Clinical Article

The effect of joint line restoration on kneeling ability after primary total knee replacement

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Abstract

Background

Total knee replacement (TKR) surgery has become one of the commonest orthopaedic procedures undertaken. Pain relief and restoration of function are two major expectations following knee arthroplasty. Kneeling is a knee function required for many types of occupation and activities of daily living, making its restoration following knee arthroplasty essential. Restoration of joint line position is a surgical factor that has been reported to have an important impact on functional outcome after TKR.

Materials and methods

We reviewed 100 (43 males and 57 females; with a mean patient age of 71 years) consecutive cemented Kinemax Plus TKRs (Stryker, Newbury, UK) performed in our unit with a minimum follow-up of two years. Joint line measurements were made on the pre-operative and post-operative X-rays. The kneeling ability component of the Oxford Knee Score questionnaire was analysed for all patients. The pre- and post-operative Oxford Knee Scores were prospectively recorded. Patients' ranges of movement (ROM) were measured.

Results

The mean pre-operative ROM for the group was 82º (std ± 15). Post-operatively, the mean ROM for the whole group was 109° (std ± 8). A joint line within ± 5 mm of the pre-operative measurement was considered 'restored' and more than 5 mm was considered 'elevated'. Seventy-five per cent of patients had the joint line restored within 5 mm of their native joint line post-operatively.

The mean ROM for restored and elevated groups was 116° and 108° respectively. This difference was statistically significant ($P < 0.01$). However, there was no significant difference in the total Oxford Knee Score between the groups.

Conclusion

Seventy-five per cent of cases in this study showed a restored joint line position. In this group, the ROM was better than in the group with elevated joint line (116° for restored joint line versus 108° for elevated joint line).
This study showed that restoring the joint line had a positive impact on the post-operative ROM and kneeling ability. However, kneeling ability can be affected by other factors and further studies are necessary to fully investigate this complex function of the knee joint.

Key words: kneeling, total knee replacement, joint line restoration, range of motion

Introduction

Total knee replacement (TKR) surgery has become one of the commonest orthopaedic procedures undertaken. Patients with significant pain and functional limitation due to arthritis benefit immensely from this operation. Although the majority of these patients are pleased with the pain relief gained from the surgery and get back to managing activities of daily living, the functional improvement can vary.[1] Kneeling is an important function of the knee joint and is required for many activities of daily living.[2] While inability to kneel in the West may make gardening and praying difficult, it also precludes certain occupations such as plumbing, flooring, carpet laying, painting, roofing, mining, building and many others.[3-9] It is an important aspect of religious practice in almost all major world religions and spiritual practices.[10] In many Asian countries citizens enjoy kneeling, squatting and sitting cross-legged. These activities are mandatory for daily living and religious acts. They are central to the culture and life of the people in the East and any loss of function which prevents these activities is unacceptable.[11] Unnanantana found that it was imperative to obtain a range of knee flexion of more than 110° for Thai patients to maintain a nearly normal life style. Postures required for daily activities in Thai culture include kneeling, squatting and sitting cross-legged.[11] Many patients presenting for surgery for arthritis of the knee enquire about the ability to kneel after operation.[12] Kneeling has also been shown to be an intermediate position exercised by older individuals to enable them to rise from the floor.[13] Various factors govern the outcome of TKR, which can be broadly grouped into patient factors and surgical factors. Patient-related factors such as age, sex, underlying pathology and pre-operative ROM cannot be changed; however, surgical factors such as surgical technique and expertise can greatly influence functional outcome. Restoration of joint line position is one such factor that has been reported to be important influencer of outcome after TKR.[14-16]

Figgie *et al*[14] have demonstrated that elevation of the joint line by more than 8 mm in primary TKR is associated with an adverse outcome. Similarly, elevation of the joint line in revision knee surgery has also been shown to result in significantly worse outcome.[17]

We have reported on perceived and actual kneeling ability after fixed bearing total, unicompartmental and patello-femoral knee replacement in previous works.[7,8,18] However, to our knowledge there are no published studies on the relationship of joint line position and kneeling ability after TKR.

The primary aim of this study was to investigate the impact of joint line position on post-operative ROM, and functional outcome with specific reference to kneeling ability.

Kneeling is an important function of the knee joint and is required for many activities of daily living

Materials and methods

We reviewed 100 consecutive cemented Kinemax Plus TKRs (Stryker, Newbury, UK) performed in our hospital between January 2005 and December 2006. The minimum follow-up was two years.

All patients received fixed bearing posterior cruciate retaining implants. Retrospective radiographic review of the tibiofemoral joint line position before and after knee arthroplasty was performed on standard anteroposterior and lateral radiographs. Joint line position was measured on lateral radiographs using the method described by Figgie *et al*.[14] Measurement was made from the top of the tibial tubercle to the superior surface of the tibial component. Because the tibial inserts are radiolucent, measuring to the most distal part of the femoral component is necessary.

Many methods of measuring the joint line are mentioned in the literature without a universal agreement.[19,20] Using Figgie's method[14] (*Figure 1*), in a previous study investigating the effect of the joint line level after revision knee replacement,[9] made us familiar with the method and we found it to be reproducible. Joint line measurements were made on the pre-operative and post-operative X-rays. A joint line within ± 5 mm of the pre-operative measurement was considered 'restored' and more than 5 mm was considered 'elevated'.

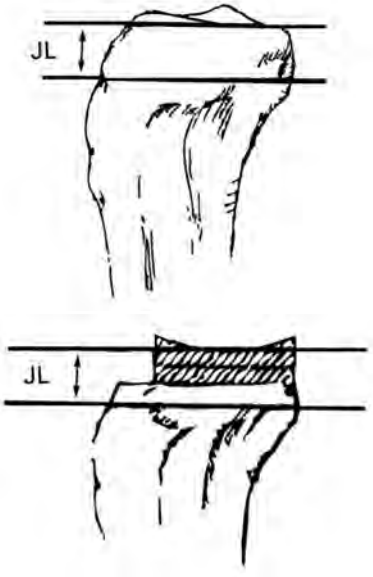

Figure 1. Figgie's method of measuring the joint line (JL) position.[14]

'The joint line position is calculated as the difference between the pre- and post-operative distance between the top of the tibial tubercle and the tibial articular surface or top of the plastic insert. The most distal point of the femoral component can be used as the reference point if the plastic insert cannot be visualised on plain radiographs.'

Table I: Kneeling question in the Oxford Knee Score questionnaire (Can you kneel down and get up again?)

Yes, easily	4
With little difficulty	3
With moderate difficulty	2
With extreme difficulty	1
No, impossible	0

Table II: Differences between restored and elevated joint line cases

	Restored	Elevated	
Joint line	(75%)	(25%)	
Mean ROM	116°	108°	P = < 0.01
Mean change of ROM	+30°	+26°	P = 0.6
Mean post-op Oxford Score	33.2	33	P = 0.46

Table III: Means of data for all groups

All groups	
Mean joint line position	2.01 mm
Mean ROM	109°
Mean change of ROM (pre- to post-op)	+27°
Mean post-op Oxford Score	**33**

An important outcome measure of TKR is the post-operative ROM

The kneeling ability component of the Oxford Knee Score questionnaire[11] was analysed for all patients (*Table I*). The Oxford Knee Scoring categories were recorded from 0 (worst) to 4 (best). The pre- and post-operative Oxford Knee Scores were prospectively recorded.

Two trained observers measured the patients' ROM in research clinics using a manual goniometer. Patients' notes and operation records were reviewed. Cases with extreme deformity were not included in this study.

Correlations between joint line level and ROM were established. Those between joint line level and kneeling ability were also calculated.

Results

One hundred consecutive Kinemax Plus cruciate retaining cemented TKRs were evaluated. There were 43 male and 57 females; mean patient age was 71 (51–87) years. Osteoarthritis was the underlying pathology in all patients.

Measurements of change in joint line height in millimetres taken by the two observers showed good inter-observer agreement with a Kappa value = 0.775. When classified as either 'elevated' or 'restored' there was complete agreement between the two observers.

The mean pre-operative ROM for the group was 82° (std ± 15). Post-operatively, the mean ROM for the whole group was 109° (std ± 8). The mean ROM for restored and elevated groups was 116° and 108° respectively. This difference was statistically significant (P < 0.01). However, there was no significant difference in the total Oxford Knee Score between the groups (*Table II*). *Table III* shows the mean joint line position, ROM and change in total score while *Table IV* shows the distribution of kneeling scores in the two groups.

Discussion

This study investigated the ability to reproduce joint line position in primary TKR. It also analysed the relationship between the joint line, post-operative ROM and kneeling ability of the knee after total knee arthroplasty.

Table IV: Kneeling ability scores according to restored or non-restored joint line position groups

Kneeling score	0	1	2	3	4	Total
Restored group (%)	39	2	15	22	22	75% of all patients
Non-restored group (%)	72	7	14	0	7	25% of all patients
% of all patients	**47**	**4**	**15**	**16**	**18**	**100%**

Table IV shows the distribution of cases according to group and kneeling scores. Twenty-two per cent of patients in the restored group could kneel easily versus 7% in the elevated group. This difference was significant (Peterson-Chi Square, P=0.004). The joint line position was restored to set range of –5 to +5 mm in almost 75% of all cases.

In 1986 Figgie *et al* stated that restoring the joint line to within 8 mm of the index level was associated with a favourable outcome in the form of better knee scores and range of motion and felt that elevating the joint line would lead to an imbalance of extensor mechanism.[14] This is due to the fact that the patellar tendon is of a fixed length. Restoration of soft tissue balance with regard to varus/valgus alignment will not necessarily tension the extensor mechanism appropriately. However, restoration of the patella tendon length, which is directly influenced by the joint line level, will lead to a favourable surgical result.[17]

Other investigators have also confirmed the need to recreate the joint line within a certain limit to achieve a satisfactory result both in primary and revision surgery.[17] In the former group Ryu *et al* stated that the level of the joint line should not be elevated by more than 2.1 mm.[21] In revision total knee surgery a comparable restoration of joint line level has been quoted as being within 3 mm to 8 mm.[21-23]

An important outcome measure of TKR is the post-operative ROM. A recent review[1] links good pre-operative range of motion, posterior cruciate ligament substituting prostheses, good surgical technique and vigorous rehabilitation to favourable total knee arthroplasty outcome. Negatively linked to the outcome are obesity and previous surgery. While pre-operative ROM is probably the greatest determinant of post-operative ROM, the restoration of joint line has been previously stated to be a contributing factor[1] and the results of our study also confirm this. Furthermore, joint line restoration has an effect not only on ROM but also stability. Both in vitro[24] and in vivo,[23] joint line elevation produces instability in TKR.

The ability to restore the joint line is dependent on the surgical technique, including the level of tibia resected[25] and the preservation or sacrifice of the posterior cruciate ligament.[17,26]

All the above-mentioned studies have used fixed bearing TKRs to look at the effect of joint line change on the post-operative function and ROM.

There has been a paucity of studies looking specifically at the ROM and its effect on kneeling ability.[7] There are no studies in the literature that investigate the relationship between joint line position and kneeling ability.

Seventy-five per cent of cases in this study showed a restored joint line position. The mean joint line position was 1.2 mm. This demonstrates that the surgical instrumentation of a modern knee replacement system can help the surgeon in effectively reproducing the joint line to within ± 5 mm of the pre-operative position. Although there was no statistically significant difference between the two groups regarding the kneeling score (Chi-Square = 7.286, probability = 0.1215 (P >0.05)), most of the cases that had the highest kneeling score (4) were in the restored group (90%). This could be clinically significant.

Joint line restoration has an effect not only on ROM but also stability. Both in vitro and in vivo, joint line elevation produces instability in TKR

Conclusion

Although the current study showed that restoring the joint line had a positive impact on the post-operative ROM and kneeling ability, the numbers involved were small and a larger prospective study is needed.

Kneeling ability can be affected by many factors. Further studies are necessary to investigate this complex function of the knee joint.

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With the increase in faculty and in research projects, there is a potential for increased confusion and conflict regarding appropriate authorship credit on manuscripts and presentations. The following are some relatively standardised criteria that can be helpful. These may be overstrict when considering clinical studies in which surgeons often do the "hands on work" that create the study but may not perform major analysis and writing functions. However, all authors should read and contribute editing comments prior to submission.

Relman criteria for authorship

In particular, to qualify as an author a person should fulfil at least three of the following five requirements:

1. Conception of idea and design of experiment
2. Actual execution of experiment; hands on lab work
3. Analysis and interpretation of data
4. Actual writing of manuscript
5. Be able to present to a learned gathering a lecture on the work; interpret it, defend it and take responsibility for it.

These are just guidelines. On the other hand it is probably far worse to leave someone off the list who feels they may have contributed than to include someone who did a bit less.

We should all be as inclusive as possible, offer our interested colleagues the opportunity to provide input, analysis and editing of our works to support each other and improve our papers.