

Polycentric Exoprosthetic Knee Joints – Extent of Shortening during Swing Phase

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Background

Tripping is a safety risk for amputated persons and it is mainly affected by reduced ground clearance during swing phase. An often assumed advantage of polycentric knee joints compared to monocentric concepts is the improved ground clearance during swing phase due to the geometric shortening of the lower leg segment (LLS)^{1,2,3}. Based on this statement safety benefits for above knee-amputees due to reduced danger of stumbling are discussed commonly for the entire group of polycentric knee joints.

Aim

To investigate whether polycentric knee joints considerably improve ground clearance and to evaluate the influence of prosthetic alignment on the extent of ground clearance

Results

Shortening of up to 14.7 mm at the instance of minimal ground clearance during swing phase was measured. One knee joint elongated by 4.4 mm. Measurements of the ground clearance demonstrated differences up to 25.4 mm. One monocentric knee joint provided more ground clearance when compared to 8 of the polycentric knee joints investigated. A comparison of different alignment methods with regards to toe clearance was conducted for one monocentric and one polycentric knee joint and showed differences up to 8.2 mm.

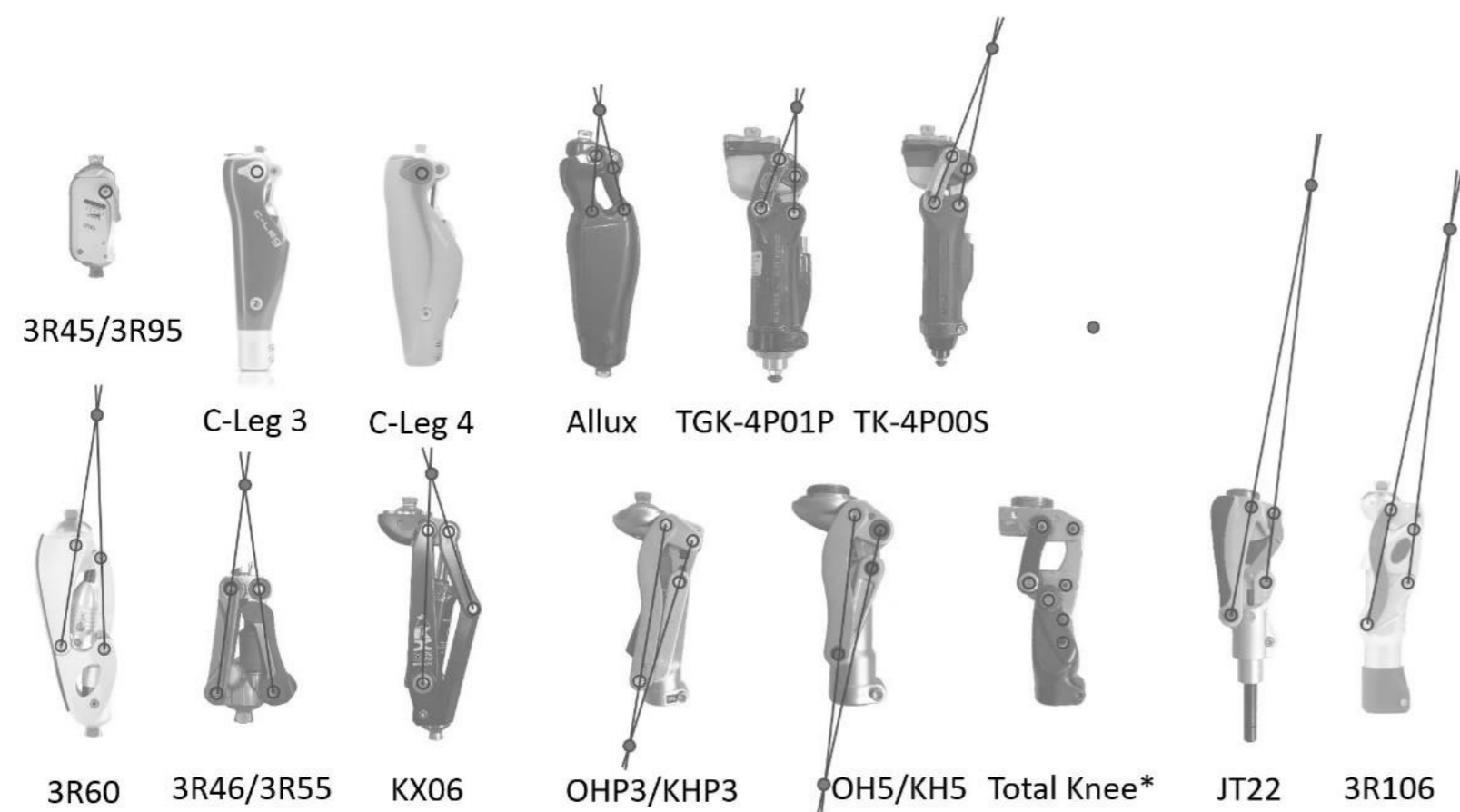


Figure 1: Polycentric and monocentric prosthetic knee joints investigated.

Methods

11 polycentric and 2 monocentric knee joints were attached to a rigid, stationary testing device which allows for a step-less adjustment of the hip flexion angle. Prosthetic components were mounted at the same height. The anterior-posterior position was in accordance with the manufacturer's alignment recommendations. Shortening of the LLS and the resulting ground clearance during knee flexion were measured at four hip flexion angles (15°, 20°, 25°, 30°) with an optoelectronic 12-camera motion capture system (Vicon, UK). A setup validation was conducted. The authors assume an accuracy of ±1.1 mm for the investigated parameters.

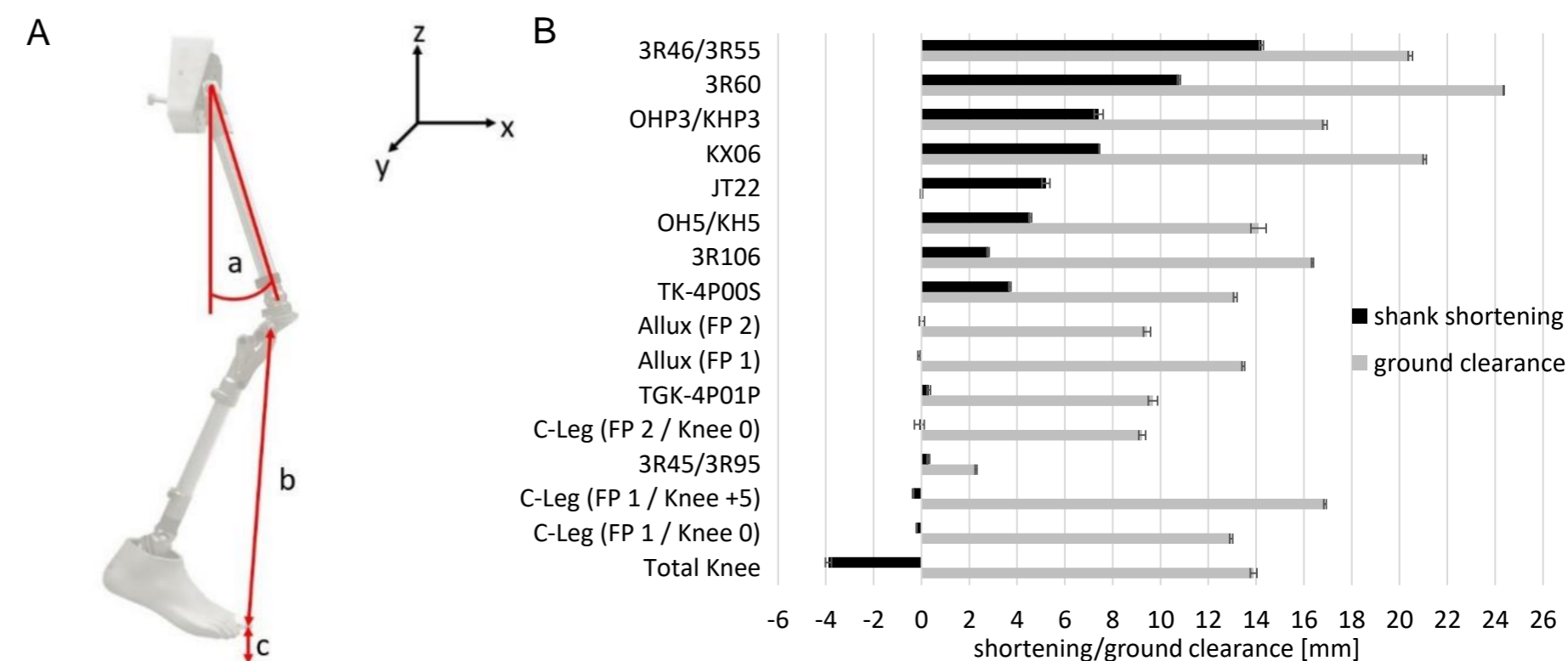


Figure 2. (A) Schematic illustration of the experimental setup, hip flexion angle (a), length of the lower leg segment (b), minimum ground clearance (c); (B) Shortening of the lower leg segment (black) and ground clearance (grey) at 25° hip flexion.

Discussion & Conclusion

The results showed, that only some polycentric knee joints shorten appreciably at the instant when a stumble might occur. Thus, the previously stated functional advantage of greater ground clearance for patients must be reconsidered. A slightly more anterior position of the knee joint or a more posterior position of the foot can compensate for or even exceed the extent of the geometric shortening of the shank of some polycentric knee joints.

References

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