Hamelynck, Karel J., Amsterdam, NL and Stiehl, James, B., Milwaukee, USA (Eds.)

with a Foreword by Frederick .F Buechel and Michael J. Pappas:

LCS Mobile Bearing Knee Arthroplasty
- 25 Years of Worldwide Experience -

Chapter 10.2

Why The Tibia Cut First?

JAMES B. STIEHL, MD

R BARRY SORRELS, MD

Orthopaedic Hospital of Wisconsin

Milwaukee, Wisconsin

e mail:

jbstiehl@aol.com
telephone:
414-961-6789
fax:

414-961-6788

Introduction:

There are three major objectives of surgical technique in total arthroplasty. First is the need to achieve anatomical alignment of 5º to 7º valgus angulation to the mechanical axis. Second is to establish ligamentous balance by achieving careful balance of the flexion and extension gaps within 2 to 3 millimeters of physiological. Finally, is the desire to optimize the potential kinematics of the chosen prosthetic implant. The basic technique of the LCS method is a tibial cut first approach, which followed the original idea of Dr John Insall that establishing the flexion gap was the most important variable in successful total condylar arthroplasty.[1] We will discuss why this approach has become so important to the LCS system and why others should consider the technique for successful of mobile bearing prosthetics.

Rationale:

Insall Method

The goals of surgical technique of the LCS total knee arthroplasty are the same as those originally established by Insall for inserting the total condylar prosthesis including balancing the ligaments and resecting the ends of the femur and tibia so that the spaces between the cut ends were the same when the knee was in flexion and in extension. The classic Insall method required resecting the anterior and posterior femoral condyles with a degree of external rotation relative to the posterior condylar axis, resecting the proximal tibia at 90º flexion with the plane of resection perpendicular to the long axis of the tibia, and then resecting the distal femur using the spacer that fits the flexion space dimension with a long rod to determine correct valgus angulation of the knee.[8] The particular innovations of this approach were to preferentially determine the flexion space, to use a perpendicular cut on the proximal tibia, and to cut the extension space based primarily on a tension spacer that matched the flexion space. The principles of preliminary ligamentous balancing and flexion/extension spacing became well estabilished.

Measured Resection of the Distal Femur

From a different point of view, surgeons sought to preserve the cruciate ligaments or at least the posterior cruciate ligament, and the concept of spacer tensioning and cutting the tibia before the femur, became secondary to anatomical preparation of the distal femur. In other words, the focus of the technique was measured resection of bone cuts with the goal of recreating the joint line and alignment of the knee. With the preservation of the posterior cruciate ligament, the primary ligamentous issue was recreating a neutral or 0º mechanical axis in the frontal plane. Balancing of the flexion space was a secondary issue and centered more on recognizing tightness or looseness of the posterior cruciate ligament. If too tight, the posterior cruciate ligament would hold the femur posterior on the proximal tibia causing anterior tibial liftoff. If too loose, there would be flexion space laxity and potential clinical instability. Numerous authors have endorsed balancing the ligaments <u>after</u> all bone cuts have been made focusing on the ligaments that affect primarily extension such as the superficial medial collateral, pes tendons, iliotibial tract and lateral collateral ligament. The posterior cruciate ligament could be recessed off the tibia at the end of the procedure.

More recent improvements of the measured resection technique have been to precisely determine the amount of distal femoral rotation for the posterior condyle cuts such that they parallel the axis of knee rotation. These have included posterior condylar reference with cuts of 3º to 5º external rotation, the Whiteside intercondylar line which utilizes a line from the center of the intercondylar groove bisecting the intercondylar space, and the transepicondylar axis reference which roughly parallels the knee flexion axis.(Fig.1) Stiehl, et.al. developed the tibial shaft axis method which uses a long rod attatched to a femoral intramedullary rod which centers on the ankle mortise.[9,10] The goal of these methods was to create a bone resection resulting in a rectangular flexion space based on the principle that the transepicondylar axis is parallel the knee flexion rotation axis and is the target anatomical structure for prosthetic placement.(Fig.2)

LCS Method

The LCS surgical technique that has evolved from the outset chose the Insall method with „tibial cut first" resection. Early on, flexion space instability was implicated as a primary cause for complications including mobile bearing „spin out" and dislocation which ranged from 0.5% for the rotating platform to over 3% for meniscal bearings. Perhaps this was best demonstrated by the experience of Bert,et.al. who through surgical misadventure had a dislocation rate of nearly 50%.[3] The problem was so severe that bearings were nearly falling out in the recovery room. Appropriately, focusing on stability of the flexion gap became the primary goal of the surgical technique. We, of the LCS camp, feel so strongly about this that we believe little can be gained by resorting to a measured distal femoral resection or other similiar methods unless they purposefully provide perfect flexion space balance every time.

The LCS Tibial Shaft Axis Method

The LCS tibial shaft axis method determines the proximal tibial cut utilizing an extramedullary guide system and the cut of the tibia is made perpendicular to the mechanical axis of the leg.(Fig 3) An intramedullary femoral rod is placed with the anterior/posterior condylar cutting block. Flexion spacing is then done using the horse-shoe spacer to precisely balance and create a rectangular flexion space.(Fig 4,5) The exact dimension of the flexion space is determined with a block which is then used to cut the distal femoral surface or extension space.(Fig 6,7)

An important step with the LCS method is that primary extension ligamentous balancing must be established before the flexion space is created. This is because any ligamentous balancing done after these cuts are made can result in the creation of a trapezoidal flexion space. Such a problem often results in bearing dislocation or „spinout“. The surgeon must have the knee balanced as his primary step though some releasing such as the posterior capsule may be made after the proximal tibial cut. This can be advantageous as the posterior capsular origin on the distal femur becomes more accessible. With the knee in full extension, the ligaments should be balanced and tense. If not, additional release should be done. An interesting evolution has been the developement of the lateral or valgus approach to the knee joint. For LCS surgeons, the apparent utility of the valgus approach is that easy access to the posterolateral corner and lateral ligaments is allowed early for primary ligament balancing. A further evolution has been the rod/plate device developed by Ponky Firer from Johannesburg, South Africa. This device has a flat plate fixed to an intramedullary rod at 6º valgus angle. When placed in the intramedullary canal, this device can be used to assess ligament tension in extension.

DISCUSSION:

The distinct disadvantage of a measured distal femoral resection is the inability to deal with certain outliers such as lateral femoral condylar hypoplasia or severe angular deformities such as proximal tibia vara with a varus joint line. In these patients, ligamentous imbalance occurs commonly and can lead to chronic instability. Berger, et.al. found the posterior condylar axis to the surgical transepicondylar axis (point of lateral epicondyle to the sulcus of the medial epicondyle) to average 3.5º for males and 0.3º for females which was a highly significant statistical difference. However, the clinical angle using the prominence of the medial epicondyle was 4.7º for males and 5.2º for females. Significantly, the variance could range from 1º to 9.3º.[1] Mantas, et.al. found in normal femurs that the range of posterior condylar axis reference to the transepicondylar axis ranged from 0.1º to 9.7º.[6]

Fehring compared the Insall method with the measured resection method of distal femur resection using a fixed posterior condylar reference guide finding that the measured resection technique resulted in rotational errors of at least 3º in 45% of knees.[4] This means that well balanced flexion gaps would have been distorted to trapezoidal gaps in 45% of cases with potential flexion instability.

Similiarily, Olcott and Scott found that the transepicondylar reference most readily determined a balanced flexion space while using 3º rotation off the posterior condyles was least consistent.[7]

Berger, et al. has shown that internal rotation of the femoral component from the transepicondylar reference combined with tibial internal rotation from the center of the tibial tubercle was a substantial cause of patellofemoral complications. In other words, a group of patients with patellar subluxation, tilt, dislocation, and prosthetic loosening, all demonstrated the presence of combined femoral-tibial prosthetic internal rotation of up to 17º.

Boldt, et.al. has studied the tibial shaft axis method with the LCS total knees comparing the resultant posterior condylar axis with the transepicondylar axis. He found the posterior condylar reference of implanted LCS components paralleled the transepicondylar axis (mean 0.3º). Lateral patellar subluxation was seen in two knees where there was femoral component internal rotation of 4º and 6º. In another study, Boldt found a consistent relationship of femoral component internal rotation (average 5º internal to the transepicondylar axis) and arthrofibrosis from a variety of causes.[2]

While the flexion space cuts depend primarily on ligamentous tension, one must avoid certain pitfalls that may occur. For example, if the leg is fixed in a leg holder at 90°, it is possible for the weight of an obese leg to place an artificial tension on the lateral side of the joint, distorting the appropriate ligament tension. With the flexion spacing jig, the surgeon should carefully assess this to make certain that tension and position are appropriate. Also if an unusual amount of medial or lateral condyle will be resected, the surgeon must check the primary extension balance to make certain that all is correct.

Conclusion

The LCS experience has led to the evolution and refinement of a predictable surgical technique to provide satisfactory prosthetic knee kinematics with the elimination of bearing dislocation. The senior author, (JBS) has personally done over 500 LCS rotating platform inserts without a single problem. Experience and careful attention to detail can explain this result with a conscious effort of achieving perfect knee flexion/extension balancing and mechanical alignment.(Fig 8,9) The tibial shaft axis method developed for the LCS surgical technique relies on the anatomical relationship of the mechanical axis of the tibia shaft being virtually perpendicular to the transepicondylar axis in both flexion and extension.(Fig 10)

Bibliography

1. Berger RA, Rubash HE, Seek MJ, Thompson WH, Crossett LS. Determining the rotational alignment of the femoral component in total knee arthroplasty using the epicondylar axis. CORR 286: 40-47, 1993.

2. Boldt J, Munzinger U, Beverland D, Stiehl JB, Keblish PA. CT evaluation of femoral rotational alignment post TKA: Comparison of the tibial shaft axis method to the transepicondylar line. Proceedings of the AAOS, 2001.

3. Bert JM. Dislocation/subluxation of meniscal bearing elements after New Jersey low-contact stress total knee arthroplasty. CORR 254: 211-215, 1990.

4. Fehring TK. Rotational malalignment of th femoral component in total knee arthroplasty. CORR 380: 72-79, 2000.

5. Insall JA, Binazzi R, Soudry M. Mestriner LA. Total knee arthroplasty. CORR 192: 13-17, 1983.

6. Mantas JP, Bloebaum RD, Skedros JG, Hoffmann AA. Implications of reference axes used for rotational alignment of the femoral component in primary and revision knee arthroplasty. Jl Arthroplasty 7: 531-535, 1992.

7. Olcott CW, Scott RD. A comparison of 4 intraoperative methods to determine femoral component rotation during total knee arthroplasty. Jl Arthroplasty 15: 22-26, 2000.

8. Scott WN, Rubinstein M, Scuderi G. Results after knee replacement with a posterior cruciate substituting prosthesis. JBJS 70A: 1163-1173, 1988.

9. Stiehl JB, Abbott, BD. Morphology of the transepicondylar axis and the application in primary and revision total knee arthroplasty. Jl Arthroplasty 10: 785-789, 1995.

10. Stiehl JB, Cherveny PM. Femoral rotational aligment using the tibial shaft axis in total knee arthroplasty. CORR 331: 47-55, 1996.

Legend

1. Distal femoral measured resection with external rotation using the Whiteside line, transepicondylar axis, or a 3º-4º external rotation.
2. Posterior condylar resection based on anterior cortical reference with appropriate measured external femoral rotation.
3. LCS tibial shaft axis method uses extramedullary guide to cut tibia perpendicular to the limb mechanical axis.
4. LCS flexion spacer attatched to anterior/posterior cutting block fixed with intramedullary rod and anterior cortical reference with saw bones model.
5. LCS flexion spacer in operative procedure showing horseshoe spacer used to balance flexion space.
6. LCS distal femoral cutting block using intramedullary based to cut extension space.
7. LCS distal femoral cutting block in operative procedure.
8. LCS flexion space assessment measures both rectangular space and alignment.
9. LCS extension space assessment measures both rectangular space and alignment.
10. Cadaver specimen demonstrates perpendicular relationship of tibial shaft axis to the transepicondylar axis with transecting pin.