INTRODUCTION

The Joint Ruler* is designed to help reduce the incidence of flexion, extension, and patello-femoral joint problems by allowing the surgeon to consider multiple dimensions in knee joint replacement. Devices that measure component rotation, limb alignment, joint depth and joint width are already routinely used in joint replacement. This device will add measurements of joint length, joint line position, patellar offset and extensor length in flexion to the surgeon’s skillful replacement of preexisting knee joint anatomy.

The Joint Ruler helps the surgeon correctly position all three prosthetic components (femur, tibia and patella).

Specifically, the Joint Ruler helps to:

- Restore correct joint length
- Restore proper joint line position
- Restore pre-existing patellar offset
- Restore appropriate extensor length in flexion
- Retain the appropriately tensioned soft tissue envelope

The system is simple, disposable, inexpensive, and accurate.

This surgical technique was developed in conjunction with:

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* U.S. Patent Pending
RATIONALE

Most surgeons are taught to implant a knee prosthesis of sufficient thickness to stabilize the joint as tight as possible at the time of implantation, overlooking the pre-replacement joint length, joint line position, patellar offset and extensor length. This may profoundly affect long term, as well as short term, results.

Lengthening of the knee joint can cause post-recovery dysfunction such as loss of maximal extension or flexion and patellofemoral problems including instability, extensor mechanism failure, and increased surface forces.

During resection of the tibia, the joint is partially destabilized by soft tissue releases. The collateral ligaments therefore provide the tension that guide the surgeon in choosing the implant size. Because resection of the menisci and cruciates can elasticize the collateral ligaments at the time of surgery, the tension on the ligaments does not provide an appropriate guide for selecting tibial spacer height. Therefore, the joint that is lengthened to provide immediate stability in extension may lose range of motion during recovery as the collateral ligaments have lost their potential elasticity and other soft tissues reattach at an incorrect length. The potential for this problem is greatly reduced when the preoperative measurements are restored.

Furthermore, patellofemoral joint problems may be the result of extensor lengthening or improper joint line placement. Reproducing the preoperative measurements will help minimize these problems and may reduce the need for patellar retinacular releases.

Increasing the joint length or the extensor length may also increase joint contact pressure between metal and polyethylene surfaces and thereby increase polyethylene wear and debris.

Reducing the patellar offset reduces the mechanical leverage of the quadriceps mechanism. This decreased leverage manifests itself in weakened patient function during stair climbing.

The Joint Ruler is designed to accurately measure the joint line position, joint length, patellar offset and extensor length which will help the surgeon to accurately restore these measurements and improve post-operative joint function.
PROXIMAL ATTACHMENT OF THE JOINT RULER

After a standard anteromedial exposure, use the Bone Screw Drill to drill a hole through the anterior femoral cortex approximately 8 cms proximal to the joint line (Fig. 1).

![Fig 1](image1.png)

Insert a 3.5mm ECT Cortical Screw, 18mm in length (2350-19-35), through the screw hole in the ruler, and into the predrilled hole (Fig.2). (Note: Do not use a holding pin to secure the ruler as this may block the femoral canal.)

![Fig 2](image2.png)

DISTAL MARKER INSERTION

Insert another ECT Cortical Screw into the tibial tubercle just distal to the tendon insertion (Fig.3). This will serve as a distal marker in determining the joint length, joint line position, and the extensor length.

![Fig 3](image3.png)

DETERMINATION OF INITIAL JOINT LENGTH

Extend the leg and place it in a reproducible position. (Metal bowl supports under the knee and foot are recommended.) With the patella everted and retracted, extend the ruler distally across the knee joint until it overlaps the distal marker. Record the length measured by the ruler or notch the ruler with a small kerosin rongeur at the point where it intersects the middle of the distal marker screw (Fig. 4). This indicates the pre-replacement knee joint length and will aid in verifying the joint line position later in the procedure.

![Fig 4](image4.png)
Note: In cases with significant joint flexion contractures, measurements must be taken before and after replacement at the same degree of maximum extension. If shortening of the joint is necessary to correct a serious flexion contracture the femoral side of the joint is shortened rather than the tibial side and the results will be apparent on the subsequent joint line position measurement.

DETERMINATION OF THE EXTENSOR LENGTH IN FLEXION

Flex the knee to 90 degrees. (The Alvarado™ Surgical Knee Holder is recommended. It allows for a reproducible placement of the leg in flexion.) With the patella everted and retracted, pull the ruler over the distal femur and distal marker. Record the length measured by the ruler or notch the ruler at that point (Fig. 5). This length indicates the pre-replacement extensor length and later measurement will determine how the femoral prosthesis and articular surface thickness affects this length.

DETERMINATION THE PATELLA OFFSET DIMENSION

The patella offset in flexion can be measured with the patella reduced and the extensor tendon approximated with a towel clip. Flex the knee to 90° in a reproducible position. Lay the ruler over the external surface of the mid patella longitudinally and over the distal marker screw. Record the length measured by the ruler or notch the ruler at the point where it bisects the distal marker screw. (Fig. 6) Later measurements, after provisionals have been inserted, will validate that the patello-femoral joint offset dimension has been reproduced accurately.

FEMORAL PREPARATION

Rotate the ruler out of the wound and towel clip to drape. Then resect the distal femur with either saw cuts or the milling device. Insert the appropriate femoral provisional component. Do not remove the menisci until after the joint line position measurement is taken.
DETERMINATION OF THE REPLACEMENT JOINT LINE

Extend the knee to the same position as previously measured. Extend the ruler distally over the femoral provisional and compare the present length with the initial length recorded by the ruler (Fig. 7). If the two lengths coincide, it indicates that the replacement joint line position is the same as the initial joint line position. If the joint ruler indicates the joint line position is lengthened by over 2mm, recut the distal femur.

Fig. 7

TIBIAL PREPARATION

Rotate the ruler out of the wound. Resect the proximal tibia and prepare the tibia for the selected tibial component. Insert the appropriate tibial provisional.

MEASUREMENT OF THE REPLACEMENT JOINT LENGTH

Position the knee at the same degree of extension as initially measured with the thinnest tibial articular surface provisional in place. Use the ruler to measure the joint length (Fig. 8). It may be necessary to modify the selected tibial articular surface provisional thickness to regain the same length as the initial joint length measurement. If the thinnest spacer will not fit, the proximal tibia may need to be recut to further reduce the length.

PATELLAR PREPARATION AND DETERMINATION OF REPLACEMENT EXTENSOR LENGTH

Measurement of the patellar thickness with a caliper is advisable as relative surgical thickening of the patella will increase the extensor length while diminishing the thickness of the patella will decrease that length. Measurement of the extensor length before patellar resection will guide the surgeon on the relative increase or decrease in total patella thickness that would restore pre-replacement extensor length. Return the leg to the previous position, and with the patella dislocated and provisionals in place, remeasure the extensor length (Fig. 9).
With the correct knee joint length restored, the extensor length may be less than the initial measurement. This may be due to a “downsized” femoral component, an angled cut on the proximal tibia, or a shallow anterior patello-femoral groove relative to the patient’s natural anatomy. It is acceptable for the extensor length to be less than the initial pre-replacement measurement.

DETERMINATION OF THE PATELLAR OFFSET DIMENSION

By varying the thickness (depth) of the patellar resection, the pre-existing patellar offset can be approximated in most instances.

In similar fashion to the initial patellar offset measurement, the patella is reduced and the extensor tendon is approximated with a towel clip with the Joint Ruler externalized proximal to the towel clip. Flex the knee to 90 degrees in its reproducible position. Lay the ruler over the external surface of the mid patella longitudinally and over the distal marker screw (Fig. 10). Compare the length to the previously recorded length. If the patella offset is increased, recutting the patella may be considered. It is acceptable for the patellar offset to be less than the initial measurement.

It is imperative not to increase the patella offset as this will likely produce patellar instability, increase patella femoral contact stress, increase risk of extensor mechanism failure and reduce range of motion postoperatively.

FINAL MEASUREMENTS

With the final femoral and tibial components implanted, recheck all measurements. Joint length variations may occur depending on the fixation method used. For example, a cement layer can increase the joint length or final impaction of the prosthesis can diminish the length from its initial implant provisional measurement.

With experience, the surgeon should be able to reestablish correct joint length and joint line position and not lengthen the extensor mechanism. The most important measurement is knee joint length in extension. This length should be accurately reestablished to optimize knee function and allow retention of the posterior cruciate ligament while maintaining the correct soft tissue envelope.

When the correct length prostheses have been appropriately inserted and measured, remove the proximal and distal joint length screws with the ruler and discard the ruler.

Note: The Joint Ruler must be used in combination with all other instrumentation required for the knee system being utilized. Devices that ensure proper component rotation, accurate limb alignment, and restoration of anterior-posterior and medial-lateral dimensions are all critical to a successful joint replacement.
Various components of the NexGen Complete Knee Solution and Micro-Mill Instrumentation are covered by one or more of the following: U.S. Patents 4,281,420; 4,336,618; 4,491,987; 4,524,766; 4,759,350; 4,979,957; 4,997,445; 5,059,216; 5,148,920; 5,192,323; 5,192,328; 5,255,838; 5,290,313; 5,326,362; 5,344,423; 5,383,875; 5,387,241; 5,395,377; 5,405,396; 5,431,660; 5,443,518; 5,458,645; 5,474,559; 5,484,446; 5,486,180; 5,492,671; 5,540,696; 5,549,686; 5,562,674; 5,571,197; 5,593,411; 5,597,384; 5,631,970; D 346,979; D 365,396; D 367,706; D 369,863; D 372,309; D 373,825; D 374,078; D 376,202/Other U.S. and foreign patents pending.