

# Inverted V-Strap Suspension for PTB Prosthesis

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The leather cuff-suspension strap described in *The Patellar-Tendon-Bearing Below-Knee Prosthesis* (2) and in the June 1962 issue of *Artificial Limbs* has been found satisfactory in the majority of cases (Fig. 1). However, in certain cases with short stumps suspension problems have arisen. One particular case (Fig. 2), a patient having a very short stump

retention was improved, but some disadvantages were noted. When tightened sufficiently to provide good suspension, the strap caused a circumferential constriction above the knee impairing stump circulation (Fig. 4). Furthermore, this type of suspension did not provide an adequate extension stop for the knee.

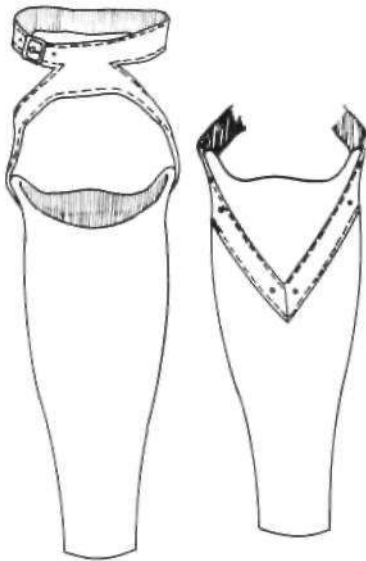


Fig. 1. Anterior and posterior views of typical cuff-suspension system for PTB prosthesis.



Fig. 2. Very short below-knee stump.

(2 3/4 in.), presented such a critical suspension problem that other means of achieving suspension were attempted. The first approach was a figure-eight dacron strap with Velcro for adjustment (Fig. 3). A continuous strap encircling the thigh was crossed over the patella. The ends of the strap were attached to the socket. Socket

Continued experimentation led to the use of the present suspension system using two straps looped through a ring for socket suspension (Fig. 5). The suspension system consists of two straps 1 in. wide and approximately 16 in. in length. When looped through a stainless steel ring, these straps form two inverted V's with the apex of each inverted V passing through the ring. The ends of the V-straps are attached

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Fig. 3. Continuous-strap suspension arranged in a figure-eight with Velcro for adjustment.

to the socket. Each strap has one end anteriorly and one end posteriorly attached to the proximal socket, thereby providing a four-point suspension. The ring joins both straps and is attached to a flexible waist belt by an elastic thigh strap. No circumferential strap is used about the thigh; a waist belt and a thigh suspension strap, plus the free-sliding characteristics of the two V-straps through the ring, provide firm suspension in all positions of knee extension or flexion.

The strap attachments to the socket should be placed so as to prevent knee hyperextension. The proper sites for strap attachment to the socket are related to the length of the stump. Usually, the shorter the stump the more anterior and proximal are the sites for attachment of the anterior suspension strap. The average short stump of 3 to 4 in. requires that the anterior attachments be located approximately 1 in. above the patellar-tendon contour of the socket and at each side of the patella,

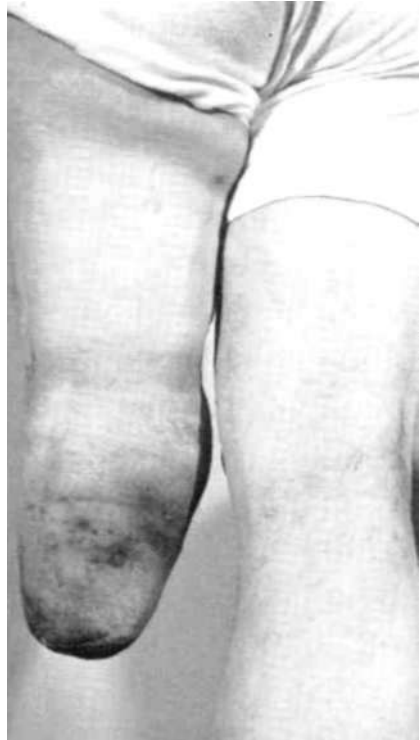


Fig. 4. Effect of circumferential constriction above the knee.

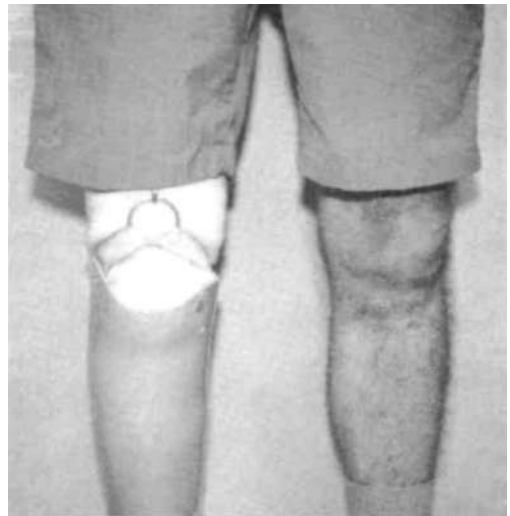


Fig. 5. Anterior view of two inverted V-straps looped through a ring and attached inside a hard socket close to the brim.

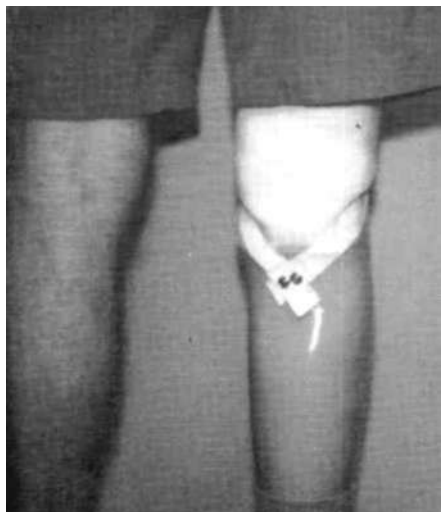


Fig. 6. Posterior view showing a common attachment point for the posterior straps. The attachment points may be either together or separate, and the straps may be attached either inside the socket or outside. Care must be taken to prevent the strap from rubbing against the (iliotibial) tendons on the lateral side of the thigh.



Fig. 7. Top view of the V-straps with the knee extended.

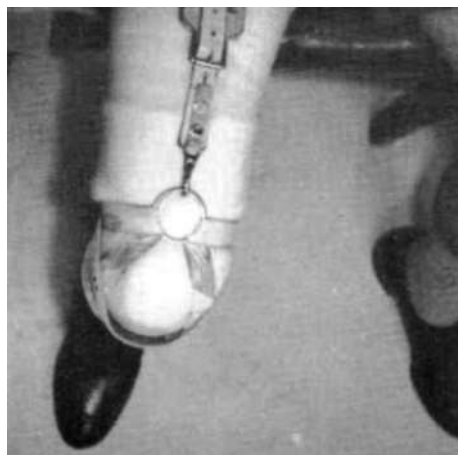


Fig. 8. Top view of the V-straps with the knee flexed.



Fig. 9. Posterior-oblique view showing retention of the prosthesis to the stump while the knee is flexed.

with sufficient space for the patella to pass between the straps as the knee is flexed. The posterior socket attachments may be located in the popliteal section of the posterior socket as shown in Figure 6. If the socket wall is thick, the posterior straps should be permitted to pass between the stump and the inner socket walls as illustrated in Figures 5, 6, and 7.

The V-straps must be sufficiently short to hold the ring down firmly against the superior margin of the patella. The elastic thigh strap may be adjusted for proper tension above the knee to prevent the ring from slipping down upon the patella.

The ring must be sufficiently large to permit two 1-in. dacron webbing straps to slide through it without overlapping one another (Figs. 7, 8, and 9). The ring shown in the illustrations accompanying this article is the Northwestern University upper-extremity harness ring described in the June 1962 issue of *Artificial Limbs*. It is an O-ring. If a D-ring is used, the flat side should be turned upward. A quick-disconnect snap fastener as illustrated may be

used to connect the elastic thigh strap to the ring.

As the knee is flexed, the suspension straps remain comfortable, and strap tension does not change regardless of knee position. Figures 8 and 9 show a knee in full flexion. The dark areas on the V-straps demonstrate the amount of their excursion through the ring as the knee is flexed. When the knee is extended, the ring will slip forward over the shadowed areas, returning to the position shown in Figures 5 and 7.

#### LITERATURE CITED

1. Artificial Limbs, June 1962.
2. Radcliffe, C. W., and J. Foort, *The patellar-tendon-hearing below-knee prosthesis*, University of California, Biomechanics Laboratory (Berkeley and San Francisco), 1961.