

Articular surfaces of the proximal interphalangeal (PIP) joint and its proper collateral ligament (PCL) fiber bundles as a crossed four-bar linkage system

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With respect to the application of synovial joint arthroplasties to alleviate joint pain and destruction in e.g. rheumatoid arthritis, there is currently a difference of opinion, which type of artificial joint is optimal (Sweets & Stern, 2011). Starting from analyses, performed to design total knee joint prostheses, we used similar approaches for the proximal interphalangeal (PIP) joint of the finger (Wachowski *et al.*, 2011). Incongruences between the articular curvatures of the proximal phalanx's caput and the middle phalanx's basis were taken into account, as well as some less-known intercrossing superficial and deep fiber bundles within the PIP proper collateral ligament (PCL) (van Zwieten *et al.*, 2011). Histological staining did not reveal notable differences in elasticity between these PCL bundles. Numerical values after measurements in parasagittal HR-MRI slices allowed us to conceive finger PIP joints as crossed 4-bar linkage systems, in view of the fact that PCL fiber bundles are fully tautened during PIP flexion. Therefore they can be modelled as solid bars, just as their solid areas of bony attachment on either phalanx. By 4-bar linkage analysis we were able to construct the curvatures of the only two articulating surfaces which can perform PIP flexion by rolling relative to each other without any gliding. Such engineering results can be used for prosthesis design although they deviate from normal anatomy.

References

Sweets TM, Stern PJ (2011) Pyrolytic carbon resurfacing arthroplasty for osteoarthritis of the proximal interphalangeal joint of the finger. *JBJS*, 93, 1417-1425

Wachowski MM *et al.* (2011) Construction-conditioned rollback in total knee replacement: fluoroscopic results. *Acta of Bioengineering and Biomechanics*, 13, 3, 35-42

van Zwieten KJ *et al.* (2011) Finger Proximal Inter Phalangeal (P.I.P.) Motion : Joint Surfaces and Ligamentous Geometries Are Interrelated. Proceedings 6th Conference "Health - the base of human potential." St. Petersburg, 24th - 26th November, 2011, www.human-potential.info/, 231-236