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Does a complete loss of articular cartilage of patella warrant a patellar resurfacing when combined with patellar denervation in primary total knee arthroplasty? Results of a randomized prospective trial

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Abstract

BACKGROUND: Complete cartilage loss and incomplete cartilage loss of the patella both have been reported to give good results with both resurfacing and nonresurfacing. We have tried to combine patellar denervation (PD) with the procedure and to compare the results of resurfacing or not resurfacing patella in posterior stabilized (PS) total knee arthroplasty (TKA).

MATERIALS AND METHODS: A prospective single-center randomized prospective trial was done, including 68 patients undergoing unilateral TKA who were divided into patellar nonresurfacing (PNR) and patellar resurfacing (PR) groups. The patients underwent PS TKA. A blinded observer followed up the patients for 2 years, and visual analog scale at stairs (VAS-stairs), Knee Society Score (KSS), and range of motion were noted.

Results: The difference in VAS-stairs score from the baseline to the end of 1 month was significantly improved in the PR group, PNR = 4.4 ± 0.8 and PR = 5.5 ± 0.6 , $P = 0.0001$. The difference in VAS-stairs score was significantly improved in the PR group again at 6 months, PNR = 5.9 ± 0.8 and PR = 7.1 ± 0.7 , $P = 0.0001$. A comparison within the two groups at 1-month postop resulted in significantly better KSS 1 scores in the PR group (Chi-square value = 43.2, $P < 0.001$). When KSS 2 was compared between the two groups, we found no statistical significance in their preoperative scores and at postoperative time intervals of 1 month, 6 months, 1 year, and 2 years.

CONCLUSIONS: Resurfacing patella with PD in an Outerbridge grade 4 patella yields better pain relief on stairs within the first 6 months. Also, resurfacing patella with PD in an Outerbridge grade 4 patella does not improve the functional outcomes at 2 years, and further long-term follow-up needs to be reported in the future.

Keywords:

Outerbridge grade 4 patellae, patellar denervation, patellar resurfacing, primary total knee replacement

Introduction

Patella resurfacing (PR) in total knee arthroplasty (TKA) remains a controversy, and decision is often made

by the surgeon either preoperatively or intraoperatively, but some only consider it as a revision strategy for patellofemoral problems, most commonly the visual analog scale (VAS) score on doing stairs

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and anterior knee pain (AKP). There continues to be a variation all over the world with few nations resurfacing more, and others preferring not to.^[1] However, it also depends on the surgeon's training, the hospital policy, and the patient-dependent factors.

Several articles do mention no significant difference between the patella non-resurfaced (PNR) and the patella resurfaced (PR) group in total knee arthroplasty,^[2] whereas a similar number of articles report better reoperation rates and lower incidence of AKP in TKA with patella resurfaced.^[3] Implant design also has been mentioned to be a factor modifying the outcome of resurfacing or not resurfacing patella.^[4] Patellar denervation (PD) has also been reported to give results at par with patella resurfacing,^[5] whereas others do not recommend PD in TKA with patella resurfacing.^[6] Commonly reported complications after PR are patella fracture, osteonecrosis, wear, and prosthesis subluxation; hence surgeons also prefer selective patella replacement.

Previous reports have mentioned that the degree of degenerative articular damage in the patella does not play any role in post-TKA knee pain,^[7,8] whereas others report an association of Outerbridge classification with AKP requiring revision.^[9] Also, implant design may play a role in the decision to resurface the patella with older implant designs having a disadvantage when the patella was not resurfaced.^[10]

Recent meta-analysis and systematic reviews have also given conflicting results.^[3,11] We conducted this study to include prospectively all TKA with Outerbridge grade 4^[12] patella using a posterior stabilized (PS) knee and randomizing them into PR and PNR groups with both groups undergoing PD during the surgery.

This would help in deciding the following:

1. With a recent implant design, do we need to replace the patella in all Outerbridge grade 4 patella?
2. Does PD affect PR by analyzing the outcome of PR and PNR groups as both groups underwent PD?

Materials and Methods

Institutional ethics committee approval was taken to conduct the study. However, registration was not done in Clinical Trial Registry of India, which may be a limitation to this study. In this comparative study, we needed to compare the VAS score when doing stairs between the two surgical techniques; scale variable was compared by independent t-test. Nonparametric procedure can also be considered for comparison. In this backdrop, we have used independent t-test for deciding the sample size. The primary endpoint of the study was the difference in VAS pain measurement on stairs from the baseline.

A difference in the magnitude of 1 was considered clinically relevant in VAS score. With 56 patients, an effect size of 1 can be detected with 5% statistical significance and 95% power using a two-sided independent t-test. The patient number was increased by 20% to account for patients dropping out of follow-up, which gave a total patient number of 68.^[13] Taking into account the VAS score on stairs as the most important parameter related to PR, we decided to calculate a sample size according to VAS-stairs. Recruitment into the study was from October 2018 to October 2019 at a tertiary care center, and all the patients were operated on by an experienced arthroplasty surgeon. Sixty-eight participants undergoing unilateral total knee replacement were included with informed written consent and divided into two study groups with 34 patients in each group. The participants were randomized by a variable block randomization using R software. The allocation ratio was 1:1 between two intervention arms, and the intervention was decided by opening sequentially sealed envelopes by a third person, who was not a part of the study. The investigator was blinded to the procedure that was done for the participants. All the patients with lesser than Kellgren Lawrence (KL) grade 4, Outerbridge grade 4 patellar wear, inflammatory arthritis, previous patella fracture, >15-degree varus, valgus knee, body mass index (BMI) > 30 kg/m², a flexion deformity of >30°, bending not possible beyond 90°, ipsilateral ankle and hip pathology, spinal and neurological pathologies, any previous history of knee surgery or instability, patellar thickness <20 mm, morbid obese, and greater American Society of Anaesthesiologists (ASA) grade 2 were excluded. Preoperative data were collected for all the patients by an investigator blinded to the procedure in a format including age, sex, BMI, Knee Society Score (KSS)^[14] divided into knee score clinical (KSS 1) and functional (KSS 2), range of motion (ROM), VAS on stairs (VAS-stairs), and any complications. The implant used was PS total knee system (Anthem, Smith and Nephew Inc, Watford, UK). All the patients underwent TKA under a tourniquet, with medial parapatellar approach, grade IV patellar cartilage damage identified, and circumferential PD with monopolar cautery for both PR and PNR groups. However, in the PNR group, patellaplasty was also done. None of the patients received lateral retinacular release. Postoperatively, an identical protocol was followed for pain management, suture removal, and physiotherapy for both groups. KSS clinical and functional, ROM, difference in VAS at stairs (VAS-stairs), and any complications or reoperation were noted at 1-month, 6-month, 1-year, and 2-years follow-ups by the observer who was blinded to the type of procedure. We hypothesized that we would find no significant difference in both the groups on comparing the difference in VAS-stairs at each follow-up interval from the preoperative baseline as our primary outcome, KSS 1 and KSS 2, and also in ROM as our

secondary outcomes. Statistical analysis was performed using SPSS software, version 23.0 (Chicago, IL, USA). Data are presented as mean \pm standard deviation (SD). Categorical data were compared using Chi-square test; an independent *T*-test was done to compare the means. A $P < 0.05$ was considered statistically significant.

Results

Out of 68 patients, we had 44 females and 24 males. In the PNR group, the mean age of patients was 58.8 ± 5.3 years. In the PR group, the mean age of patients was 59.2 ± 3.6 years. The difference of mean age within the two groups was not statistically significant ($P = 0.69$). In the PNR group, the mean BMI of patients was 25.8 ± 1.7 (kg/m²). In the PR group, the mean BMI of patients was 25.9 ± 1.9 (kg/m²). The difference in the mean BMI between the two groups was not statistically significant ($P = 0.70$). Baseline characteristics are mentioned in Table 1.

Visual analog scale at stairs

The preoperative difference in VAS-stairs score between the two groups was not statistically significant, PNR = 8.2 ± 0.6 and PR = 8.4 ± 0.7 , $P = 0.95$. This helped us eliminate any bias in the outcome. There was a significant improvement in the VAS score after 1 month from the preoperative VAS score ($P < 0.05$), and the difference in VAS-stairs score from the baseline to the end of 1 month was significantly improved in the PR

group, PNR = 4.4 ± 0.8 and PR = 5.5 ± 0.6 , $P = 0.0001$. The difference in VAS-stairs score was significantly improved in the PR group again at 6 months, PNR = 5.9 ± 0.8 and PR = 7.1 ± 0.7 , $P = 0.0001$. At the end of the first year and second year, the difference in the VAS-stairs score was not statistically significant ($P = 0.89$, $P = 0.26$).

Range of motion

Preoperative ROM comparison within the two groups was not statistically significant ($P = 0.26$). The ROM at 1 month, 6 months, 1 year, and 2 years was not statistically significant on comparison between the two groups ($P = 0.18$, $P = 0.68$, $P = 0.69$, $P = 0.24$). The comparison of VAS score and ROM are mentioned in Table 2.

Knee Society Score 1 and 2

We compared both the groups for KSS 1 and found no significant difference preoperatively ($P = 0.86$). However, a comparison within the two groups at 1-month postop resulted in significantly better scores in the PR group with 31 patients having *excellent* scores in the PR group and 24 patients having *good* scores in the PNR group (Chi-square value = 43.2, $P < 0.001$). There was no statistical significance between the two groups at intervals of 6 months, 1 year, and 2 years. See Tables 3 and 4.

When KSS 2 was compared between the two groups, we found no statistical significance in their preoperative scores and at postoperative time intervals of 1 month, 6 months, 1 year, and 2 years.

None of our patients needed revision surgery at the end of the 2-year follow-up. We managed to follow up all the patients with no attrition.

Discussion

It continues to be a debate on whether to resurface the patella or not, especially in patella where the bone is already exposed, and on whether combining it with PD yields any better results. We find major geographical differences with Norway replacing patella in 4% of cases and the United States of America being at 82%,

Table 1: Baseline characteristics of PR and PNR groups

Characteristics	PR group, N = 34	PNR group, N = 34	P value
Gender			
Male	17	7	0.003
Female	17	27	
Mean age in years (SD)	59.2 (3.6)	58.8 (5.3)	0.69
BMI (kg/m ²)	25.9 (1.9)	25.8 (1.7)	0.70
KL grade 4 ^a	34	34	NA
Outerbridge grade 4 ^a	34	34	NA

NA: not applicable

^aPresented as a number of knees

Table 2: Mean and SD of the VAS-stairs and ROM at each follow-up in PR and PNR groups

Time	Difference in VAS-stairs, mean (SD)		P value	ROM (°), mean (SD)		P value
	PNR	PR		PNR	PR	
	Preoperative	8.2 (0.6)		8.4 (0.7)	0.95	
1-month postoperative	4.4 (0.8)	5.5 (0.6)	0.00	105.1 (5.3)	106.8 (4.6)	0.18
6-month postoperative	5.9 (0.8)	7.1 (0.7)	0.00	114.8 (4.1)	114.4 (4.6)	0.68
1-year postoperative	7.4 (0.8)	7.8 (0.7)	0.89	121.8 (2.7)	122.1 (3.2)	0.69
2-year postoperative	8.2 (0.6)	8.4 (0.7)	0.26	123.7 (2.2)	119.8 (1.9)	0.24
P value*	0.001	0.001		0.001	0.023	

*Repeated measures analysis of variance

Table 3: Comparison of KSS 1 scores between two groups

	KSS 1 (knee score)				Chi-square	P value
	Grade	PR ^a	PNR ^a			
At 1 month	1	0	0	43.16	0.00	
	2	6	0			
	3	24	3			
	4	4	31			
At 6 months	1	0	0	1.015	1.00	
	2	0	0			
	3	1	0			
	4	33	34			
At 1 year	1	0	0	-	-	
	2	0	0			
	3	0	0			
	4	34	34			
At 2 years	1	0	0	-	-	
	2	0	0			
	3	0	0			
	4	34	34			

Grade 1 = poor, grade 2 = fair, grade 3 = good, grade 4 = excellent

^aRepresents participant knees**Table 4: Comparison of KSS 2 scores between two groups**

	KSS 2 (functional score)				Chi-square	P value
	Grade	PR ^a	PNR ^a			
At 1 month	1	34	34	-	-	
	2	0	0			
	3	0	0			
	4	0	0			
At 6 months	1	0	0	4.80	0.9	
	2	11	4			
	3	19	27			
	4	4	3			
At 1 year	1	0	0	-	-	
	2	0	0			
	3	0	0			
	4	34	34			
At 2 years	1	0	0	-	-	
	2	0	0			
	3	0	0			
	4	34	34			

Grade 1 = poor, grade 2 = fair, grade 3 = good, grade 4 = excellent

^aRepresents participant knees

with a very little change in the trend over the past decade.^[1] Indian Society of Hip and Knee Surgeons has reported resurfacing being done in 51.64% of cases, whereas 48.36% do not undergo resurfacing.^[15] So, a difference in opinion persists among arthroplasty surgeons. Factors that influence the fate of the patella in a TKA can be related to preoperative patellofemoral problems, valgus knee, obesity, rheumatoid arthritis, medicolegal issues, hospital contracts, implant design, and also on the surgeon's training. Some surgeons prefer selective resurfacing of patella. A study of 203 surgeons

reported that the "usually resurfacing surgeons" (>90% resurfacing) achieved better results at the end of 5 years as compared to the surgeons, but in a subgroup analysis, the category of surgeons preferring selective resurfacing had better results with PS knee.^[4] The implant design is also a very important factor, which, if the femoral component has a deeper and posterior trochlear groove, results in lower articular pressure with the nonresurfaced patella.^[16] Major changes in the implant design making it patella friendly have occurred over the last decade,^[17] thus reducing the major cause of revision, which was patellofemoral complications.^[18] We have used a patella-friendly PS prosthesis. Research continues, and multiple articles have been published reciting their results after comparing PNR to PR in TKA for functional outcomes, AKP, reoperation rates, etc. No significant difference in outcomes has been obtained by researchers on comparing PR and PNR groups.^[19] Also, there are reports of PR being better in terms of functional outcome, VAS, and AKP with reduced reoperation chances.^[3,20]

Some authors have concluded that PD helps reduce AKP significantly when the patella is not resurfaced and has a similar incidence of AKP as compared to PR.^[5,21] On the contrary, it has also been observed that there is no added advantage of PD when resurfacing the patella and does not add to any reduction of AKP, however with a follow-up of 1 year.^[6] In a more recent randomized control trial (RCT), it has been seen that PD is an important tool even when the patella is resurfaced and gives better early outcomes at 3 months when PD was done along with PR and has recommended circumferential PD even when resurfacing patella.^[22] Similarly, we also report better VAS-stairs in the PR group than in the PNR group at the first and sixth month follow-up, and we suggest it may be the result of a synergistic effect of both circumferential PD and PR in that group. Hence it appears to be beneficial to do both circumferential patellar denervation as well as patellar resurfacing in TKA when the patella is completely denuded of cartilage as it gives better pain relief at the first 6-month follow-up. However, at the end of the first- and second-year follow-up, the difference in VAS-stairs between the two groups was not statistically significant, suggesting that PR has no advantage over PNR at midterm follow-up. This agrees with a recent meta-analysis where no significant difference in PR and PNR group was found in three RCTs with short-term to long-term outcome results.^[3] It appears that PR over PNR may not be beneficial when doing a circumferential PD in TKA and provides equal pain relief on stairs at 2-year follow-up though it is required to report long-term follow-up.

On analyzing the ROM in both the groups, we did not find any significant difference within the two groups at each follow-up interval. Similar results have been

reported by recent articles.^[3,8] There was no statistically significant difference in KSS 1 mean scores between the two groups at 6 months and up to 2 years of follow-up, but the first-month follow-up suggested higher knee score (KSS 1) in the PR group with 31 patients having excellent scores as compared to the PNR group having 24 patients with good scores, which may be related to the resurfaced patella and decreased knee pain. This is of clinical importance as the first month is important for early rehabilitation of the patient and gives confidence to the patient about the surgery and at the same time motivating him/her for the other side surgery as well. There was no functional difference in between the two groups in our study at 6-month, 1-year, and 2-year follow-up. Similarly, Thiengwittayaporn *et al.* reported no statistical difference between resurfaced and nonresurfaced patella when comparing functional outcomes at 1 year.^[23] Agarwala *et al.* reported similar outcomes of a comparison between resurfaced and nonresurfaced patella but it was a nonrandomized trial with no mention regarding the status of the patellar articular surface.^[24] A study by Thilak and Mohan included Indian population reported a retrospective study with no clinical difference between PR and PNR groups at the end of 10 years of follow-up.^[20] So, the difference between PR and PNR with respect to functional outcome may be limited to very early outcomes, but long-term outcome reports need to be evaluated in the future.

Nonresurfaced TKA has been reported to have higher rates of reoperation.^[3] It has been also observed that PS knee has higher chances of secondary PR,^[4] and the results of secondary resurfacing are not promising.^[25] Higher rates of secondary PR may be associated with bias as it is the only option left for the surgeon in the PNR group for dealing with postoperative pain in TKA.^[26] We did not have any need for reoperation in any of our cases in both the groups till the time of reporting this study.

The results of our study have indicated that we should resurface patella when it is Outerbridge grade 4 articular loss in the patella and combine it with PD to achieve better pain relief on stairs in the early follow-up of up to 6 months.

The strength of our study is that it is a prospective randomized trial with two procedures (PR and PNR) being compared in a similar group of patients with respect to age, BMI, preoperative diagnosis, with exclusion of major comorbidities.

It takes into account the most important aspect as outcome when replacing or not replacing patella in TKA, i.e., pain while using stairs.

Limitations of our study are that it was a study involving all the surgeries done by a single surgeon and also Outerbridge grading was done by him. We have used only KSS for the functional evaluation of all the patients. A single design of implant was used in all the patients. Our follow-up period is not long term, which may vary the results depending on the wear and tear of the prosthesis and the bone, which happens over time. Severe deformity such as >15-degree varus, valgus knee, BMI > 30 kg/m², a flexion deformity of >30°, bending not possible beyond 90°, ipsilateral ankle and hip pathology, and any previous history of knee surgery were excluded in an attempt to minimize the bias by excluding patients with gross deformity and instability. Our study is an intermediate term follow-up study, and the long-term results are unknown. Long-term outcome of this study should be evaluated in terms of polyethylene wear, complication related to PR, the fate of native patella, and its associated complications.

Conclusions

Resurfacing patella with PD in an Outerbridge grade 4 patella yields better pain relief on stairs within the first 6 months. Also, resurfacing patella with PD in an Outerbridge grade 4 patella does not improve the functional outcome at 2 years, and further long-term follow-up needs to be reported in the future.

Ethical approval and consent to participate

Ethical approval was taken from the Institutional Ethics Committee (ref no. ECR/246/Inst/OR/2013/RR-2016). Written informed consent was taken from all the participants.

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Conflicts of interest

There are no conflicts of interest.

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