Temporal-spatial parameters, energy expenditure and perceived comfort of transfemoral amputees: Ischial containment vs atmospheric pressure stabilization sockets

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INTRODUCTION

Ischial containment (IC) is a standard transfemoral (TF) socket style which was introduced in the 1980s by Ivan Long as an alternative to the traditional quadrilateral socket. (Schuch and Pritham, 2004) While an IC socket is effective in reducing weight bearing on the distal end of the femur, patients may find the ischial seat uncomfortable and trimlines are often visible through clothing. An atmospheric pressure stabilization (APS) socket is a new brimless socket design which combines a sub-ischial design with the idea of compression–release stabilization. (Alley, 2011) The socket utilizes trimlines that minimize the amount of socket that the patient has to wear and openings in the socket to allow for greater range for muscle contraction and sensory feedback during sitting. The socket is worn simply with a gel liner and sleeve and suspended via vacuum. See Photo 1 below comparing one subject’s IC and APS sockets. This study investigated differences related to patient comfort, energy expenditure and gait parameters between the IC with lanyard suspension and APS with vacuum suspension by direct comparison using 3 outcome measures including the Prosthetic Evaluation Questionnaire (PEQ), the physiological cost index (PCI) and the GaitRite mat.

METHODS

IRB approval for this study was obtained prior to subject enrollment. Six subjects currently wearing an IC socket were recruited to participate. While wearing their IC socket, subjects completed the PEQ, their PCI was measured and the GaitRite mat was used to calculate their velocity, step lengths, base of support distance and cadence. An APS socket was then fabricated in a standardized method for each subject and placed onto their current prosthetic knee and foot and they wore it for four weeks. They then returned to complete the same three outcomes measures while wearing the APS socket. Results were then compiled and compared within Excel.

RESULTS

Two subjects completed the full four week study. For the two subjects who completed the study, both showed higher scores in the PEQ. Both subjects also had higher cadences, velocities and lower differences between step lengths and base of support between their sound and prosthetic legs while wearing the APS socket compared to the IC socket. One subject showed an improvement in PCI and the other showed a decline in PCI. Unfortunately, four of the six subjects were unable to complete the study due to inability to return for follow up or an inability to tolerate the pressures applied to the residual limb by the socket.

DISCUSSION

We believe the brimless design in combination with the areas of compression and release allowed for the subjects in this study to obtain a more normal step length on their prosthetic side along with faster speeds and higher cadences, which was evidenced by the gait data. This data is confirmed by Rabuffetti, et al. (2005) who found reduced hip extension and flexion at heel strike in the gait of TF amputees wearing an IC socket. He also demonstrated that TF amputees wearing an IC socket have increased anterior pelvic tilt which was deemed to be a compensation strategy in order to obtain a more functional step length. However, this leads to overloading of the lumbar spine and could contribute to the back pain frequently seen in the amputee population. The lack of the ischial seat in the APS socket removes some stability, but in turn allows for greater ROM into hip extension and flexion. Further study could show whether or not the lack of the ischial seat in the APS socket reduces the anterior pelvic tilt and thus has potential for reducing back pain.

CONCLUSIONS

As is well known in the practice of prosthetics, not all patients are suited for all socket types, suspension mechanisms and componentry. This study presents a prime example of two patients who benefited from a new socket design. Aside from the subjects enrolled into this study, the APS has been used on patients intolerant of an ischial seat, one with colostomy bags that interfered with a brimmed design and an individual who sits frequently. There are trade-offs involved with every prosthesis design and it is ultimately up to the amputee and the prosthetist to determine what the best option is for the patient. Given the results of this study, we believe the APS socket is a design worthy of consideration for amputees who need an alternative to an IC socket.

CLINICAL IMPLICATIONS

Just as Ivan Long introduced the IC socket as an alternative to the quadrilateral socket, our intention is to present outcomes associated with a new TF socket design which clinicians may consider for patients who cannot be fit with an IC socket.

REFERENCES

Schuch and Pritham, 2004
Alley, 2011
Rabuffetti, 2005