J. of Korean Orthop. Assoc.
Vol. 5, No. 1, September, 1990

Upper Tibial Osteotomy for Osteoarthritis of the Knee

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=*Abstract*=

In osteoarthritis of the knee with varus deformity, abnormal stress is concentrated in the medial compartement of the knee joint. So, logically, the correct treatment must reduce the force subjected to the medial compartment and shift the force laterally so the effective weight -bearing surface can be as wide as possible. This can be attainedy by proximal tibial osteotomy with a few degrees of overcorrection.

From 1984 to 1989, a closing wedge valgus osteotomy of the proximal tibia was performed on knees (patients) with degenerative arthritis of the medial compartment and varus deformity. The patients were followed for 12 to 80 months (average 44.2 months). At last assessment, the total knee Rating Score improved from a preoperative mean of 61 to 84 points; the pain component score improved from a preoperative mean of 12.5 to 24.8 points; knees had either no pain or occasional mild pain; and the tibiofemoral angle was corrected from a preoperative mean of 6.2 degrees of varus to a mean of 8.9 degrees of valgus.

Key Words: Knee, Osteoarthritis, Osteotomy

INTRODUCTION

The physiologically young or obese patient with severe osteoarthritis in the medial compartment of the knee presents the orthopedic surgeon with a difficult management problem. The dilemma involves the choice between high tibial osteotomy and a total knee arthroplasty (TKA). Joint replacement is best avoided in favor of the valgus high tibial osteotomy, because of the high risk of implant loosening or failing in this population group[24,25].

Tigh tibial osteotomy for the treatment of osteoarthritis of the medial compartment of the knee with a varus deformity is a well-accepted procedure that usually results in relief of the pain[2,3,7,14,24,32,37,46]. The operation is bases on the biomechanical principle which relieves the load placed on the medial compartment of the knee joint by realignment of the joint to a valgus position created by proximal tibial osteotomy[36].

The authors compared the preoperative clinical status and postoperative results of patients (knees) who had a proximal tibial osteotomy for osteoarthritis with varus deformity. The aim of this study is to analyze the results of proximal tibial osteotomy.

*이 논문은 1990년도 계명대학교 을종연구비 및 동산의료원 조사연구비로 이루어졌음.

MATERIALS AND METHODS

1. Materials

Twenty-two osteotomies, unilateral and four bilteral, were performed on 10 men and eight in the period from 1984 to 1989. The average age of the patients was 50.9 years (range : 23 to 66 years).

The osteotomies, were performed for primary degenerative arthritis in knees and for post-traumatic arthritis secondary to a fracture of the tibial plateau (one knee) or a fracture of the proximal tibial shaft (one knee).

The average follow-up was 44.2 months (range: 12 to 80 months).

2. Methods

(1) Knee Rating Score

Clinical evaluation was performed using the Hospital for Special Surgery Knee Rating System[23], which allots a maximum of 100 points to a normal knee. This value is divided as follows: 30 points for pain (walking and at rest): 22 points for function (includin walking for some distance, climbing stairs, and transfer activities): 18 points for range of motion; and 10 points for muscle strength, flexion deformity, and angular instability (measured clinically in extension). Points are subtracted for external supports, extenison lag, and residual angular deformity (Table 1).

Results of 85-100 points were graded as excellent;70-84 points, good; 60-69 points, fair; and less than 60 points, poor.

(2) Alignment

Table 1. Knee-Rating Scale

PAIN (30 points)	
No pain at any time	30
No pain on walking	15
Mild pain on walking	10
Moderate pain on walking	5
Severe pain on walking	0
No pain at rest	15
Mild pain at rest	10
Moderate pain at rest	5
Severe pain at rest	0
FUNCTION (22 points)	
Walking and standing unlimited	12
Walking distance of 5-10 blocks and standing ability intermittent (1/2hr)	10
Walking 1-5 blocks and standing ability up to 1/2hr.	8
Walking less than 1 block	4
Cannot walk	0
Climbing stairs unlimited	5
Climbing stairs with support	2
Transfer activity	5
Transfer activity with support	2
RANGE OF MOTION (18 points)	
1 point for each 8' of arc of motion to a maximum of 18 points	18
MUSCLE STRENGTH (10 points)	
Excellent:cannot break the quadriceps power	10
Good:can break the quadriceps power	8
Fair:moves through the are of motion	4
Poor:cannot move through the arc of motion	0
FLEXON DEFORMITY (10 points)	
No deformity	10
Less than 5'	8
5-10'	5
More than 10'	0
INSTABILITY (10 points)	
None	10
Mild:0-5'	8
Moderate:5-15'	5
Severe:more than 15'	0
SUBTRACTION	
One cane	1
One crutch	2
Two crutches	3
Extension lag of 5'	2
Extension lag of 10'	3
Extension lag of 15'	5
Each 5' of varus	1
Each 5' of valgus	1

The femorotibial angle (FTA) was measured by the Bauer method[5] in single leg standing roentgenograms. The long axes of the femur and tibia are represented by appropriate lines drawn on the radiograms. The long axes of the femur and tibia are represented by appropriate lines drawn on the radiograph, and the angle formed by their intersection at eh knee joint makes up the FTA.

OPERATIVE TECHNIQUE

Witha tourniquet to the thigh, the knee is flexed to at least 45 degrees (a position that relaxes the neurovascular structures and allows them to fall posteriorly); an oblique incision is made extending from the tibial tubecle to the fibular head. Skin flaps are raised proximally and distally. The upper tibia is exposed by making a facial incision along the crest of the tibia extending proximally to the fibular head. The patella ligament and tibial tubercle are exposed by a vertical incision along the lateral border of the patella ligament. The tethering effect of the fibular is eliminatel by the removal of the inferomedial portion of the fibular and neeck. The soft tissues are stripped from the front of the tibia anteriorly as far as the patella tendon and posteriorly for the full width of the posterior surface of the tibia, so that both the anterior and posterior tibial cortex can be seen. The proximal cut should be at least 1.5cm distal to the joint surface, which can be located either with a needle or by direct inspeciton. A Kirschner guide wire is inserted, and roentgenograms are made to determine the location and depth of the proposed osteotomy. A lateral wedge is removed with an osteotome; the posterior structures of the knee should be protected during this process. After the wedge is re-

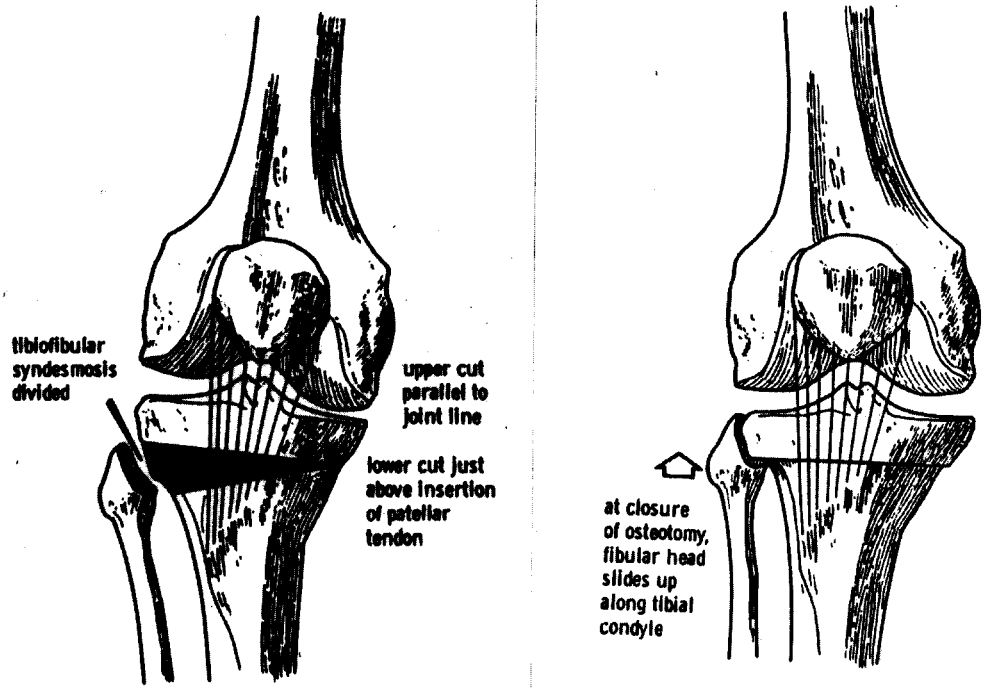

Fig. 1. Technique of proximal tibial osteotomy A) Division of superior tibiofibular joint and outline of osteotomy, B) Completed osteotomy.

moved, valgus force is exerted and the medial cortex breaks in a greenstick manner, and the osteotomized edgether (Fig. 1). Then the osteotomy is fixeal by a molding cast without internal fixation. Postoperatively , a cylinder cast is applied with the knee in zero degree of extension with cast changes at two 2-week intervals to maintain a secure fit. The day after surgery the patient is allowed to walk on crutches with the foot touching the floor for its compressing effect at the site of the osteotomy. The cast is worn until there is early union at the osteotomy site, usually five to six weeks. Exercises are then begun, with a gradual return to full activity. Full weight bearing on the extremity is allowed by 10 to 12 weeks.

RESULTS

The aim of proximal tibial osteotomy in osteoarthritis of the knee joint is to relieve pain. All patients in this study were carefully evaluated for pain and other factors such as walking distance, use of a walking aid, range of motion of the knee, and knee stability.

Function

The Hospital for Special Surgery knee Score improved significantly from a preoperative mean of 61 points to 84 points at last assessment (Fig. 2).

Postoperatively, 19 (86 percent) of the knees were rated as excellent or good.

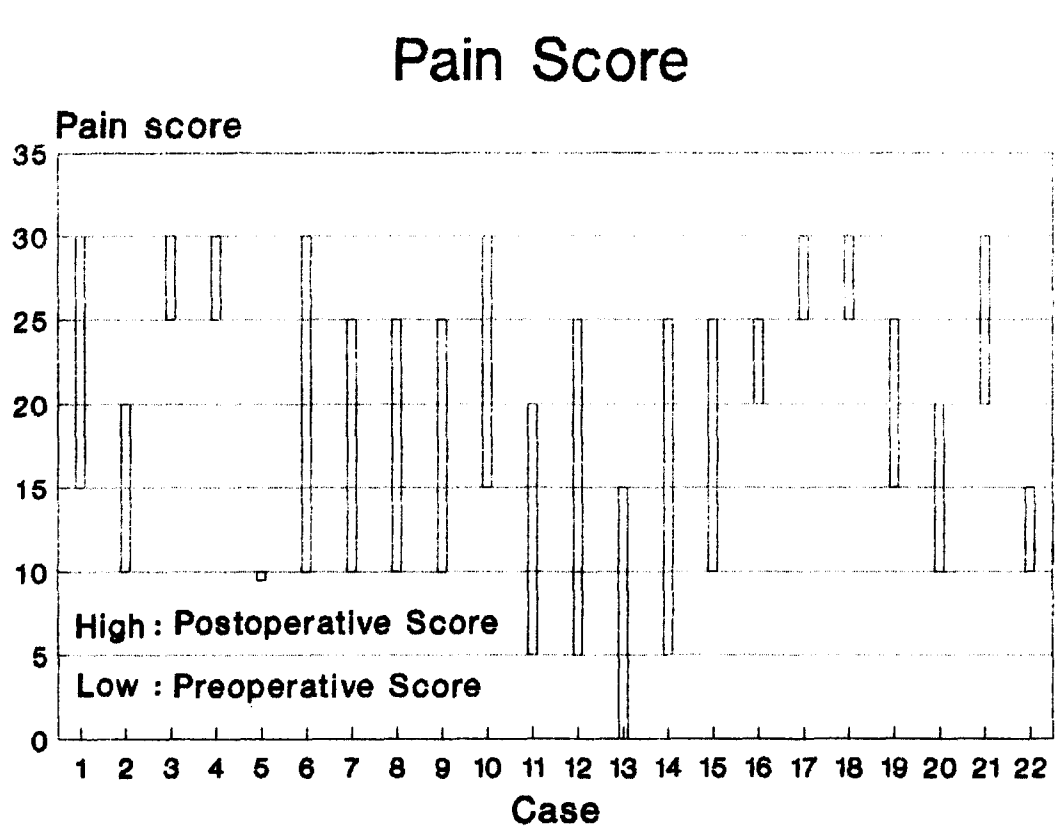

Fig. 2. A longitudinal analysis of total Insall Knee Rating scores (naximum 100 points) pr-eoperatively postoperatively in patients treated with proximal tibial osteotomy.

Three knees were rated as fair and were considered a treatment failwes these patients were advised to have a total knee replacement.

Pain

The most striking improvement was in the relief of preoperative pain. The pain score component improved significantly from a preoperative mean of 12.5 points to 24.8 points at the last assessment (Fig. 3).

Motion of the Knee

Motion of the knee ws evaluated both before and after the operation, and no significant change in the range of flexion or extenstion was noted for most patients. Restoration of motion has not been a problem, and most joints regained their preoperative range within one week of cast removal and improved slightly in extension lag. However, older patients took longer to regain the preoperative range.

Alignment

Preoperative TFA had 0° -5° of varus deformity in 10 knees, 6° -10° in 10 knees, and 11° -15° in two knees. In our series of proximal tibial valgus osteotomies, the tibiofemoral angle was corrected from a preoperative mean of 6.2 degrees of varus to a mean of 8.9 degrees of valgus at the last assessment.

Complications

No patient had a delayed union, nonu-

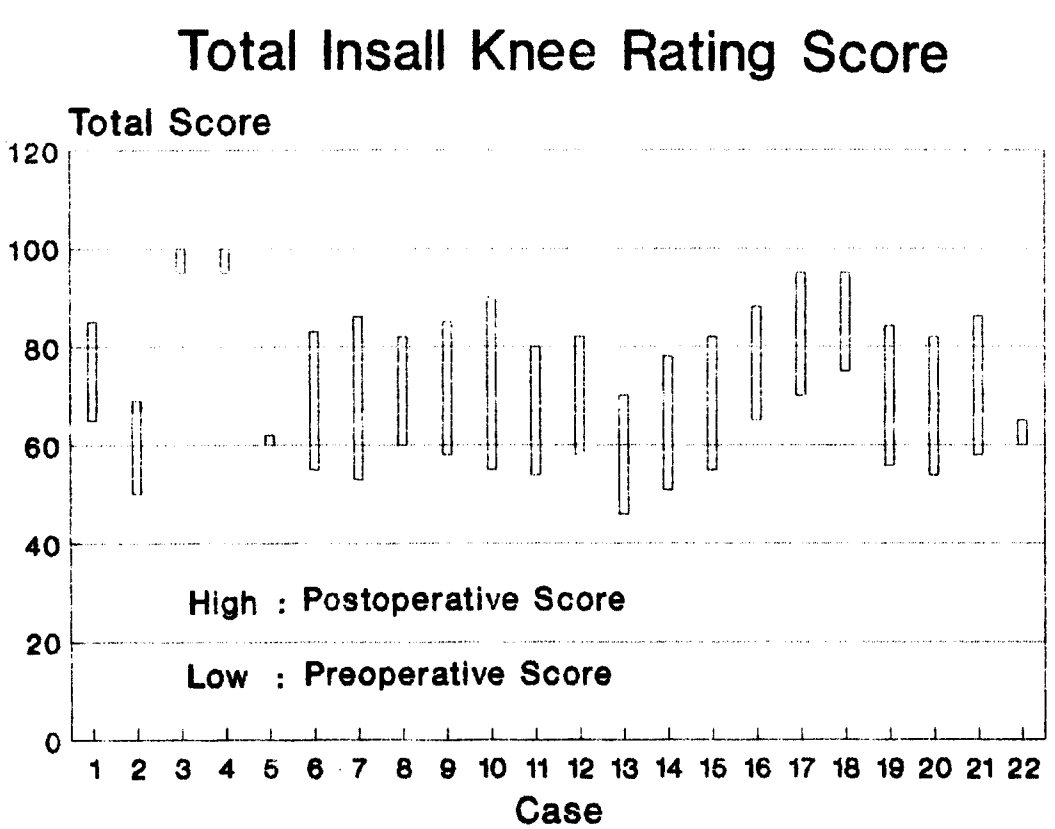

Fig. 3. A longitudinal analysis of the pain componeut (maximum 30 points) of the total Insall Knee Rating scale preoperatively and postoperatively in patients treated with proximal tibial osteotmy.

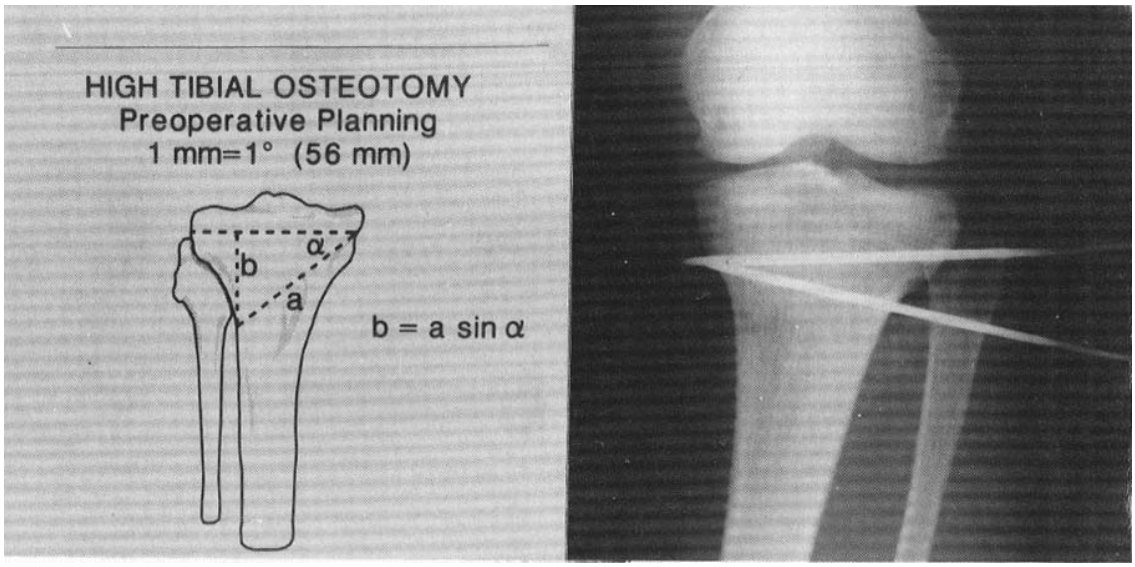

Fig. 4. This is the geometric way to ascertain the width of the tibial wedge. Magnification secondary to the radiograph must also be taken into account. Thus, if this procedure is done under fluroscopic guidance, the angle between two Kischner wires can be measured, assurihg that the appropriate wedge will be taken.

nion, or vascular injury. One patient had a transient peroneal nerve palsy than was caused by a tight postoperative cast. One patient had a superficial wound infection.

DISCUSSION

Although the etiolgy of degenerative arthritis of the knee is multifactorial, one of the principal causative and accelerating factors is abnormal stress produced by a biomechanical alteration[2,3,29,30,31,35,41,44].

The varus and valgus deformity of the knee cause an abnormal distribution of the stresses of weight-bearing within the joint. When the deformity is one of varus position, these stresses are concentrated medially and the degenerative changes in the medial part of the joint are accelerated. If, however, the knee is in balance, with normal loading medially and laterally, the progress of degeneration should be slower and less severe. Knowledge of this principal should lead the surgeon to institute early treatment not only as correction or palliation but also as prophylaxia against the development of a more severe condition. Painful varus or valgus deformity with osteoarthritis may be corrected by proximal tibial osteotomy[2~5,18~22,24~33,37,38,41,44,45].

The earliest attempts at osteotomy were made at the junction of the upper and middle thirds of the tibia (Wardle[43]); the site was then moved to just below the tibial tubercel (Jackson and Waugh[26]) and, finally, to just proximal to the tibial tubercle (Gariepy[19], Conventry[9]). Currently, most surgeons prefer the proximal level. Thus, the osteotomy is closest to the deformity and passes through canellous bone, which allows early union. In addition, there is a compressing action of the quadricepas mechanism on the osteotomy site.

In 1965 Coventry[9] described a closing-wedge osteotomy made just distal to the knee through the cancellous bone of the proximal tibia. Bauer and associates[5] and

Fig. 5A) Weight-bearing standing A-P and lateral roentgenograms of the knee of a 56-year-old man demonstrate osteoarthritis of the medial compartment, which lead to a varus deformity before the operation.

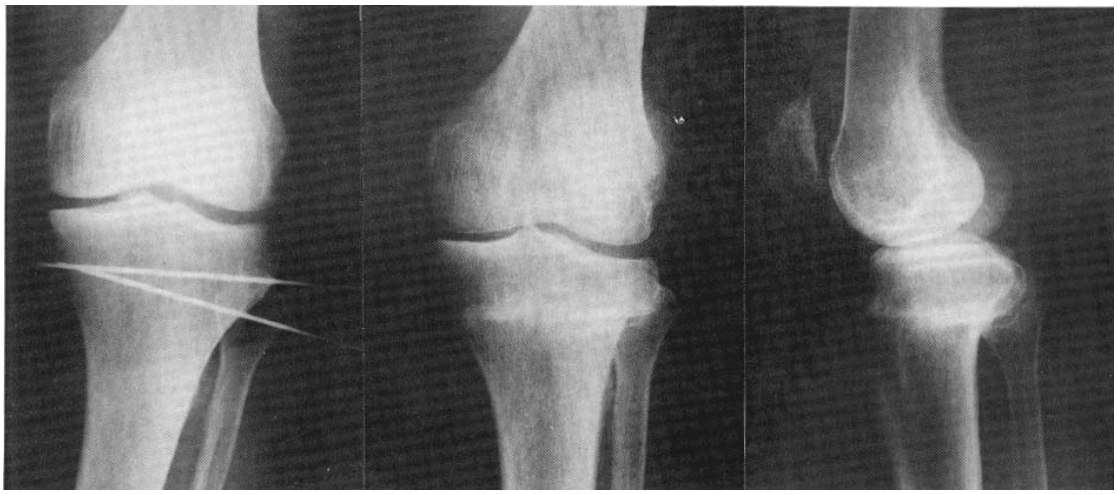

Fig. 5B) Left:Portable A-P view of the left knee for correction angle and position of the wedge osteotomy during the operation Middel and Right:Follow-up weight-bearing A-P and lateral views (postop. 15 months).

Harris and Kostuik[21] added their reports in 1969 and 1970. Retes of good to excellent five-year results have been reported to be high as 85 percent by Insall et al[24]., 88 percent by Coventry[11],and 92 percent by Healy and Riley[22]. With longer follow-ups, reports indicate that continued satisfaction can be expected in 60 percent of the patients seven to 10 years after osteotomy.

Fig. 6. Weight-bearing standing A-P view of the knee of a 52-year-old woman demonstrates advanced osteoarthritis of the medial compartment, which lead to a varus deformity (left) before the operation: (rigth) 4 years after proximal tibial osteotomy.

Generally the preferred method is the Gariepy method[19] of wedgs osteotomy done through through the cancellous bone of the upper tibia proximal to the tibial tubercle. The advantages of this procedure are that (1) the osteotomy is near the site of deformity, namely, the knee, (2) it is done through cancellous bone which heals rapidly, (3) postoperative immobilization is short, (4) the danger of delayed union or non-union is virtually eliminated, (5) compression at the osteotomy site is aidey by contraction of the quadriceps (and weight-bearing), and (7) the collateral ligaments can be replaced under physiological tension.

The anatomical axis is that angle formed by lines drawn from the center of the femoral and tibial diaphyses across the knee joint on the anteroposterior radiograph. Five to 7 degrees of valgus is considered normal. The normal mechanical axis is considered to be a straight line from the center of the femoral head to the center of the ankle joint. On the anteroposterior radiography, this line should pass through the center of the Knee joint. A full-length standings radiograph is required for this assessment. Using the clinical data derived from five major investigators, Bauer and associates[5] recommended alignment in the 3 to degrees of valgus, a relatively broad range. Coventry[11] recommender five 5 degrees of overcorrectioncompared with a normal of five 5 to eiglt 8 degrees of valgus. Kettelkamp and associates[29] recommedned eiglt 8 to 11 degrees of valgus. Maquet[34] recommended two 2 to fous 4 degrees of valgus with respect to the mechanical axis. The correction to eiglt to 10

degrees of valgus in the anatomic axis system should give a satisfactory result 80 % to 90 % of the time. Based on Kettelkamp and associates' measurements[29], there is normally a force of 0.25 times the body weigh (BW) on the medial plateau. The goal of an osteotomy is to decrease the elevated medial plateau force to less than 0.5 BW. Those patients who had a force less than 0.5 BW on the medial plateau had a satisfactory result. Maquet made his calculations using a full-length radiography and imparted a much stronger role to the iliotibial band (calling it the "pelvic deltoid") that helps balance the knee in a varus deformity. Accordingly, however, this approach increases the load on the knee much as the abductors increase the load on the hip. Again, he believed that two 2 to fous 4 degrees of valgus with respect to the mechanical axis was the most appropriate.

Along with previous authors[7,11,12,28,29,33,35,36], we recommend that osteotomy in medial gonarthrosis aim for overcorrection. Overcorrection is needed for the following reason: (1) Usually there is some lateral laxity, which can be compensated for by overcorrection[31]. (2) Medial compartment destruction and lateral subluxation can be present; if they progress, recurrence of varus ensues. (3) A tendency toward recurrence of varus angultion, but in the early healing phase and later, has been shown by others. Changes of the alignment in the early postoperative period can be caused by inadequate immobilization or delayed union. Later recurrence is probably secondary to continued high medial forces and secondary degenerative changes. (4) The load in the medial compartment, even after "adequate" correction, has been shown to be above normal[25,29,33].

The autors used the method of Bauer et al[5]. for calculating the size of the wedge removed as roughly one 1 degree of correction for each millimeter of length at the wedge. The commonly accepted estimation that 1 one millimetes one 1 degree is true only if the tibia is 56 mm wide, which is a relatively narrow tibial width. For men, who generally have a larger bone size, the calculation is likely to lead to undercorrection. The measurement can be individualized as demonstrated in Figure 4.

Coventry excises the head of the fibular in a valgus osteotomy, but we have found that removing only the inferomedial portion of the fibular head and neck is necessary for adequate exposure, and thus the lateral collateral ligament and biceps tendon need not be reattached to the fibular neck.

We used the technique of leaving a posteromedial lip of bone on the proximal tibial fragment. Following closure of the osteotomy after removal of the wedge of bone, this posterior lip overrides the proximal end of the distal fragment and thus gives added support and stability to the osteotomy.

Biologic evidence exists to substantiate reconstruction of functional articular surfaces after surgery in cases of osteoarthritis. Endler has reported the new joint surface of the hip is filled with two 2 layeres of tissue varying from fibrocartilage to hyaline cartilage[16].

Radin, et al. could demonstrate experimentally the formation of the same type of tissue after removal of all the cartilage covering the articular surfaces of the hip in cats when the joint pressure was significantly relieved multiple tenotomy[39]. Fujis-

awa et al. carried out a eeries of arthroscopies in severe osteoarthritis of knee with a varus deformity just before and several years after upper tibial oeteotomies. They also examined biopsy specimens of the load-transmitting surfaces of the joint in the area which looked preoperatively overstressed on the X-rays. Before surgery, the arthroscops showed eburnated bone on both femoral and tibial articular surfaces. In the hips in which overcorrection of the deformity had been sufficient, white smooth tissue similar to cartilage covered the joint surfaces postoperatively. Under the microscope this tissue appeared to be fibrocartilage with a tendency of its deep layers to remodel into hyaline cartilage[18]. In all the reported cases, the prerequisite for a biologic healing of the joint consisted of a significant reduction of the articular compressive stresses.

Contraindications to proximal tibial osteotomy are (1) varus deformity of more than 15 degrees or subluxation, (2) flexion contracture greater than 20 degrees, (3) range of motion of less than 70 degrees, (4) bicompartment involvement, (5) instability, and (6) an age range oven 65. Patellofemoral arthritis definitely does not contraindicate osteotomy[7,25], which may improve patellofemoral function by a subtle alteration in patella tracking or by anterior advancement of the tibial tubercle. Maquet[34,35], Ferguson[17], and Radin[40] have demonstrated the relief of patellofemoral joint symptoms with advancement of the tibial tubercle. Large correction can be obtained by Barrel-Vault osteotomy in varus deformity of more than 15 degrees or subluxation[31].

Now that total knee replacement has become an established and reliable operation, it may be considered an alternative to osteotomy. Current prosthetic designs have proved quite durable, offer a higher proportion of excellent results, and give a more rapid recovery than osteotomy, particularly in bilateral cases. On these grounds, TKR seems preferable to osteotomy in most patients over 65 years of age, except for those who perform heavy manual labor and for those who continue vigorous sports.

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골성슬관절염에 대한 경골 근위 절골술

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=국문초록=

내반변형을 동반한 슬관절의 골성관절염에서 비정상적 스트레스 (stress)가 슬관절의 내측구획에 집중된다. 그래서 적절한 치료는 특정부위에 국한되는 스트레스를 하중의 부하면적이 가장 넓은 부위로 균등하게 재분포시켜서 국소압박을 감소시키는 것이다. 이것은 경골 근위부 절골술과 약간의 과교정으로 얻을수있다.

1984년부터 1989년까지 계명대학교 의과대학 동산의료원 정형외과교실에서 슬관절 골성 관절염에 대해 경골 근위부 절골술을 시행했던 환자중 최단 12개월부터 최장 80개월까지 (평균 44.2개월) 추시가능한 18명, 22슬관절에 대한 결과 Insall의 Knee Rating Scale은 수술전 평균 61점에서 수술후 평균 84점으로 증가하였다. 동통은 22슬관절중 19슬관절에서 감소되었으며 동통점수는 수술전 평균 12.5점에서 수술후 평균 24.8점으로 호전되었다. 대퇴경골각은 수술전 평균 6.2도 내반슬에서 수술후 평균 8.9도 외반슬로 교정되었다.