports Traumatol Arthrosc 20:1227–1244
16. Sharma A, Leszko F, Komistek RD, Scuderi GR, Cates HE, Liu F (2008) In vivo patellofemoral forces in high flexion total knee arthroplasty. J Biomech 41:642–648
17. Smith TO, Davies L, Hing CB (2010) Wound closure in flexion versus extension following total knee arthroplasty: a systematic review. Acta Orthop Belg 76:298–306
18. Tecklenburg K, Dejour D, Hoser C, Fink C (2006) Bony and cartilaginous anatomy of the patellofemoral joint. Knee Surg Sports Traumatol Arthrosc Ger 14:235–240
19. Theiss SM, Kitziger KJ, Lotke PS, Lotke PA (1996) Component design affecting patellofemoral complications after total knee arthroplasty. Clin Orthop Relat Res 326:183–187
20. van Jonbergen HP, Scholtes VA, van Kampen A, Poolman RW (2011) A randomised, controlled trial of circumpatellar electrocautery in total knee replacement without patellar resurfacing. J Bone Joint Surg Br 93:1054–1059
21. van Jonbergen HP, Reuver JM, Mutsaerts EL, Poolman RW (2012) Determinants of anterior knee pain following total knee replacement: a systematic review. Knee Surg Sports Traumatol Arthrosc. doi:10.1007/s00167-012-2294-x
22. Victor J, Wong P, Witvrouw E, Sloten JV, Bellemans J (2009) How isometric are the medial patellofemoral, superficial medial collateral, and lateral collateral ligaments of the knee? Am J Sports Med 37:2028–2036
23. Wiberg G (1941) Roentgenographic and anatomic studies on the femoro-patellar joint. Acta Orthop Scand 12:319–410