Arch Orthop Trauma Surg (2003) 123 : 1–4
DOI 10.1007/s00402-002-0453-0

ORIGINAL ARTICLE

Kotaro Yamakado · Katsuhiko Kitaoka · Hiroshi Yamada
Kensaku Hashiba · Ryuichi Nakamura · Katsuro Tomita

Influence of stability on range of motion after cruciate-retaining TKA

Received: 6 November 2001 / Published online: 16 November 2002

Abstract *Background:* A loosely balanced total knee arthroplasty (TKA) is reported to produce a good postoperative range of motion (ROM), but too much laxity is thought to be the cause of persistent pain and worsened functionality. *Methods:* The anteroposterior and mediolateral laxity values were measured to evaluate the influence of stability after cruciate-retaining (CR) TKA on ROM and the modified Knee Society score at 4–8 years after the operation. Twenty-one knees in 15 patients with an average age of 68 years who had undergone a CR TKA for osteoarthrosis were examined. The mean preoperative and postoperative ROM was 124° and 112°, respectively. The mean anteroposterior and mediolateral laxity values were 9.7 mm and 10.6°, respectively. *Results:* No correlation was found between the postoperative ROM and laxity or between the modified Knee Society score and laxity. A loosely balanced TKA did not produce a good postoperative ROM. No parameters suggested that lax knees showed a higher pain score and lower functional score than stable knees.

Keywords Total knee arthroplasty · Laxity · Range of motion

Introduction

Range of motion (ROM) has been an important measure of outcome and is an important part of most knee scoring systems [9, 17]. There is controversy about laxity in prosthetic knees. In many clinical rating systems, either anteroposterior or mediolateral laxity is regarded as a negative point [9, 17]. In the Knee Society (KS) clinical rating system, coronal laxity of more than 10° and/or anteroposterior laxity of more than 10 mm are regarded as indicative of an unstable knee [9].

However, several surgeons believe that a loosely balanced knee leads to a better postoperative ROM [6, 10, 24], although too much laxity is thought to be a cause of persistent pain and catastrophic long-term results [7, 9, 13, 15, 17, 25]. To our knowledge, few studies have examined the relationship between postoperative stability and function [6, 10, 24]. The aim of this study was to determine the influence of stability on ROM after cruciate-retaining total knee arthroplasty (CR TKA).

K. Yamakado (✉) · K. Kitaoka · H. Yamada · K. Hashiba
R. Nakamura · K. Tomita
Department of Orthopaedic Surgery, School of Medicine,
Kanazawa University,
13–1, Takara-machi, Kanazawa, 920–8641, Japan
e-mail: yamakado@nsknet.or.jp,
Tel.: +81-76-2652370, Fax: +81-76-2344261

Patients and methods

Twenty-one knees were examined in 15 patients (average age 68 years; age range 58–78 years) who had undergone CR TKA for osteoarthritis. This group consisted of 3 men and 12 women. The average follow-up period of the affected knees was 7.1±0.84 (range 4–8) years. All knee components were implanted using a standard parapatellar incision, and all posterior cruciate ligaments (PCL) were intact at the time of surgery. Y/S-4 (Yoshine/Shoji-4; Biomet, Warsaw, IN, USA) was used in 16 knees and AGC-S (Anatomic Graduated Components-Shoji; Biomet), which is the successor to Y/S-4, was used in five knees. The design of the Y/S-4 and AGC-S prostheses is almost same: They retain the posterior cruciate ligament, and their femorotibial articulation is minimally constrained with minimal conformity design. The tibial component is slightly dished in the sagittal plane with a slightly elevated anterior lip. In the coronal plane, the femorotibial articulation is ‘flat-on-flat’. In a condylar TKA, stability depends on the collateral ligament balance, posterior restraint, and conformity between the femoral and tibial components. The articullar contours of Y/S-4 and AGC-S which are relatively flat in the coronal and sagittal planes allow greater

Table 1 Anteroposterior and mediolateral laxity in prosthetic knees

	Mean±SD	Range
Anteroposterior laxity (mm)	9.7±1.1	2–27
Mediolateral laxity (degree):		
Varus laxity	6.2±0.9	1–16
Valgus laxity	4.3±0.5	1–8
Total (varus + valgus) laxity	10.6±0.9	5–22

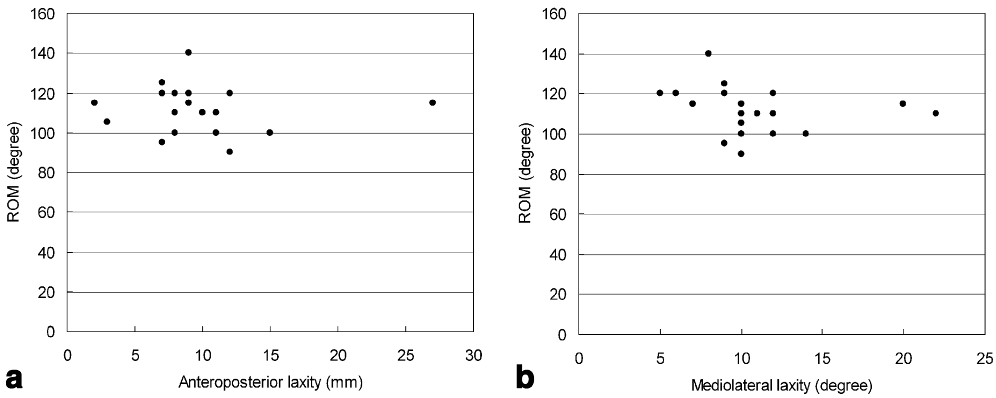

Fig. 1 **a** Scattergram of anteroposterior laxity and postoperative ROM (R^2=0.0041, p=0.78). **b** Scattergram mediolateral laxity and postoperative ROM (R^2=0.063, p=0.27). Note that there are no correlations between anteroposterior laxity and postoperative ROM, nor between mediolateral laxity and postoperative ROM

translation and provide less articular stability than conforming surfaces. Stability depends mainly on the soft-tissue balancing when using these unconforming prostheses. Anteroposterior laxity was examined using a KT 2000 (Medmetric, San Diego, CA, USA) arthrometer at 30° knee flexion. The relative movement between the patella and the tibial tubercle sensor pads was recorded when an anterior force of 133 N was applied to the leg. Mediolateral laxity at full extension was examined with manual stress anteroposterior radiographs. When performing the stress tests, the examiner grasped the foot to prevent rotation of the lower leg. Unacceptable rotational error was not observed in this series. All examinations were performed by one of the authors (K.Y.). Each patient had outcome assessments based on the KS clinical rating system [9]. The KS score was modified by omitting the stability points (25 points) and ROM points (25 points). The evaluation is based on the percentage of the maximum allowable (150) points.

Data were analyzed to show the relationship between laxity and postoperative ROM or the KS score. Peason's correlation coefficient test and multiple regression analyses were used for the statistical analysis with an alpha level of 0.05 and were conducted using Excel 2000 (Microsoft, Seattle, WA, USA).

Results

The mean preoperative and postoperative ROM was 124º± 20.7° (range 90º–165°) and 112º±2.4° (range 90º–140°), respectively. No statistically significant correlation was found (p=0.39). The mean anteroposterior laxity was 9.7 mm, and the mean mediolateral laxity (total varus plus vulgus) was 10.6° (Table 1). No correlation was found between the postoperative ROM and anteroposterior laxity (p=0.78), and between the postoperative ROM and mediolateral laxity (p=0.27) (Fig. 1). Multiple regression analysis also showed no significant correlation between the postoperative ROM and sagittal laxity (F=0.21, p=0.65) or coronal laxity (F=1.4, p=0.26). The mean modified KS score was 86.2% (range 33.3%–100%) (Table 2). The mean KS function score was 82.1 points (range 40–100 points). The mean KS pain score was 47.1 points (range 10–50 points). No correlation was found between any component of the KS score and anteroposterior laxity (p=0.81), nor between any component of the KS score and mediolateral laxity (p=0.55) (Fig. 2). Multiple regression analysis also showed no significant correlation between the modified KS score and sagittal laxity (F=0.017, p=0.9) or coronal laxity (F= 0.31, p=0.6).

Table 2 Modified Knee Society score (mean±SD)

Pain (points)	47.1± 8.9
Function (points)	
Walking	43.3±14.2
Stairs	41 ± 9
Total (%)	86.2±17.7

Discussion

These results showed no correlation between anteroposterior or mediolateral laxity and postoperative ROM or clinical outcome measurements. The present findings suggest that moderate laxity does not alter the patient outcome at intermediate follow-up. Various authors have examined the relationship between instability and postoperative ROM or instability and clinical outcome [6, 7, 10, 13, 15, 24]. Edward et al. showed that greater coronal laxity correlated with better clinical scores [6]. They examined coronal laxity in a subjective clinical manner without objective measurements and reported that only 9% of lax knees (total laxity >110) complained of pain, whereas 38% of stable knees were painful. However, they warned not to leave knees purposefully unbalanced or lax at the time of surgery since they thought the laxity was mainly due to postoperative relaxation or stretching of ligaments. Warren et al. showed that too much stability might affect ROM [24]. Anteroposterior translation in their study was 1.16 – 10.21 mm (mean 4.67 mm), and these results could be explained as slight laxity, which would be better than stiff. Itokazu et al. reported similarly that sagittal laxity correlated with better ROM. The range of anteroposterior translation was 2 – 10 mm (mean 5.05 mm) [10]. Our results confirmed these findings and suggested that moderate degrees of laxity were acceptable after TKA. Nevertheless, Fehring and Valadie suggested that instability could be the cause of a painful TKA [7]. Pagnano et al. suggested that flexion instability could be a cause of persistent pain and functional impairment after CR TKA [15]. Mitts et al. suggested that greater laxity and subclinical instability adversely alter the patient outcome at intermediate follow-up [13]. Instability after TKA is a commonly reported mode of failure [7, 9, 13, 15, 17, 25]. Too much laxity is thought to be a cause

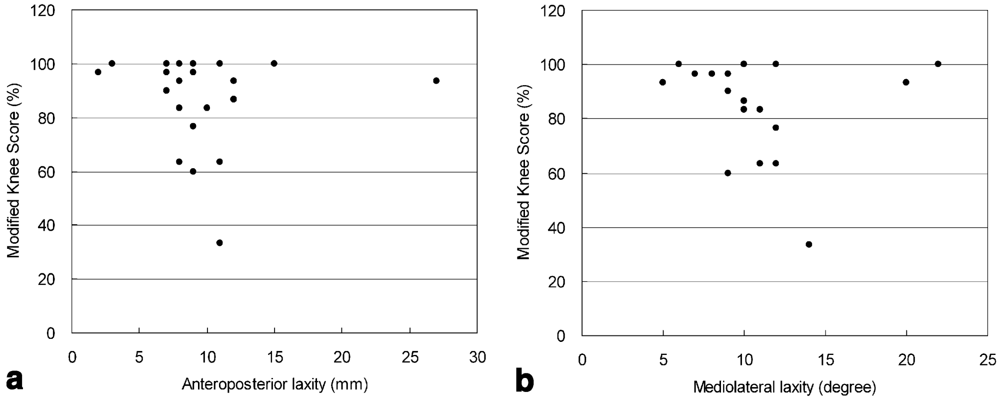

Fig. 2 a Scattergram of anteroposterior laxity and modified Knee Society score (R^2=0.0033, p=080). **b** Scattergram mediolateral laxity and modified Knee Society score (R^2=0.019, p=0.55). Note that there are no correlations between anteroposterior laxity and the modified Knee Society score, nor between mediolateral laxity and the modified Knee Society score

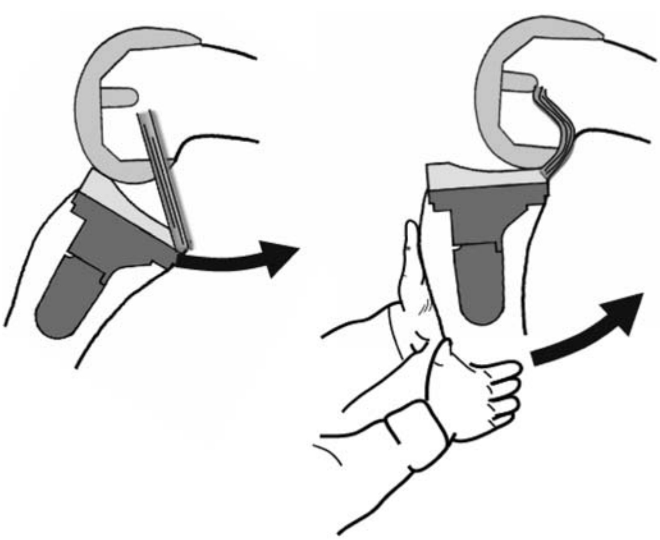

Fig. 3a, b Schematic illustration of postoperative physiological flexion (**a**) and intraoperative anesthetic flexion of the knee (**b**). Too much laxity makes posterior cruciate ligament (PCL) slack and leads to functional PCL deficiency that interferes with femoral rollback and flexion of the knee

for catastrophic long-term results and should be avoided. Further study is needed to determine the permissible range of laxity.

A loosely balanced knee easily accomplishes good flexion (even full flexion) intraoperatively. However, the intraoperative ROM does not necessarily equal the postoperative physiological ROM. To explain the discrepancy here, we think that too much laxity makes the PCL slack and leads to functional PCL deficiency, which conducts abnormal anterior femoral translation (Fig. 3). Anterior translation may interfere with flexion because of impingement between the tibial component and the femur. Several studies reported abnormal anterior femoral translation in CR TKA [2, 3, 4, 21, 22, 23], whereas preservation of the PCL in TKA has been believed to reproduce more normal knee kinematics [14].

There was no statistically significant correlations between the preoperative and postoperative ROM, whereas the preoperative ROM is reported to be the most important determinant of the postoperative ROM [1, 8, 10, 11, 12, 20]. We think that the large preoperative ROM in this study influenced the result. The 95% confident interval of the preoperative ROM in this study was over 110º (114.5º–134.8º). Parsley et al. showed that patients with more than 105º of preoperative flexion demonstrated a decrease in flexion postoperatively [16]. In addition, some studies showed that the postoperative ROM migrates to the average value of the implanted prosthesis [10, 18].

We conclude that at the intermediate follow-up, a loosely balanced TKA did not result in a good postoperative ROM. No parameters suggested that lax knees showed a higher pain score and lower functional score than stable knees.

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