Orthotic Management of Knee Injuries in Athletics with the Lenox Hill Orthosis

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INTRODUCTION

The knee is a complex structure and any structural change results in a lessened ability to withstand the stresses of athletic competition. The subsequent material is a brief discussion of knee instabilities secondary to injury and the role of a Lenox Hill Orthosis in compensating for any functional deficit. The various instabilities of the knee can be separated into four categories:

- Straight.
- Rotatory.
- Combined.
- Patellar.

Straight lateral or straight medial instability is demonstrated by widening of the joint space with varus or valgus stress exerted on the knee at full extension and in various degrees of flexion.

- The straight anterior and posterior instabilities are illustrated by the classic anterior-posterior drawer sign.
- The rotary instabilities involve abnormal motion about a rotary axis of the tibia in relation to the femur. These can be categorized as posterior/medial, antero/medial, antero/lateral, and posterior/lateral rotatory instabilities.
- Two or more of the above instabilities can and commonly do occur in the same knee, forming a combined instability.
- Lateral displacement of the patella from the patellar-femoral groove produces an instability that will not be a part of this discussion.

COMPONENTS OF KNEE STABILITY

The stabilizing components of the knee joints include bone, meniscii, muscles and ligaments.

Bone

The bony stability of the knee is derived from the shape of the femoral condyles and saucer shape of the tibial plateaus. The intercondylar emminence of the tibia and the slight concavity of the plateau when viewed in relation to the shape of the femoral condyles plays a role in controlling the amount of rotation possible within the joint, and with weight bearing this produces some straight medial-lateral and anterior-posterior stability.

Meniscii

Meniscii additionally add to stability within the knee. The saucer shape and the ligamentous attachments allow the miniscii to move with flexion of the knee, filling the peripheral space created by the spherical configuration of the femoral condyles. The function of the meniscii include shock absorption, lubrication, reduction of contact stress and transmission of loads across the joint. The increased concavity of the plateau and the wedge effect of the moving meniscii contribute to the stability of the joint.

Muscle

The quadriceps muscle group has a function as an important dynamic stabilizer of the knee. Its primary function is extension of the tibia in relation to the femur, but it also acts as an antagonist against flexion stresses created by the hamstrings. The quadriceps also influence the anteromedial and lateral joint capsule stability.

Flexion of the tibia on the femur dynamically is a function of the hamstring muscles. Additionally the semitendonosis, gracilis, and sartorius sweep around the medial side of the upper tibia to attach anteriorly giving additional stability against rotatory and anteroposterior stresses. The biceps femoris tendon has a similar function of dynamic lateral stability.

Ligaments

The knee is enclosed in a capsule which is reinforced by ligaments. The static stability of the knee joint depends upon the integrity of the supporting ligaments of the knee.

Collateral Ligaments—The lateral collateral ligament originates from the femoral condyle and inserts into the fibular head acting as a stabilizer against varus stresses. Additionally, the iliotibial tract laterally protects against varus stress and anterolateral rotatory instability. The medial collateral ligament consists of two layers, the deep fibers originate from the femoral condyle inserting into the upper tibial margin reinforcing the capsule and the peripheral attachment of the meniscus. The superficial fibers extend three inches below the upper tibial margin to the tibial flare stabilizing the knee medially against valgus stresses contributing to resistance against anteromedial rotatory stresses.

Cruciate Ligaments—The anterior cruciate ligament originates from the lateral femoral condyle and inserts into the tibia at the intercondylar notch anteriorly. The posterior cruciate ligament arises on the lateral side of the medial femoral condyle and inserts into the posterior surface of the tibia in the midline. Cruciate ligaments contribute to stability against anterior and posterior stresses as well as rotatory and medial-lateral stresses.

Ligamentous Injuries—Ligaments are fibrous structures that function in a manner to prevent abnormal motion of the joint. A ligamentous injury can vary from tearing of a few fibers and no loss of function to complete disruption of the structure. Forced motion beyond the normal limit in any direction of knee motion can result in some degree of injury. A common type of athletic injury to the knee occurs with the foot fixed to the ground and the thigh rotated inward, and the tibia outward, causing abduction and external rotation of the leg. The stress is exerted against the medial capsular structures as well as the collateral ligament and the anterior cruciate ligament. The resultant injury varies from mild to severe disruption of the supporting structures and includes injury to the medial collateral ligament both deep and superficial, medial meniscus and/or its attachment as well as the anterior cruciate ligament. The knee severely injured in this manner may be a candidate for surgery and subsequent rehabilitation. The category of injury and subsequent surgical procedure are dependent upon the degree and specific structural changes.

ORTHOTIC MANAGEMENT WITH THE LENOX HILL ORTHOSIS

At the Upstate Medical Center in Syracuse, the rehabilitation of the previously injured knee includes the use of a Lenox Hill Orthosis. The advantages of the Lenox Hill Orthosis are:

Post Injury: non-operatively treated patients are protected against recurrent stresses to the injured structures during subsequent athletic activities.

Post Operatively: The Lenox Hill Orthosis is used to provide increased static stability during rehabilitation and when returning to athletic activities.

Two methods are used at the Upstate Medical Center for fitting of the orthosis:

1. The positive mold for the Lenox Hill Orthosis is taken before surgery so the orthosis is ready for application on cast removal in six weeks.

2. The mold is taken during the first cast change two weeks post-operatively, and the orthosis prepared for application six weeks post-operatively. The latter method allows for some atrophy during surgery and cast management, and assures a closer fit at time of application.

The Lenox Hill Orthosis is worn throughout the rehabilitation program to allow motion necessary for rehabilitation exercises and for protection against stresses on the repaired ligaments. If athletic activity is allowed, the orthosis is worn up to one full year during the activity for protection against further injury.

The Lenox Hill system has been developed and designed to control the straight medial-lateral, anterior-posterior, rotatory and combinations of these instabilities. An understanding of the various designs available, and the location of the force pressures that resist deviation, will help prevent prescription uncertainty.

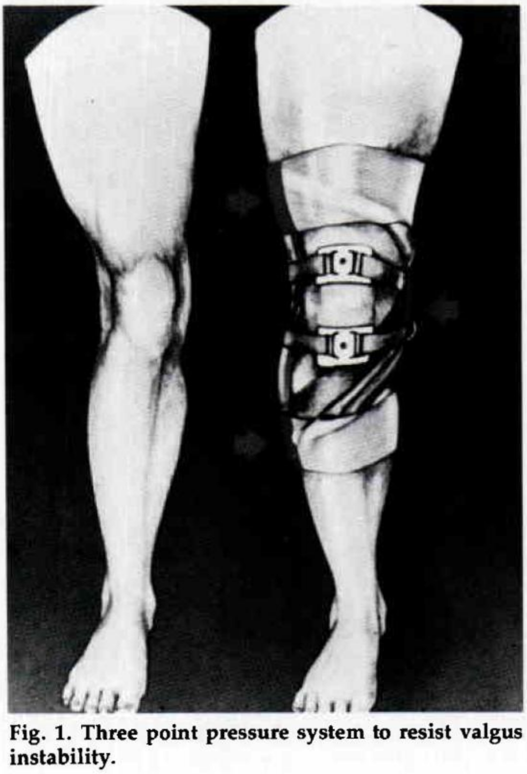

Fig. 1. Three point pressure system to resist valgus instability.

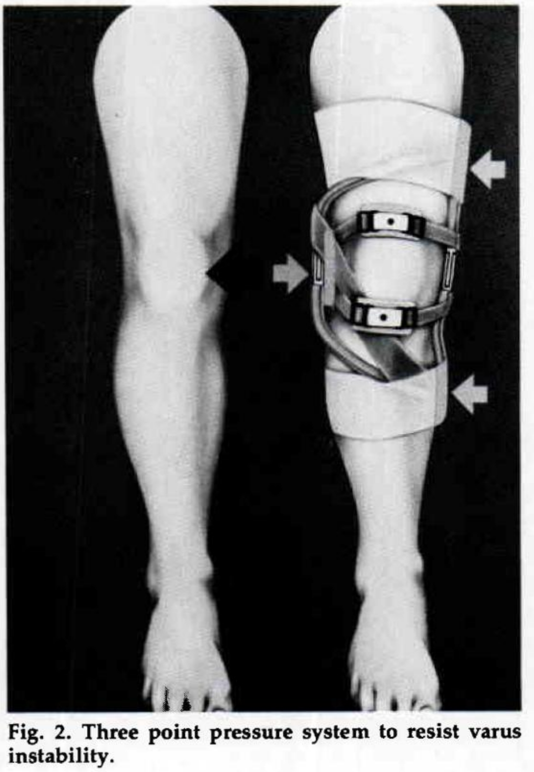

Fig. 2. Three point pressure system to resist varus instability.

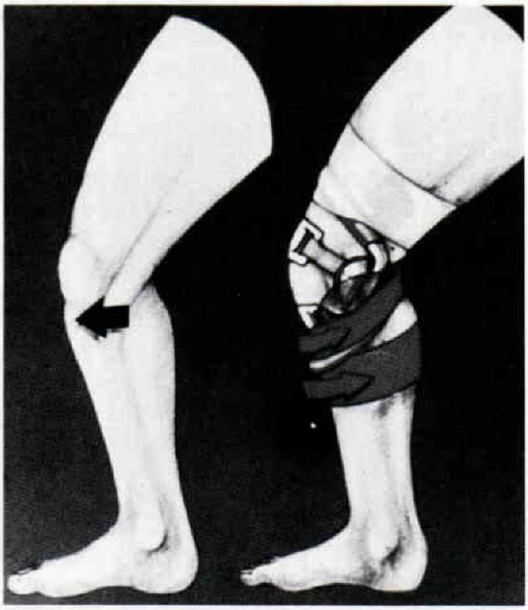

Fig. 3. Force system to prevent anterior-posterior instability includes the pre-tibial bar, distal knee loop and circumferential rubber. A hyperextension stop and non elastic popliteal strap are also used.

CONTROL OF STRAIGHT MEDIAL-LATERAL INJURIES

With the knee in full extension (Fig. 1.), the valgus deviation (medial instability) is resisted by the three point force of the Lenox Hill created by the lateral leg pads, above and below the knee, opposed by the medial knee disc. With the knee in full extension (Fig. 2.), the varus deviation (lateral instability) is resisted by the three point force created by the medial leg pads, above and below the knee, opposed by the lateral knee disc.

CONTROL OF STRAIGHT ANTERIOR-POSTERIOR INJURIES

With the knee in flexion (Fig. 3.), the anterior-posterior excursion of the tibia,

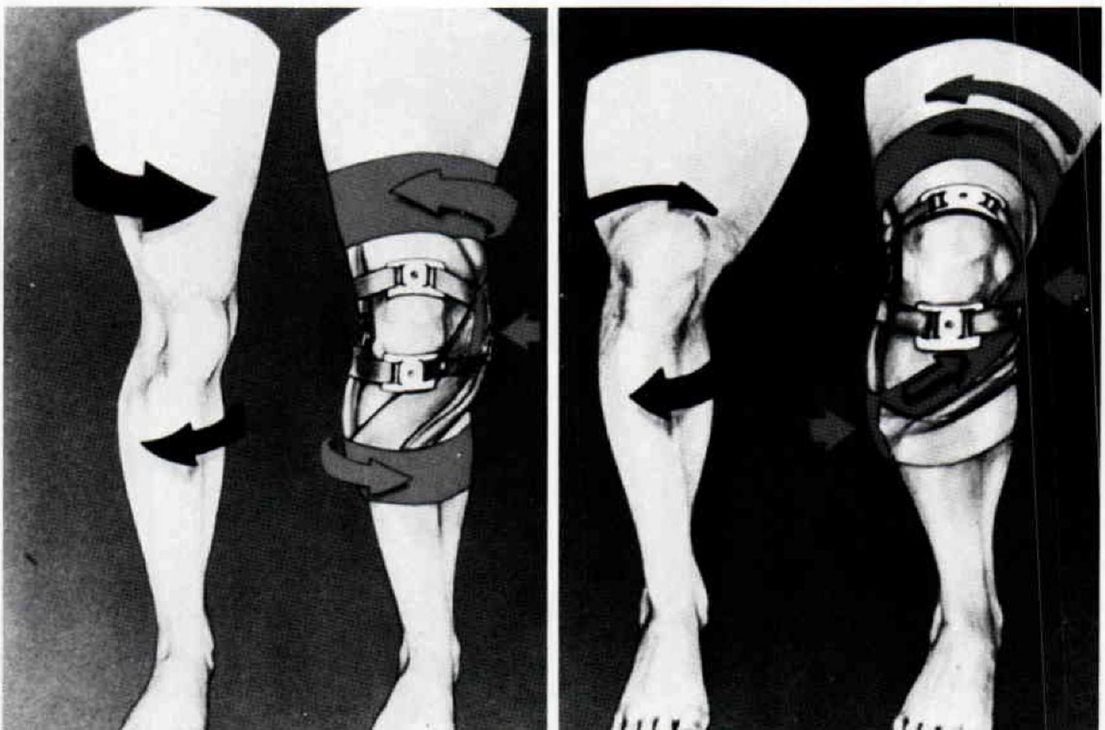

Fig. 4 & 5. Rotary instability is counteracted by the lateral leg pads, medial disc and derotation straps.

(anterior-posterior instability) is resisted by the Lenox Hill forces created by the pre-tibial bar, the derotation strap, the distal knee loop and the circumferential rubber, all opposed by the circumferential rubber above the knee. With anterior-posterior instability, a hyperextension stop at the joint, and a non-elastic popliteal strap to resist hyperextension is added to the Lenox Hill. In post-surgical application, the stop may be adjusted to limit the degree of extension.

CONTROL OF ROTATORY INJURIES

With the knee in full extension (Fig. 4.), the rotational deviation, (rotatory instability) is resisted by the contour and placement of the lateral leg pads and the medial knee disc, the circumferential rubber above and below the knee, and the derotation strap. With the knee in flexion (Fig. 5.), the anti-rotation resistance is augmented by the derotation strap.

CONTROL OF COMBINATION INJURIES

With the addition of the second below-the-knee leg pad, second derotation strap, and hyperextension stop, the Lenox Hill is designed to resist the combination antero-medial rotatory, antero-lateral rotatory, and antero-medial-lateral rotatory instabilities.

In the combined medial design (Fig. 6.), the knee disc is positioned on the medial side, with lateral leg pads above and below the knee, medial leg pad below the knee, and a hyperextension stop incorporated into the knee joints. This combination design is for primary antero-medial, lesser antero-lateral, rotatory instabilities.

The combined lateral design (Fig. 7.), the knee disc is positioned on the lateral side with medial leg pads above and below the knee, lateral leg pad below the knee, and a hyperextension stop incorporated into the knee joint. This combination design is for

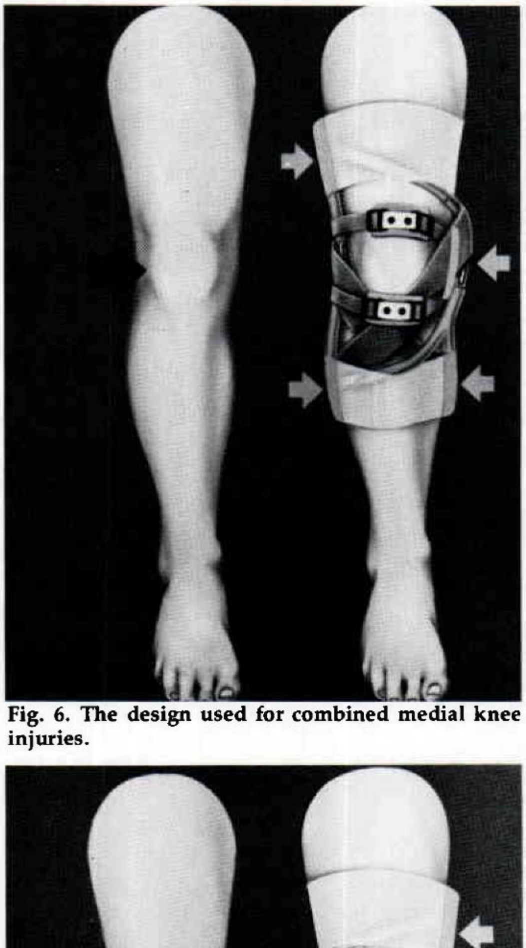

Fig. 6. The design used for combined medial knee injuries.

Fig. 7. The design used for combined lateral knee injuries.

primary antero-lateral, lesser antero-medial rotatory instabilities.

SUMMARY

At Upstate Medical Center, Syracuse, New York, the Lenox Hill Derotation Orthosis has been prescribed for athletic injuries to the knee since 1972. Its use post-injury and post-operatively has been consistently positive.

The Lenox Hill advantages are:

1. Individual design and custom fabrication insure intimate fit and proper application;
2. Simple measurement procedures with plaster mold and materials available to physician and orthotist;
3. Ample design choices and the ability to design the orthosis to resist specific instabilities.

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