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**Titel**

The effects of two different types of chopart prostheses during level walking on gait parameters, socket and plantar pressure.

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**Zusammenfassung**

The loss of the forefoot lever due to Chopart amputation is a known problem and often a Bellmann (BP) or Clamshell prosthesis (CSP) is fitted to restore the foot length. Both devices address foot length however the CSP seems to be more effective in creating an adequate foot lever.

**Einführung**

After partial foot amputations at the Chopart line (Articulatio tarsi transversa) usually two kinds of prostheses (e.g. Bellmann (BP) or clamshell-type prostheses (CSP)) [1] are most frequently used to restore the foot length and regain an adequate foot lever arm [2]. The BP is a flexible slipper socket which allows full ankle joint range of motion (ROM). Whereas the CSP is a semi-rigid, shin high device with a fixed ankle joint and a carbon fiber footplate (e.g. Chopart-Plate, Ossur, Iceland). So far the device decision is mostly based on the patients remaining ROM in the ankle joint, present stump status, level of daily activity and cosmetic aspects rather than on evidence based literature, concerning biomechanical effects [3]. The aim of this study is to compare the biomechanical effects of these two devices on gait pattern, restored foot lever, as well as pressure distribution during gait. 3D gait analysis is performed including plantar- and socket pressure measurements.

**Methodik**

A cohort of 12 Chopart amputees shall be recruited. The subjects are separated in two groups according to their current prosthesis (Group 1: CSP; Group 2: BP). If a subject owns both types of prosthesis, the subject will be included in both groups and measured twice. Inclusion criteria are a K-Level of at least 3 or higher, no walking aids, and no limitations in the sound side and

either a BP or CSP. Every subject performs a 3D gait analysis including plantar and socket pressure measurements during level ground walking. A total of 12 cameras (T-Series, Vicon) and two AMTI Force plates (AMTI, USA) are used, as well as the Vicon PiG model (Vicon, UK). The plantar pressure is measured by insoles (Novel, GER) inside the shoe for both prostheses. Only for the CSP a socket sensor (Novel, GERM size: 15x6 cm) was placed along the tibia. To determine changes in gait parameters, plantar pressure and socket pressure an ANOVA is used to compare effects between these two groups.

### **Ergebnisse**

The first preliminary results of one participant fitted with both prosthetic devices are presented exemplarily. Temporo spatial parameters show, that self-selected speed (CSP:  $1.26 \pm 0.03$  m/s; BP:  $1.11 \pm 0.03$  m/s) and cadence (CSP:  $104 \pm 1.4$  Stride/min; BP:  $99.9 \pm 2.1$  Stride/min) of this particular subject was higher wearing the CSP compared to the BP.

The BP enabled the user to perform a higher Ankle-ROM ( $35 \pm 1.6^\circ$ ) during level walking than the CSP ( $7.8 \pm 0.6^\circ$ ). The external dorsiflexion moment during terminal stance was higher with the CSP ( $1.2 \pm 0.1$  Nm/kg) than with the BP ( $0.3 \pm 0.1$  Nm/kg). In terminal stance the total ground reaction force (GRF) was higher in CSP ( $11.5 \pm 0.1$  N/kg) compared to BP ( $10.2 \pm 0.2$  N/kg) (Fig. 1, Row 1).

The CoP excursion in anterior posterior direction measured by the insoles showed that the CoP stays at the hind foot of the insole until 50% of the gait cycle wearing the BP, whereas the CoP with CSP has a constant progression to the toes. A corresponding increase of pressure at the ventral shell could be seen at 20% of the gait cycle, when the CoP started to progress forward with CSP (Fig.1, row 2).

### **Schlußfolgerung**

The BP has the advantage of a higher range of motion in the ankle joint, however was not able to create a proper ankle joint moment during terminal stance. The Subject was not able to put pressure on the forefoot wearing the BP, therefore the CoP stayed at the hind foot, resulting in a low ankle joint moment and low GRF during terminal stance.

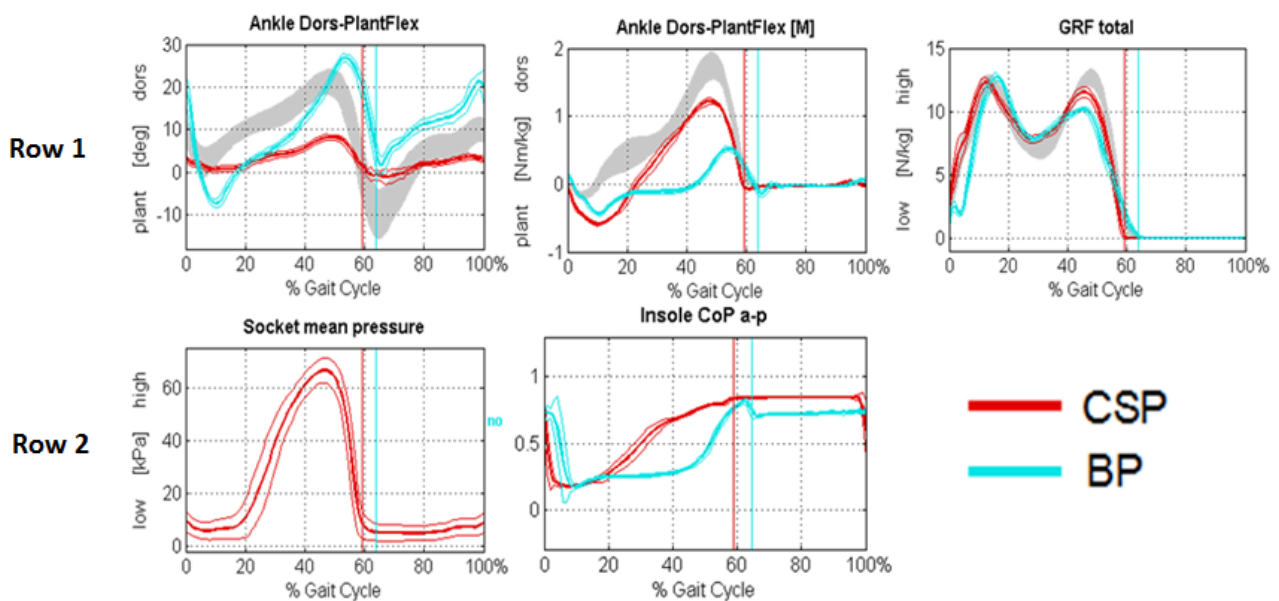
In contrast the framework of the CSP allowed the wearer to apply pressure at the ventral shell, through the tibia progression, which results in a forefoot loading. Due to this, the CoP

can progress further anterior resulting in an increased dorsiflexion moment and GRF during terminal stance. These findings show a potential mechanical advantage of the CSP compared to the BP in creating an adequate toe lever. However this discussion is based on the first measured subject out of a bigger cohort. Therefore this can only be seen as a prognosis. Further discussion can be made once the whole cohort is measured.

**Literaturreferenzen**

- [1] Baumgartner, Die orthopädietechnische Versorgung des Fußes 2001.
- [2] Rubin, Orthop Rev 1985,14:688-695.
- [3] Dillon et al., Journal of Prosthetics and Orthotics 2007, 19:2-35.

**Image:** Figure 1\_2190.png



**Figure 1:** Kinematics, Kinetics in the sagittal plane and the GRF (row 1). As well as the mean socket pressure and CoP excursion in anterior posterior direction (row 2). All graphs are normalized to the gait cycle.