Transverse incision advantages for total knee arthroplasty

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journal or publication title	Journal of Orthopaedic Science
volume	16
number	5
page range	524-530
year	2011-09-01
URL	http://hdl.handle.net/2297/30110

doi: 10.1007/s00776-011-0133-4

**TRANSVERSE INCISION ADVANTAGES FOR TOTAL KNEE
ARTHROPLASTY**

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1 **TRANSVERSE INCISION ADVANTAGES FOR TOTAL KNEE**

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Introduction

A longitudinal incision is commonly used for total knee arthroplasty (TKA) ¹. However, there are three problems with this type of incision: first, a hypertrophic scar with pain and itching; second, numbness at the distal lateral side of the knee joints; and third, frontal knee pain while kneeling. According to these problems, the rate of the neuropathy of the infrapatellar branch of the saphenous nerve has been reported to be from 55 to 100 percent ^{2,3}. It causes incision-site problems, which leads to dysfunction in daily life ^{4,5}. They have been thought to be difficult problems to resolve.

On the other hand, it is well known that transverse incisions provide better cosmetic results for patients who undergo surgery for patellar fractures ⁶. This incision is approximately parallel to the course of the infrapatellar branch of the saphenous nerve, allowing the surgeon to better identify and preserve the nerve. If a transverse incision can be safely used for TKA, this would satisfy the patients' desire for decreased scar formation and increased kneeling motion. The purpose of this study was to compare transverse and longitudinal incisions for TKA focusing on scar cosmesis, the infrapatellar branch of the saphenous nerve, and kneeling.

Patients and methods

Among the 103 patients (110 knees) with primary TKA performed from April 2004 to July 2007, we evaluated 95 patients (101 knees) with follow-up for more than two years. Scorpio NRG PS (Stryker, Kalamazoo, MI, USA) was used. Patients with the following conditions were excluded: a previous surgery wound around the new one, an apparent keloid constitution, skin diseases, bleeding tendency, diabetic disease requiring insulin administration, nerve disorders, or cancer. All cases were performed by the same surgeon (TO). Longitudinal incision was used for the first 40 knees, and a transverse incision was used for the remaining 61 knees; the use of a transverse incision for all TKAs began in 2006. Our institutional review board accepted the use of the transverse incision. We also obtained informed consents regarding patients' rights about the transverse incision from all candidates. There were no significant differences in age, male-to-female ratio, preoperative diagnoses, and body mass indices. There were no significant differences between the two groups in Knee Society Score (KSS) and the femoro-tibial angle, which represents the degree of knee deformity. The follow-up durations were 33.2 months for the transverse incision cases and 50.4 months for the longitudinal incision cases (Table 1).

Air tourniquets were not used in any of the operations. The longitudinal incisions were made at the midline, from three centimeters proximal to the upper end of

the patella to the tibial tuberosity (Fig 1A). The transverse incisions were made at a ninety-degree knee flexion at the level of the lower end of the patella, along the skin crease, and the medial and lateral ends were targeted around the medial and lateral epicondyles (Fig 1B). Other than the incisions themselves, the surgical procedures for both incisions were basically the same. Careful attention was paid not to injure the infrapatellar branch of the saphenous nerve, when it could be observed (Fig 2). The arthrotomy was performed using a medial parapatellar approach. With an intramedullary guide, we first cut the tibial bone, and then the femoral bone. Without using any tools for minimally invasive surgery (MIS), bones were cut with ordinary-sized cutting guides (Fig 3A and 3B). Wounds were subcutaneously sutured using 3-0 Vicryl (Johnson and Johnson, NJ, USA), leaving the superficial skin layer unsutured to maintain the blood supply to the wound margins. The same postoperative treatments were given to both groups.

The evaluation criteria included: operation time, blood loss during the operation, complications and KSS one year after the surgery. As for the wounds, we examined the wounds for complications and measured wound lengths and widths one year after the surgery. The Manchester Scar Scale (MSS)⁷ was used for an objective cosmetic evaluation. For evaluation of the wound conditions, two doctors (TO and

MY) examined the worst part of the scar cosmesis. The three criteria measured with MSS were color, contour and distortion, each on a scale of one to four points. The fourth criterion of MSS is appearance, rated at one for matte and two for shininess. The Visual Analogue Scale (VAS) was also used for evaluation by both surgeons (objective) and patients (subjective): zero denoted excellent, while ten denoted poor. In addition, we further examined whether sensory disturbance existed or not. Using a TKK2335 algometer (Takei Kiki Kogyo Co., Ltd., Tokyo, Japan), we conducted an objective evaluation and mapped the sensory disturbance areas on tracing paper. Area-measuring software was downloaded from the Internet (lenaraf220.xls) and used for surface-area measurements. The kneeling motion was evaluated to determine whether kneeling was possible. If the patient could kneel on the operated knee without any support for more than ten seconds, we defined his or her kneeling motion as possible.

A t-test and χ^2 -test were used for statistical analysis, and a risk rate of $p < 0.05$ was determined as significant, using the StatView 5.0 software for Macintosh (SAS Institute Inc., Cary, NC, USA).

Results

The mean operation time required for a transverse incision was 125 minutes, taking slightly longer than for longitudinal incisions (118 minutes), although it was not a statistically significant difference. Blood loss during surgery was nearly equal. Concerning complications, one patient suffered from a fungal infection one year following the surgery, and a two-stage revision TKA was performed using the same transverse incision. After an additional year, fungal infection was detected again, and the re-revision TKA was again conducted using a midline longitudinal incision that was perpendicular to the previous transverse incision. Neither a third fungal infection nor skin problems have occurred so far, one and a half years following the re-revision surgery. A proximal deep vein thrombus was found in one knee in each group, which was improved by heparin administration. No pulmonary embolism occurred in either group. We obtained satisfactory KSS scores in both groups, without a significant difference, at one year after the operation (Table 2).

As for wound complications, in the transverse incision group, three knees had subcutaneous hematomas, which were treated with puncture, and one knee had a prolonged wound-healing time of more than two weeks. In the longitudinal group, two knees had subcutaneous hematomas and one knee had a prolonged time for wound healing. Neither superficial infection nor skin necrosis that required additional

treatment was found in any cases, but one knee had strong itching at the scar due to hypertrophic scarring of the longitudinal incision (Table 3).

When follow-up evaluation took place one year after surgery, the wound lengths at the knee extension were significantly longer in the transverse group than in the longitudinal group. But the wound lengths at a ninety degree knee flexion were approximately 15 cm, without a significant difference between groups. The average wound width measured at its maximum was significantly smaller in the transverse group than in the longitudinal group. The two MSS criteria, color and VAS, scored lower in the transverse group and no significant difference was found among the three criteria: appearance, contour and distortion (Table 4). The total score for the transverse group was significantly lower than for the longitudinal group. The typical appearance of the scar at one year after TKA using a transverse incision is shown in Fig 4A and 4B.

Subjective complaints of sensory disturbance, such as numbness or hypoesthesia were found to be significantly less in the transverse group than in the longitudinal group. Even patients without subjective sensory disturbance showed some degree of sensory disturbance in the objective evaluation using an algometer. Its frequency was significantly less in the transverse group than in the longitudinal group.

The sensory disturbance area measured by mapping was also significantly smaller in the transverse group than in the longitudinal group (Table 5).

In total, 54 knees (70.4%) with transverse incisions, and 13 knees (40.6%) with longitudinal incisions could kneel for daily-activity movements. Anterior knee pain complaints in the transverse group (63.0%) were found to be fewer than those in the longitudinal group (78.1%), but the difference was not significant (Table 6).

Discussion

The difference between our method and the conventional one is in the incision only. Scar cosmesis, improvement in the disorder of the infrapatellar branch of the saphenous nerve, and kneeling motion are the expected advantages of our method. However, we have to take into consideration skin problems caused by decreased blood supply by retracting the skin to maintain a clear operating field of view.

Langer's lines are well known as appropriate surgical incisions. They were originally examined as slit-like wound arrangements after making circular holes with pins on a corpse's skin. However, as for a juxta-articular area, such as the knee, Langer himself noted that the line was complex, depending on the knee position when the holes were made ⁹. Therefore, Borges ¹⁰ and Kraissl ¹¹ proposed relaxed skin

tension lines (RSTLs), which were simply obtained by pinching the skin. The RSTL in the frontal knee runs transversely and corresponds to the crease. It is clinically well known that the transverse incision provides a better cosmetic result for patients who have undergone surgery for a patellar fracture, among other procedures ^{6,8}. In our two-year follow-up study of TKA using transverse incisions, it was confirmed that scar cosmesis was significantly better than in the longitudinal incision group.

It has been reported that the infrapatellar branch emerges from the main trunk of the saphenous nerve at the level of the inferior pole of the patella. The infrapatellar branch runs transversely, just inferior to the lower pole of the patella, and controls the sense of the distal lateral side of the knee joint ¹². It has been described that the direction of the incision at the graft-harvesting area, made obliquely rather than vertically, can decrease the incidence of sensory disturbance ¹³. In TKA surgery, when a longitudinal incision is used with a medial parapatellar approach, the nerve is cut off before arthrotomy ¹⁴. When a transverse incision is used in TKA, the direction of the incision corresponds approximately to the running direction of the nerve, so the nerve can be confirmed and preserved in many cases.

Studies have described the possibility of a kneeling motion after TKA, varying from 34 to 82 percent ^{5,15}. It may be associated with many factors: range of knee

flexion of at least 110 degrees¹⁶, problems with the patello-femoral joint, muscle strength, lumbar spine conditions, and adjacent joint conditions. In our department, kneeling and rising from the kneeling position are allowed approximately three weeks after TKA surgery, when the wound has healed perfectly and swelling has subsided. At that time, many patients are nevertheless unable to kneel, complaining of their scars, pain, and numbness around the wounds, as well as uncomfortable feelings.

While performing the kneeling motion, the kneeling triangle, the area bounded by the femoral condyles on either side at the lower level of the patella proximally and the tibial tubercle distally, faces the ground¹⁷. Pain in this area becomes a major obstacle to kneeling. We considered pain in this area to be caused mainly by injury to the infrapatellar branch of the saphenous nerve. When a transverse incision is used for TKA, the incised part does not face the floor, and less pain and numbness occurs because the infrapatellar branch of the saphenous nerve is intact. In our investigation, one year after surgery, we found that the performance of the kneeling motion was greater in the transverse group than in the longitudinal group.

According to several studies in the literature, the skin over the anterior knee is sufficiently fed with a blood supply by the perforating artery through the deep fascia¹⁸. By changing only the incision, from longitudinal to transverse, no blood-supply

reduction was caused in the skin. Further, it is generally believed that subcutaneous tissue detachment should be avoided as much as possible ¹⁹. Although wider subcutaneous dissection was needed in transverse incisions than in longitudinal incisions, no major skin problems were seen in this series. It goes without saying that careful and tender treatment of the skin is important, regardless of the incision. To prevent skin problems, according to additional advantages, the tension of the wound can be decreased only by the extension of the knee in the transverse incision.

From our results, we found that the same operative field of view can be obtained using a transverse incision as with a longitudinal incision. There was, however, a problem concerning which incision to make in the case of revision TKA. It is not a problem to use a longitudinal incision perpendicular to the transverse incision, which was made in the patellar fracture surgery ¹⁹. We did not encounter any wound problems in the two-stage reimplantation performed at an interval of one year, although we used a longitudinal incision that was perpendicular to the previous incision.

In our retrospective study, the case numbers were small and the follow-up duration was short. Nevertheless, we demonstrated the safety of transverse incisions and the possibility of scar-formation reduction. Additionally, dysfunction of the infrapatellar branch of the saphenous nerve and kneeling motion were shown to be

184 improved.

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186 None of the authors of this manuscript have received any benefits or funding

187 from anything related directly or indirectly to this article.

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Table 1. Patient Demographics

	Transverse incision		Longitudinal incision		p-value
Number of patients	58		37		
Number of knees	61		40		
Mean age in years (range)	75.3	(57-82)	73.8	(51-84)	0.45
Male:female	11:50		6:34		
Preoperative diagnosis					
Osteoarthritis	57		37		
Rheumatoid arthritis	2		3		
Osteonecrosis	2		0		
Mean body mass index (range)	24.4	(20-33)	25.2	(19-33)	0.50
Mean femoro-tibial angle (range)	182.5	(160-194)	180.3	(162-188)	0.10
Mean follow up in month (range)	33.2	(24-41)	50.4	(42-60)

Fig 1 A,B. Skin incision.

A Longitudinal incision was made at the midline, from three centimeters proximal to the upper end of the patella to the tibial tuberosity.

B Transverse incision was made at a ninety-degree knee flexion at the level of the lower end of the patella, along the skin crease.

Fig 2. Infrapatellar branch of the saphenous nerve.

Attention was paid not to injure the infrapatellar branch of the saphenous nerve, when it could be recognized.

Fig 3 A,B. Surgical exposure.

The same operative field of view could be obtained using a transverse incision as with a longitudinal incision.

A Exposure of the tibial side

B Exposure of the femoral side

Fig 4. Scar cosmesis at one year after TKA using transverse incision.

Color, contour and distortion were scaled at one point respectively, and appearance was

evaluated as matte. Objective VAS was one and total MSS was calculated as five points.

A At knee extension

B At a ninety-degree knee flexion

Table 2. Surgical Data

	Transverse incision (n=61)		Longitudinal incision (n=40)		p-value
Mean operation time in min (range)	125	(98-180)	118	(85-187)	0.10
Mean intraoperative blood loss in ml (range)	239	(100-435)	264	(100-490)	0.37
Postoperative complications					
Periprosthetic infection	1		0		
Pulmonary embolus	0		0		
Proximal deep-vein thrombosis	1		1		
Knee Society Score					
Knee score (range)					
Pre-operative	48.6	(14-68)	46.7	(12-70)	0.56
At one year	81.3	(62-92)	79.8	(60-91)	0.65
Functional score (range)					
Pre-operative	44.5	(14-66)	46.0	(14-65)	0.76
At one year	75.2	(42-85)	76.5	(43-88)	0.80

Table 3. Wound Complications

	Transverse incision (n=61)	Longitudinal incision (n=40)
Subcutaneous hematoma requiring puncture	3	2
Delayed healing over 2 weeks	1	1
Superficial infection	0	0
Skin necrosis requiring treatment	0	0
Scar itching	0	1

Table 4. Postoperative Results of Scar

	Transverse incision (n=61)		Longitudinal incision (n=40)		P-value
Mean scar length in cm (range)					
Extension	13.7	(12.5-14.5)	11.6	(9-13)	<0.01
90 degree flexion	15.2	(14-17)	15.3	(13-17.5)	0.74
Maximum scar width in mm (range)	1.5	(1-3)	4.2	(2-9)	<0.01
Manchester Scar Scale (range)					
Color	1.5	(1-3)	1.7	(1-4)	0.13
Matte/shiny	1.2	(1-2)	1.3	(1-2)	0.22
Contour	1.1	(1-2)	1.8	(1-3)	<0.01
Distortion	1.5	(1-2)	1.4	(1-2)	0.33
VAS	1.1	(0-6)	3.0	(2-8)	<0.01
Total	6.5	(4-10)	9.1	(6-18)	<0.01
Subjective assessment (range)					
VAS	1.1	(0-4)	1.8	(0-6)	0.03

Table 5. Assessment of Hypoaesthesia

	Transverse incision (n=61)		Longitudinal incision (n=40)		P-value
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Subjective assessment					
Number of knees with hypoaesthesia (%)	14	(21.3)	25	(62.5)	<0.01
Objective assessment					
Number of knees with hypoaesthesia (%)	21	(34.4)	33	(82.5)	<0.01
Mean area of hypoaesthesia in cm2 (range)	14.8	(0-35)	40.5	(0-90)	<0.01

Table 6. Assessment of Kneeling

	Transverse incision (n=54)	Longitudinal incision (n=32)	P-value
Kneeling is possible(%)	38 (70.4)	13 (40.6)	<0.01
Anterior knee pain (%)	34 (63.0)	25 (78.1)	0.14
Flexion angle (range)	121 (85-145)	123 (80-150)	0.33
Replacement of patellar (%)	28 (51.9)	18 (56.3)	0.69
Muscle strength of quadriceps femoris	4 (34), 5 (20)	4 (19), 5 (13)	

Acknowledgments

We are deeply grateful to Dr Nobuyuki Yoshino at Kyoto Kujo Hospital for valuable advices. I am also greatly indebted to all the people who gave me support and cooperation during this study, especially those at Yatsuo General Hospital, Harue Hospital and Fukui General Hospital.

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