Will patients with a transfemoral amputation have improved functionality or comfort from an ischial containment socket compared to a quadrilateral socket?

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Clinical Question:

Will patients with a transfemoral amputation have improved functionality or comfort from an ischial containment socket compared to a quadrilateral socket?

Background: There are various designs of sockets for all levels of amputation. Over the years, there have been modifications to transfemoral sockets to ensure functionality, safety, and comfort. Each socket design is relatively similar, but the biomechanics of both designs are important in understanding the benefits of each.[1] The medial-lateral dimension of the quadrilateral socket (1950s) is wider in comparison to the anterior-posterior dimension. In addition, the flat posterior shelf allows for a weight-bearing surface for the ischium. The ischial containment socket (1980s) has a smaller medial-lateral dimension and contains the ischial tuberosity.[1,2] Throughout history, the ischial containment socket encourages a natural femoral adduction angle and a narrow base of support. However, selection of socket type comes down to personal input and clinical indications because biomechanical principles, distal socket design and socket alignment are similarities between the two sockets.[1] The clinician collaborates with the patient to limit skin breakdown while controlling movement of the femur. Transfemoral sockets are capable of being individualized for each patient's needs as there are no specific contraindications reported for either socket type.[1] The articles included in this paper were chosen regardless of publication year due to gaps in data collection. The quadrilateral and ischial containment sockets were created in an attempt to improve ambulation; research, such as Lee, 1997, was produced to support this theory. [1,3] Therefore, results dating back to the 1900s are still considered relevant today.[1,3] This comprehensive analysis of the literature is necessary in order to understand where the process began, the current evolution of sockets, and any potential improvements that can be made in the future. This CAT is intended to help guide clinical decision making based on four articles that compare socket designs for patients with transfemoral amputations.

Search Strategy *databases/sites, search terms or phrases, yield*

PubMed: "Ischial containment socket," yield=16; 2002-2021 & (Transfemoral amputee) AND (Ischial containment socket), yield=11; "quadrilateral socket," yield=22; (quadrilateral socket AND ischial containment socket), yield=6

JPO: "Transfemoral socket design," yield=108, "quadrilateral socket," yield=14

CINHAL: "Ischial containment socket," yield=2

Web of Science: "Ischial containment socket," yield=28

Inclusion Criteria: English primary sources, transfemoral amputee

Exclusion Criteria non-English, secondary sources

Synthesis of Results: Four articles were examined that focused on fit of ischial containment and quadrilateral sockets with a total of thirteen participants. Lee, et. al, created and designed a system to study pressure distribution in the quadrilateral and ischial containment sockets during standing and ambulation. The analysis indicated that higher pressures were recorded at the proximal brim of the quadrilateral socket compared to the ischial containment socket having a more evenly distributed pressure profile, but the differences in the distribution of pressures was not significant enough to influence patient preference. Neumann, et. al delved into developing a methodology for mapping the pressures occurring inside an ischial containment socket during gait. It was found that there was no correlation between perceived pressure at distinct phases of gait and socket design. Klotz, et. al, examines influence of socket type on hip range of motion. Hip range of motion is limited

by any socket, but there was no significant difference in the restriction of the hip joint between socket types. Fatone, et.al, investigates socket comfort during gait and tissue loading. Common gait adaptations used to minimize discomfort are increased lateral displacement of the trunk and a wider step with. The results showed there was not a significant difference in step width or lateral trunk lean as well as walking speed and coronal plane hip moment. It is stated that the absence of ischial containment in the case of quadrilateral sockets implies that the stiffness of the medial soft tissue of the residual limb will be imperative in maintaining coronal plane stability. In sockets with ischial containment, differences in tissue loading had no influence on socket comfort. Sockets without containing the ischium were significantly less comfortable in the lower tissue compression conditions. Overall, no significant differences were found between the ischial containment and the quadrilateral socket; both socket designs are suitable depending on patient preference and prosthetist skill set and abilities. The studies did not suggest with enough evidence that there is definitive advantages in one socket design over the other.

Clinical Message: Neither the ischial containment socket nor quadrilateral socket have been shown to decrease functionality. When biomechanical intentions are considered and sockets are well made, patients find the socket to fit comfortably. Patient goals and desires should dictate and help lead the prosthetist in the direction of best fit. Quadrilateral sockets are shown to be successful on long, firm residual limbs while ischial containment sockets show success on fleshy, short, or unstable residual limbs. Due to the small variation in patients studied, findings may serve as a loose guideline for how patients may respond to socket designs. A comprehensive understanding of each socket design allows flexibility in patient treatment and better outcomes. Experience and clinical use of each socket design based on individual patient prognosis, level of amputation, and residual limb characteristics is critical for successful treatment. Each socket design has a justifiable and well-founded place in the treatment of patients with a transfemoral amputation.

References:

[1] Schuch CM, Prithman CH. Current transfemoral sockets. *Clinical Orthopaedics and Related Research.* 1999;361:48-54.

[2] Atlas of Amputations and Limb Deficiencies. *American Academy of Orthopedic Surgeons.* 2016;4:17-543.

[3] Lee VSP, Solomonidis SE, Spence WD. Stump-socket interface pressure as an aid to socket design in prostheses for trans-femoral amputees- a preliminary study. *Proceedings of the Institution of Mechanical Engineers.* 1997;211:167-180.

[4] Klotz R, Colobert B, Botino M, Permentiers I. Influence of different types of sockets on the range of motion of the hip joint by the transfemoral amputee. *Annals of Physical and Rehabilitation Medicine.* 2011;7:399-410.

[5] Neumann E, Wong J, Drollinger R. Concepts of pressure in an ischial containment socket: measurement. *Journal of Prosthetics and Orthotics.* 2005;17:2-11.

[6] Fatone, S., Dillon, M., Stine, R., & Tillges, R. Coronal plane socket stability during gait in persons with transfemoral amputation: Pilot study. *Journal of rehabilitation research and development.* 2014;51:1217-1228.