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The P.A.D.*—A New Alignment Device for Prosthetic Systems (The Case of an A.K. Endoskeletal Prosthesis**)

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INTRODUCTION

The alignment of an above knee prosthesis can be defined as the position and angulation of the foot, knee joint, and socket relative to each other. These are essential characteristics of prostheses. Every change you make when moving one component affects many important characteristics of the amputee, including:

- comfort
- stability and safety
- energy consumption
- cosmesis of gait.

Alignment also modifies the level of tensile and shear forces on components, thereby affecting reliability.

REVIEW OF THE FIELD

In the past, highly competent craftsmen worked to achieve good visual alignment, never being sure when the best possible configuration was established. Over the past 30 years, a vast range of alignment systems have been designed.

The principal systems can be grouped in three categories:

1) *A.K. adjustable legs*

One of the first designs was made at the University of California at Berkeley. It is a good system; however, its disadvantages include:

- its availability with only a single axis knee mechanism
- increased weight during training
- extra work and tooling for duplication.

2) *Alignment couplings*

The Staros Gardner unit is well-known, but it requires extra work and tooling for duplication.

3) *Incorporated alignment systems*

The Blatchford and Otto Bock systems are very popular. However, some disadvantages need to be considered:

- an increase of weight
- often, a decrease in reliability
- use is limited to a medium or a short residual limb (if you want to adjust the socket position with respect to knee-joint)

Moreover, it is our experience that all alignment devices on the market have one major deficiency: adjustment of the socket angulation affects the socket position with respect to foot and knee-joint.

In Figure 1, you can see that hip flexion draws back the socket. An A.P. shift is absolutely necessary to correct the socket po-

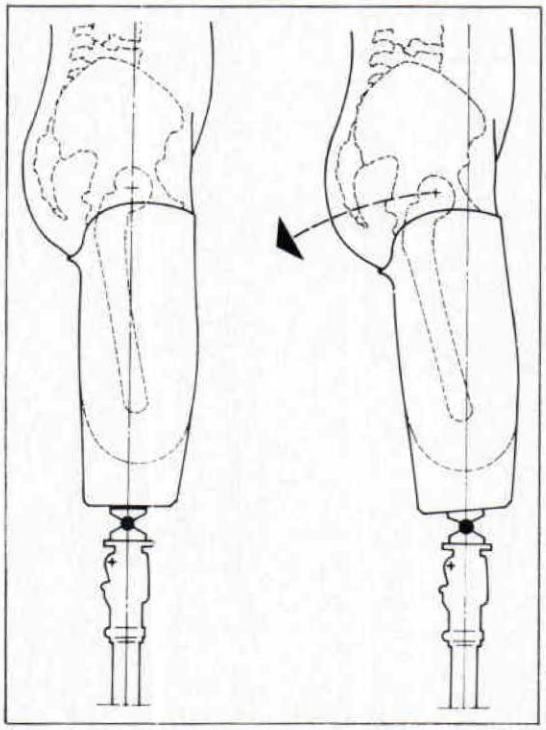

Figure 1. A flexion draws back the socket.

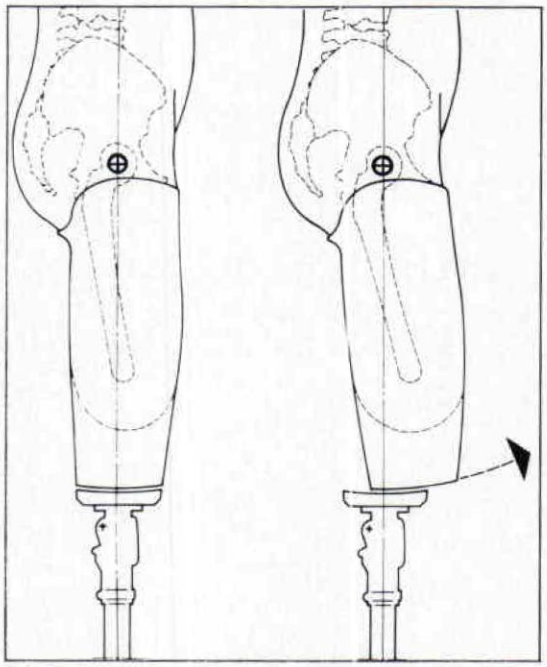

Figure 2. P.A.D. is designed according to physiology: its center of tilt matches the hip-joint of a "universal patient."

sition. But that is not always possible with devices on the market. In some cases, the range of adjustment is limited.

DESIGN AND FEATURES

To satisfy requirements of the amputee and the prosthetist, we have designed the P.A.D. to incorporate many advantages over other alignment devices. As you know, the above knee residual limb moves with respect to the hip-joint. The P.A.D. is designed according to human physiology. Its center of tilt matches the hip-joint of the "universal patient" (Figure 2). Flexion, extension, abduction, and adduction adjustments do not affect the socket position with respect to the hip joint. Tilting and shifting adjustments are independent.

Each adjustment is independent of the others. Figures for all adjustments are as follows:

- anteroposterior tilt: 10° flexion–10° extension (Figure 3).
- anteroposterior shift: 50mm. anterior–50mm. posterior (Figure 4).
- mediolateral tilt: 10° adduction–10° abduction (Figure 5).
- mediolateral shift: 50mm. medial–50mm. lateral (Figure 6).
- internal/external rotation is derived from the knee mechanism.

The P.A.D. is thin. It does not require any more room than would a socket attachment block (approximately 37mm). It adds no extra weight to the prosthesis. It replaces a socket attachment block without any increase of weight after trimming (160 g. after trimming in a standard shape). The P.A.D. is also adaptable on a vast range of knee mechanisms.

The unit does not require any extra work for duplication. When the best possible configuration for your patient is obtained, you drive a screw through the P.A.D., where marked, to secure the final position (Figure 7). You then trim and sand off any excess material (Figure 8), and laminate in the whole system along with the socket (Figure 9).

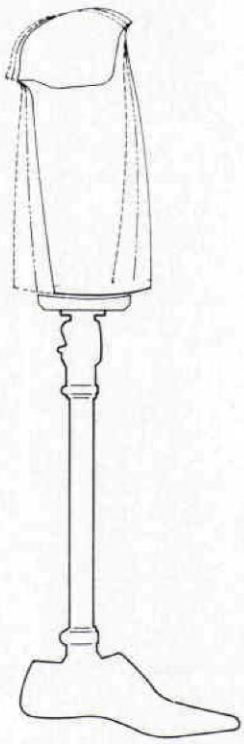

Figure 3. Anteroposterior tilt.

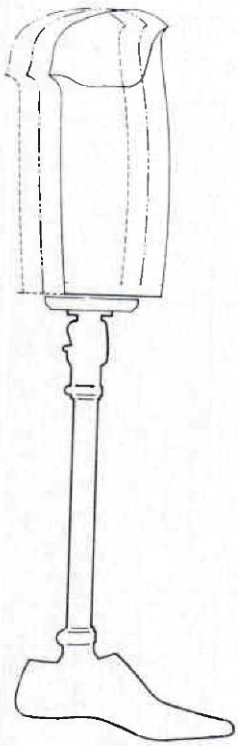

Figure 4. Anteroposterior shift.

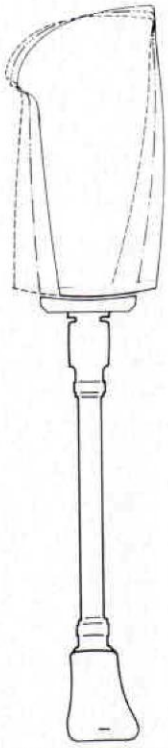

Figure 5. Mediolateral tilt.

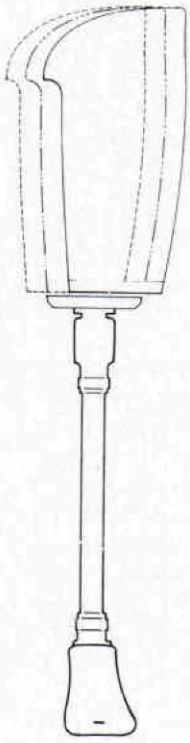

Figure 6. Mediolateral shift.

Figure 7. AN A.K. socket dynamically aligned with P.A.D.

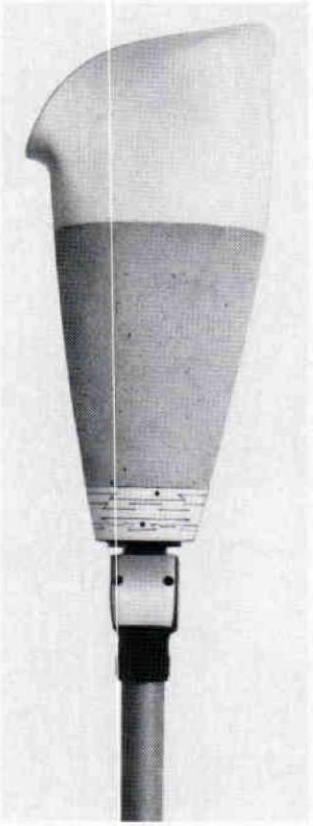

Figure 8. An A.K. socket after trimming and sanding off excess material.

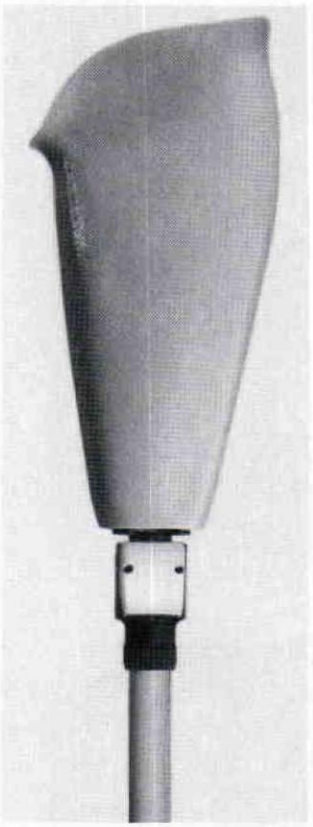

Figure 9. An A.K. socket laminated with P.A.D.

DISCUSSION

In a finished definitive, above knee endoskeletal prosthesis aligned with the P.A.D., only adjustability of internal and, external rotation of foot, socket, and height remain. One question to answer is whether or not it is necessary and desirable to have full capability for alignment adjustability present in a definitive prosthesis.

Only a very few times, from experience, has this capability been necessary. This occurs if the temporary prosthetic alignment time is too short, or if the alignment procedures are not strictly critiqued. But, in most cases, with incorporated alignment systems on the market, is it possible to really readjust the socket position and angulation?

Permanent adjustability may not always be desirable if we want to meet the needs of the majority of amputees. Most of our patients are sixty years old or over, with vascular diseases and several involvements. They need a light weight prosthesis, which would not be available with the standard permanent alignment couplings. The majority of the other amputees have fewer troubles with the alignment of their prostheses.

Moreover, it is our experience that, with the P.A.D., the alignment procedure is easier, and the prosthetist can quickly obtain the best possible alignment for his patient. In Figures 10 and 11 you can see a patient during the trials for fitting and adjustment.

CONCLUSION

According to our experience, the P.A.D. offers the most advantages of all alignment devices:

- tilting does not affect socket position,
- all adjustments are independent of each other,

Figure 10. A patient during trials for fitting and adjustment.

Figure 11. The same patient; he has a medium length residual limb but a very short femur.

- no transfer and increase of weight or length is required,
- no duplication procedures are necessary.

The P.A.D. provides for an easy, short, and accurate alignment procedure for the prosthetist and a light-weight prosthesis for the patient.

AUTHORS

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*patent pending

**Other designs of A.K. and B.K., both endoskeletal and exoskeletal are available.