Blatchford Stabilized Knee
A Review

Susan Bergholtz, B.S.

The Prosthetics and Orthotics program at New York University has completed a technical and clinical review of a recently marketed knee unit, the Blatchford Stabilized Knee (BSK). Its distributors claim the knee provides a stabilizing effect that "virtually eliminates falls, increases confidence, and reduces general fatigue."

Description of Unit

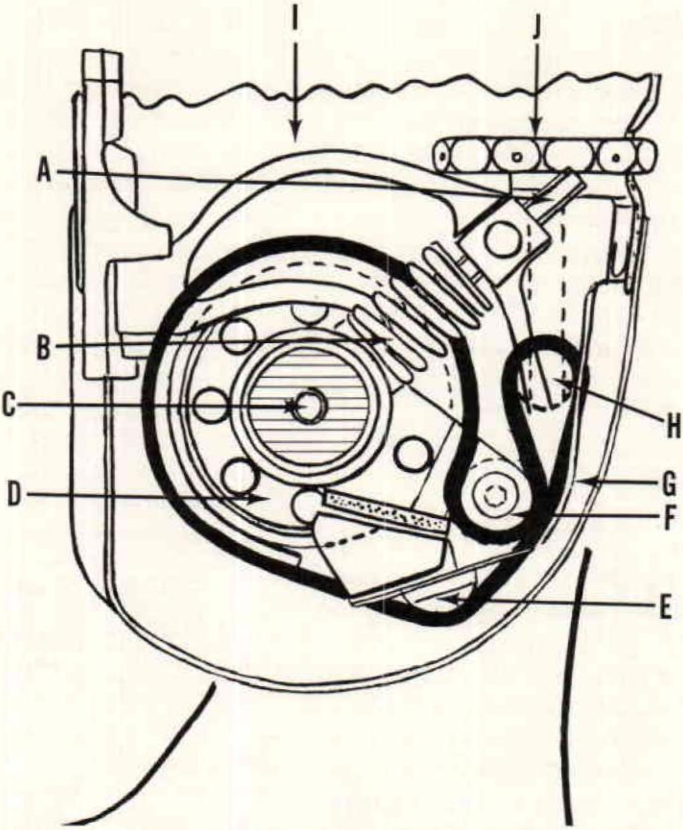
The new device is a single axis knee unit with constant friction and friction lock. The amounts of swing phase friction and locking friction are controlled by a continuous terylene break band which rides on a stationary steel friction drum (Figure 1).

[1] Assistant Research Scientist, Prosthetics and Orthotics, New York University Post-Graduate Medical School.

This study was conducted under the general supervision of Sidney Fishman, Ph.D. Appreciation is expressed to Joan E. Edelstein, M.A., Virgil Faulkner, C.P., and Marshall Kaufman, B.S., for their assistance.

The knee mechanism with its belting rotates around the axis formed by two pivots set on the same horizontal plane. The amount of friction is determined by the pressure between the belting and the drum. The friction drum is concentric with and attached to the pivots. Swing phase friction is controlled by the swing phase adjustment wheel. Clockwise rotation raises the friction belting support (Figure 2), increasing belt tension and, in turn, the friction between the drum and the band.

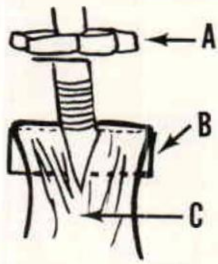
Any downward pressure on the posterior portion of the knee block (as by weight-bearing) stabilizes the knee. This pressure rotates the unit counterclockwise about an anterior fulcrum, causing the terylene band to grip the brake drum and thereby resist knee flexion. The more weight applied, the more resistance to flexion. Locking friction is especially important during the period from heel strike to midstance when a poorly aligned prosthetic knee is



A. Stance Phase Stability Adjustment Screws
B. Release Spring
C. Single Axis
D. Stationary Friction Drum
E. Friction Regulation Bar
F. Anterior Fulcrum
G. Friction Belting
H. Friction Belting Support
I. Horizontal Knee Block
J. Swing Phase Friction Adjustment Wheel

LATERAL VIEW OF THE BLATCHFORD STABILIZED KNEE

Figure 1



A. Swing Phase Adjustment Wheel B. Friction Belting Support
C. Friction Belting

ANTERIOR VIEW OF SWING PHASE ADJUSTMENT WHEEL WITH FRICTION BELTING

Figure 2

most likely to bend. A single axis knee depends upon alignment and stump extension force or a positive lock to keep it extended during the first part of stance phase. The Blatchford Knee, however, requires only the downward force of the amputee's body weight. The manufacturer claims that this stabilization is achieved if the knee is loaded in any position between full extension and thirty-five degrees of knee flexion.

Two release springs eliminate the stabilizing effect at toe-off. They are set to counteract the small amount of weight still applied by the amputee late in stance phase. Without such counterbalancing springs, even partial weight-bearing would lock the knee. The springs also enable the amputee to bend the knee, as when sitting.

When the basic knee unit is incorporated into a shank, an extension lever is added. Knee flexion stretches an elastic strap located at the lower end of the extension lever. The tensed strap prevents excess heel rise at toe-off and accelerates the shank forward during the initial part of swing phase. Because the axis of the lever is posterior to the axis of knee rotation, the knee remains flexed during sitting.

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A leather hyperextension strap is attached from the knee bolt to the posteroproximal portion of the shank. As the knee approaches full extension at the conclusion of swing phase, the strap is tensed, thereby reducing terminal impact.

An external cover contributes cosmesis and protects the mechanism.

The knee unit with its wood setup and cover weighs 4¼ pounds, as compared with 2¾ pounds for the Bock Safety Knee 3P23, and 2¼ pounds for a single axis knee with friction adjustment.

Clinical Findings

The one test wearer was a sixty-one year old jazz musician who acquired a left above-knee amputation in 1966 as the result of circulatory insufficiency. He required maximum stability in stance, yet could manage an unlocked knee in swing phase if external support (such as a cane) were provided. Up to the time of the study, he had worn his own prosthesis all day, every day. It was of the following design:

Proximal Socket—Quadrilateral
Distal Socket—Air chamber
Socket material—Wood, plastic coated
Suspension—Pelvic belt
Knee type—Single axis, manual lock
Friction—No adjustable friction
Extension aid—None
Shank material—Wood, plastic laminate finish
Foot-ankle assembly—SACH

After the subject was fitted with a prosthesis in which a Blatchford Stabilized Knee was installed, the following data were gathered:

1. Prosthetic Considerations
   a. Installation

The attending prosthetist reported that the time and ease of installation of the Blatchford Stabilized Knee unit was comparable to that required in mounting a Bock Safety Knee or a constant friction single axis knee unit into a new prosthesis.

b. Maintenance

One minor adjustment was required during the one-month test period. When the subject returned for the two-week followup, the swing phase friction had decreased slightly. A quarter turn clockwise of the Swing Phase Adjustment Wheel returned the unit to the friction established at the initial fitting. No decrease in the friction was apparent from the two-week followup to the final evaluation four weeks after delivery.

No further mechanical problems occurred during the test period. However, areas of potential difficulty included the following:

1) The BSK mechanism is more complex than either of the comparable conventional units. In referring to its installation, the manufacturer acknowledges "great care must be taken at all stages to keep the mechanism clean . . . to avoid having to dismantle it to remove any foreign material."

2) The two release springs on the BSK are mounted with plastic end caps, each of which has a lip covering the end of the spring. This lip might be a source of mechanical breakdown, for it bears the full force of a heavy spring.

3) It might become necessary to remove the friction belt to clean dirt that had accumulated between the belt and the friction drum. This requires a major dismantling of the unit.

2. Performance Observations

a. Initial Evaluation

Ordinarily this amputee ambulates with a manually locked knee unit and a cane. Although he states that he feels insecure with the prosthetic knee unlocked, he can walk slowly with the use of a cane. For the purposes of functional comparison with the BSK, the subject's gait was studied while he used his own prosthesis both with the artificial knee locked and with it unlocked.

With his conventional prosthesis and cane, the amputee displayed the following gait deviations whether walking with the knee locked or unlocked: (1) lateral trunk bending toward the side of the prosthesis; (2) ipsilateral arm often rigidly extended, not swinging reciprocally with the contralateral, sound, leg; (3) circumduction of the prosthesis when walking with a locked knee; (4) a longer prosthetic step and terminal swing impact with an unlocked knee and support of a cane. The subject took seventy-six steps per minute with the locked knee but slowed to sixty-six steps per minute when he ambulated with the mechanical knee unlocked.

One step stair ascent was unaffected by the status of the knee. When the knee was locked, the subject descended by the one step method. With an unlocked knee, however, he was capable of using the step-over-step technique, although he customarily descended stairs with a locked knee.

Upon delivery of the experimental prosthesis, an effort was made to estimate stance phase stability by positioning the patient between parallel bars, and having him attempt to support most of his weight on the prosthesis with the knee unit placed at various angles. In the judgment of the observers, he bore most of the weight on the prosthesis, very little on his hands, and none on the sound extremity during the actual tests. The knee remained stable when loaded by a great deal of downward pressure. This test was repeated as the knee flexed at five degree increments to maximum angulation of thirty-five degrees (a fully extended knee being considered to be zero degrees). Stability was obtained at all test points, except the final position, where moderate weight-bearing caused the prosthetic knee to buckle.

Gait on a level surface was examined after the terylene belt tension was adjusted to provide moderate swing phase friction. The subject displayed most of the deviations found with his conventional free swinging prosthesis, namely: (1) lateral bending; (2) long prosthetic step; (3) failure to swing arms reciprocally. Since the BSK provides constant friction throughout swing phase, terminal swing impact was less with the test knee than with the previous, nonfriction unit. The cadence of sixty-four steps per minute was similar to that with the conventional unlocked knee.

He climbed stairs one step at a time. He could not descend step-over-step because he could not transfer enough weight from the prosthesis to negate the stabilizing action of the Blatchford Stabilized Knee.

Two weeks later he still used a cane, but had become more proficient in walking, utilizing more of the features of the test knee. Lateral trunk bending was still prominent, but the arm on the side of the prosthesis was now employed in reciprocal arm-leg movement and the prosthetic step length was nearly that of the sound side. Cadence increased to seventy-six steps per minute, equalling that with the locked knee in his previous prosthesis.

At the conclusion of the test period, one month after delivery, the subject's gait was re-evaluated with his two prostheses. Walking patterns with the conventional prosthesis had not changed since the initial evaluation. Performance with the BSK also remained similar to that displayed at the two-week follow-up.

3. Subject's Reactions

Initially, the amputee was skeptical about the safety of the Blatchford Stabilized knee. He stated that he lacked confidence while ambulating with it.

At the end of one month, the subject's opinion had altered considerably. He said that he would *"definitely choose"* this prosthesis over his previous one, for the following reasons:

1) **Stability in Stance**

He felt very confident that his knee would not collapse while he was walking. He stated that he felt safer on curbs and was not as "afraid of falling" when someone bumped into him on the street. The subject also related that he was beginning to feel more confident without the cane.

2) **More Natural Gait**

The subject claimed he was "happy at not walking with a stiff leg." He felt that the unit had a definite advantage over his previous one, for it allowed him to feel safe while producing a more natural gait.

3) **Less Fatigue**

The subject stated that he was less tired when using the BSK. Because of its freedom in swing, he did not have to circumduct the prosthesis as he did with his manually locked prosthetic knee. The inherent stance stability of the BSK obviated the need to extend his stump at heel strike.

The subject was unable to descend stairs by the step-over-step method. Although he did not find this detrimental himself, he conjectured that it might limit a more active individual.

Summary and Recommendations

The Blatchford Stabilized Knee incorporates a mechanism to resist knee flexion to thirty-five degrees of knee flexion upon downward loading. The unit was fitted to an amputee who needed substantial stability in stance phase, but was also able to utilize an unlocked knee in swing phase if external support were provided. After wearing the unit for a month, he stated that he preferred it over the manually locked knee unit in his previous prosthesis. The test unit gave him stance phase stability while offering a more cosmetic gait and reduced fatigue when he walked long distances. The major difficulty noted by both the subject and the evaluator was in stair descent. A step-over-step descent could no longer be used because sufficient body weight could not be removed from the prosthesis to negate the inherent stability of the knee.

The additional weight of the unit (approximately one and a half pounds heavier than his previous unit) presented no difficulty to the wearer. This subjective reaction may relate to the fact that the BSK was mounted in a prosthesis with suction suspension, unlike the looser socket and pelvic belt on his own limb. The more intimate socket fit may have been as responsible for the "lighter feeling" as the action of the test knee.

The prosthetist encountered no difficulties in installing the knee. He predicted, however, that any internal derangement of the mechanism would require time-consuming dismantling of the entire unit.

On the basis of this study, the Blatchford Stabilized Knee appears to be a useful addition to the prosthetic armamentarium for those amputees who require maximum stability in stance, yet desire a cosmetic swing phase. Further study may answer certain other questions:

1. How durable is the unit over a prolonged period of wear?
2. How suitable is the mechanism for bilateral above-knee amputees, feeble geriatric amputees, or those with a hip disarticulation?
3. Will the additional weight of the unit affect its applicability?