Differential function of mechanical prosthetic knees: An overview based on technical and biomechanical considerations.

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INTRODUCTION

The selection of mechanical, non-MP controlled prosthetic knees (NMPK) for an individual is primarily based on the prosthetist´s experience and/or insurance coverage of the patient, but not substantiated by clinical evidence (1). Therefore, this paper aims at finding more objective criteria for the selection of mechanical prosthetic knees.

METHOD

A search of the scientific literature was performed in the Medline, CINAHL, OTseeker, and PEDro databases as well as in the online library of the Journal of Prosthetics & Orthotics. Search terms were related to mechanical prosthetic knees. In addition, English and German language prosthetic textbooks as well as the personal library of the author were reviewed.

RESULTS

Most of the references found were primarily technical and/or biomechanical. Many classifications of NMPKs did not prove useful to guide selection of a knee type for an individual patient. A systematic review of studies with NMPKs was unable to give any useful guidance for knee selection either (2). A German language publication suggested a classification of knees based on their ability to allow for flexion during weight-bearing (3). Knees have been classified to allow for no knee flexion (locked knees, friction brake [safety] knees, 4-bar knees), limited knee flexion (multiaxial knees with >5 axes), and unlimited knee flexion (hydraulic stance control knees) during weight-bearing. Knees that do not allow for flexion during weight-bearing basically support walking on level surfaces only. Locked knees may be fitted in patients only who are not able to make sure that an unlocked knee is safe (fully extended) prior to heel strike of the next step. Friction brake knees are suitable for subjects who can make sure the prosthesis is extended (safe) prior to heel strike, but still require great stability during the stance phase of gait. More dynamic walkers may benefit from a 4-bar knee that allows for a more physiologic knee flexion at terminal stance and shortening of the calf during swing for increased toe clearance. Knees that allow for limited flexion during weight-bearing (multiaxial knees) support stance flexion for shock absorption and, depending on the amount of knee flexion, ambulation on slightly uneven terrain and shallow slopes. Knees that allow for unlimited flexion during weight-bearing (hydraulic stance control knees) allow for ambulation on all kinds of terrains, but require very good muscle strength and coordination to control them as mechanical knees are generally characterized by an inverse relationship between stance stability and functional support: The more stable a knee, the fewer functions it supports and vice versa.

DISCUSSION

Clinical studies with NMPKs that could give useful guidance for knee selection for individual patients are lacking, but technical and biomechanical considerations may help improve knee selection criteria for the physical condition and needs of individual patients.

CONCLUSION

Mechanical prosthetic knees may be classified based on their ability to allow for flexion during weight-bearing, and technical and biomechanical considerations allow for improving knee selection criteria.

REFERENCES

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DISCLOSURE

Andreas Kannenberg is a full-time employee of Otto Bock HealthCare LP, Austin, TX, a leading manufacturer of prosthetic components.