



Pre-discharge postoperative radiographs after primary total knee replacement : tradition or science?

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Consistent evidence exists on the inutility of immediate postoperative radiographs after a total knee replacement (TKR). We hypothesized that eliminating the pre-discharge film would not have any effect on the postoperative patient outcomes.

Retrospective analysis of prospectively collected data was performed on 220 knees. Patients undergoing a simple primary TKR operated by 2 surgeons (Surgeon A and B) from January 2013 to July 2015 were divided into 2 groups (Groups 1 and 2 having 112 and 108 knees respectively). While Surgeon A routinely asked for the second postoperative day pre-discharge radiograph, Surgeon B directly performed weight bearing radiographs 6 weeks postoperatively. Greater knee pain was seen in Group 1 ($p = 0.01$). No changes in rehabilitation protocols based on pre-discharge radiographs, complications, medico-legal issues or revision surgery could be identified in any patient. The quality of the pre-discharge radiographs was adequate in 65 of the 112 knees (58%). A cost reduction of approximately \$220 per patient was observed with the exclusion of the pre-discharge film. Eliminating routine inpatient pre-discharge radiographs after simple primary TKR does not alter the rehabilitation protocol, identify any of the standard complication or have any medico-legal implications. On the contrary, these films seem to increase postoperative pain and costs.

Keywords : total knee arthroplasty ; postoperative radiographs.

INTRODUCTION

With a global prevalence of 3.8%, knee osteoarthritis (OA) is a frequently encountered clinical condition (3). Widespread acceptance of Total Knee Replacement (TKR) as a solution can be estimated by a 4.2% prevalence in patients above 50 years (20). Current annual figures of over 700,000 TKRs (2) and future projections of almost 3.5 million TKRs by 2030 in the U.S. reveal the ever-increasing demand for surgery (12).

With a less than 1% risk of postoperative mortality, complications associated with TKR include bleeding, infection, wound complications, thromboembolic events, neurovascular and ligament

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injury, instability, implant issues, stiffness and fracture among others (4,8). Fractures during a primary TKR are uncommon. Alden et al. reported 67 (0.39%) intraoperative fractures in 17,389 primary TKRs (1). Among these, only 3 (4%) were not detected intraoperatively and were diagnosed on postoperative radiographs.

Literature provides evidence that immediate postoperative films lack quality and are ineffective in identifying complications and altering rehabilitation regimes (6,7,13,15,18). The annual expenditure on postoperative knee radiographs can range well over \$ 150,000,000 in the US alone (17). Studies have rejected pre-discharge films as cost-ineffective (16,19) and have successfully contained expenses on radiology by 55% by their elimination (9). Though figures are currently unavailable, it remains a common practice among surgeons to ask for postoperative radiographs despite the existing evidence.

The purpose of this study was to determine whether the elimination of pre-discharge radiographs after TKR would have an impact on (i) the rehabilitation protocol, (ii) identification of any standard complications, (iii) medico legal implications or (iv) cost reduction by comparing the outcomes to a control population of patients in whom immediate postoperative radiographs were carried out routinely following simple primary TKR. We hypothesized that eliminating the pre-discharge film would not have any effect on the postoperative patient outcomes.

MATERIALS AND METHODS

This study was conducted at a tertiary care teaching centre after obtaining IRB approval. We performed a retrospective analysis of prospectively collected data on 220 patients divided among 2 groups undergoing a simple primary TKR from January 2013 to July 2015. The first group (Group 1) consisted of 112 knees operated upon by Surgeon A, who routinely obtained pre-discharge anteroposterior (AP) and lateral radiographs on postoperative day 2 after all TKR surgeries. The second group (Group 2) had 108 knees operated by Surgeon B who did not obtain pre-discharge

radiographs. Instead, he performed a weight bearing radiograph at the 6 weeks postoperative visit. Revision and complex primary TKRs with stems and metaphyseal sleeves were excluded. Patients with complicated intraoperative courses (suspected femoral condyle and tibial plateau fractures, visualized cortical perforation and notching) requiring immediate postoperative films to confirm intraoperative findings were also excluded from the study.

Both surgeons had similar preoperative preparatory and operating routines and used cemented implants for all patients. Postoperative pain management protocol included patient controlled epidural analgesia (PCA pump), along with oral administration of 1g (maximum thrice a day 8 hours apart) intravenous paracetamol infusion for two days. Oral 650 mg paracetamol and 50 mg tramadol twice daily were administered from the 3rd day onwards till discharge.

For both groups data was collected on age, sex, preoperative diagnosis (10), preoperative range of motion (ROM), implants used, duration of surgery, postoperative pain requiring additional medications, length of hospital stay (LOS), clinical complications, drain usage, reoperation rates, rehabilitation protocols and deviations, quality of radiographs, Knee Society radiological scores (5), radiological findings in the inpatient and outpatient radiographs. Second day pre-discharge radiograph of Group 1 and six week follow-up radiograph of Group 2 were studied by the two operating surgeons and one radiologist for abnormal findings (periprosthetic fractures, loose bodies and retained drains). Radiograph adequacy was judged by measuring beam angle accuracy and exposure using criteria set forth by Glaser et al (6). A film with a tibiofemoral clear space more than 3mm and sufficient contrast between bone-cement interface was deemed adequate.

Group 1 pre-discharge radiographs were examined for any findings which led to revision surgery within 3 months, change in inpatient or outpatient rehabilitation protocols, delay in discharges, poor outcomes or medicolegal issues. Likewise, radiographic findings of Group 2 were analysed at 6 weeks with respect to similar outcome

variables and differences between two groups were noted. All 220 patients were available for follow-up and were reviewed at 2, 6, 12 weeks followed by 6 and 12 months postoperatively.

RESULTS

Demographics : Group 2 consisted of 22.2% male patients (24/108), the mean age being 62.2 years with an average BMI of 31.1 kg/m² while Group 1 was comprised of 35.7% male patients (40/112), the mean age being 60.1 years with an average BMI of 32.5 kg/m² while (Table I).

Preoperative and intraoperative data : The mean preoperative radiological grades according to the Kellgren and Lawrence system in groups 2 and 1 were 3.2 and 3.0 respectively while mean preoperative ROM among both were 74 and 66 degrees respectively. In all patients, an anterior midline incision along with a medial parapatellar approach was used for exposure. Cruciate retaining (CR) implants were used in most, 97 Group 2 knees (89.8%) and 97 Group 1 knees (86.6%) while the remainder required a posterior stabilized (PS) TKR system. The average duration of surgery was 109 and 105 minutes respectively for groups 2 and 1 (Table II) A drain, used in all cases, was removed on the second postoperative day.

Postoperative pain : Fourteen Group 2 patients (13%) and thirty group 1 patients (26.8%) complained of knee pain postoperatively recorded on the second postoperative day (after the radiograph)

which required addition of paracetamol intravenous injections and a buprenorphine patch ($p=0.01$). None of the 220 patients required analgesic prescriptions at the 6 week postoperative visit.

Rehabilitation : There were no reports of postoperative stiffness. The mean postoperative LOS in both groups was 6 days. All 220 knees were subjected to the standard knee replacement postoperative rehabilitation protocol followed at our institution. Weight bearing as tolerated (WBAT) with assistive devices (walker) was initiated in all patients of both groups on the first postoperative day. Group 2 patients had a mean duration to full unassisted weight bearing of 43 days. The other group progressed to full weight bearing between 5 to 7 weeks (mean = 40 days) postoperatively. Mean pre-discharge ROM in Groups 2 and 1 were 65 (55 to 78) and 62 (50 to 70) degrees respectively while those at 6 weeks postoperatively were 92 (86 to 102) and 94 (84 to 108) degrees respectively. All patients were discharged walking with a walker with WBAT. There were no changes made in the rehabilitation protocol of Group 1 based on the inpatient pre-discharge radiographs (Table III).

Complications: Four patients in Group 2 and 5 in Group 1 had clear discharge from the wound seen on the second postoperative day. Further wound inspection and dressing were dry and the wound healed uneventfully in all patients. No other complications could be identified in the remaining patients. There were no reoperations or manipulations required for any patient.

Table I. — Demographics

| Group | Sex distribution | | Mean age (yrs) | Mean bmi (kg/m ²) |
|---------|------------------|--------|----------------|-------------------------------|
| | Male | Female | | |
| Group 1 | 40 | 72 | 60.1 | 32.5 |
| Group 2 | 24 | 84 | 62.2 | 31.1 |

Table II. — Preoperative and intraoperative data

| Group | Mean kellgren -lawrence grade (osteoarthritis) | Mean preoperative rom (Degrees) | Implant used | | Mean duration of surgery (minutes) |
|---------|--|---------------------------------|--------------------|----------------------|------------------------------------|
| | | | Cruciate retaining | Posterior stabilized | |
| Group 1 | 3.0 | 66 | 97 | 15 | 105 |
| Group 2 | 3.2 | 74 | 97 | 11 | 109 |

Table III. — Rehabilitation data

| Group | Postoperative knee pain | Stiffness | Mean length of stay in hospital (days) | Mean duration to full weight bearing (days) | Mean range of movement (degrees) | |
|---------|-------------------------|-----------|--|---|----------------------------------|----------|
| | | | | | Pre-discharge | 3 Months |
| Group 1 | 30 | 0 | 6 | 43 | 62 | 94 |
| Group 2 | 14 | 0 | 6 | 40 | 65 | 92 |

Medicolegal issues : We did not encounter any medico legal issues regarding the exclusion of the postoperative radiographs from our postoperative protocol in any patient.

Radiograph quality : The quality of the pre-discharge radiographs was adequate in 65 of the 112 knees (58%) of Group 1. It was difficult to assess the orientation, position and alignment of the prosthesis in the remaining 42% of the knees (Figure 1). Follow up radiographs taken 6 weeks postoperatively could be obtained with proper alignment (Figure 2). The radiologist could report satisfactorily (100%) on all 220 knees (Table IV). In Group 2, the mean scores for the femoral and tibial components were 2.1 and 1.4 respectively. The lateral view tibial scores ranged between 0 and 3 with mean of 0.8. Mean knee scores for the femoral and tibial components were reported as 2 and 1.4 respectively in Group 1. The lateral view tibial scores ranged between 0 and 2 (mean = 1). Follow up radiographic series were similar in values and all knees tolerated physiotherapy well (Table V).

Cost reduction : A cost reduction equating to approximately \$ 220 per patient was identified in our study group with the exclusion of routine pre-discharge inpatient radiograph.

DISCUSSION

Our comparative study shows that eliminating the pre-discharge radiograph after a TKR does not alter patient rehabilitation or compromise patient safety. Obtaining the first postoperative radiograph at 6 weeks yields higher quality films. Further, there is an improvement in the patient comfort and decrease in the overall cost without any medicolegal implications.

The postoperative radiograph has been debated for the past two decades as a part of cost containment.

Ververeli et al., from Thomas Jefferson University retrospectively reviewed the usefulness of two sets of radiographs namely, the immediate recovery room radiograph and the pre-discharge radiographs in a cohort of 124 patients who underwent uncomplicated TKR (19). Each set was reviewed by two orthopaedic surgeons with respect to quality and presence of abnormal findings (fractures, implant orientation, dislocations and retained drains). Their interpretation was compared with that of the radiologist. They noted that 94% of recovery room radiographs were of satisfactory quality but neither the recovery room nor the pre-discharge radiographs revealed any abnormal finding that would alter the management. Interestingly, they noticed a trend of over-diagnosis of periprosthetic fractures by the radiologist which was eventually found to be the fabella, retained debris or osteophytes. The authors therefore questioned the practice of routine radiologist interpretation itself. They also estimated cost saving of \$145,360 at \$92 per case for the 2300 joints at their centre. Based on these findings, they recommended that pre-discharge radiographs be eliminated and recovery-room radiographs be performed for academic purposes.

Other authors have however, questioned the teaching role of recovery-room radiographs and recommended that radiographs be taken during follow up visits. In contrast to Vervelli's retrospective review of uncomplicated TKR, Moussa et al. retrospectively reviewed 136 complicated knee replacement patients who had reoperation in the first 60 days at MGH, Boston (16). Immediate inpatient pre-discharge radiographs were available for 76 patients. The most common causes for reoperation were arthrofibrosis in 54 patients, infection in 17 patients and hematoma in 5 patients. They noted that radiographic findings were non-contributory towards the re-surgery decision. Further, they



Fig. 1. — Difficulty in assessing prosthesis position and orientation and obtaining proper alignment in the inpatient pre-discharge postoperative day radiograph.

noted that only 43% radiographs qualified to be adequate. On deeper analysis, their study revealed that the cohort of 136 complicated knees requiring re-surgery was from an initial cohort of 6603 patients undergoing TKR. Since the remaining 6467 (almost 98%) knees did not require any re-surgery, we think it is safe to assume that pre-discharge radiographs in the 6467 patients did not identify any finding that led to a reoperation. They noted

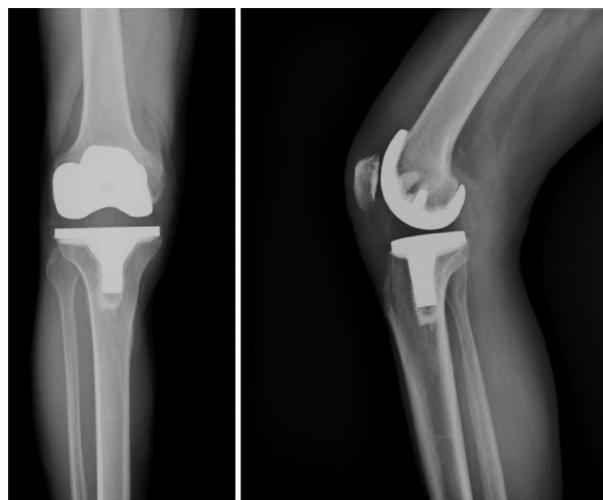


Fig. 2. — Three months postoperative radiograph could be obtained in proper alignment.

a cost saving of \$429 per case. Hassan et al. from Blackpool, UK, in a recent retrospective review of 624 consecutive knees analysed the usefulness of routine pre-discharge radiographs (7). Their review identified two radiological abnormalities namely, an undisplaced tibial plateau fracture and a partial inferior pole patellar avulsion. Neither of the 2 cases needed any change in mobility or further treatment. Hence they concluded that the first radiograph could be safely delayed till the first postoperative clinic visit.

Unlike the retrospective nature of the previous three studies, a few authors have prospectively studied the impact of eliminating pre-discharge radiographs after uncomplicated TKR. Moskal

Table IV. — Radiographic quality

| Group | Adequate quality | |
|---------|------------------|----------------|
| | Pre-discharge | 6 Weeks postop |
| Group 1 | 58% | 100% |
| Group 2 | ----- | 100% |

Table V. — Knee society score (mean)

| Group | Knee society score (mean) at 3months post op | | |
|---------|--|------------|-------------|
| | Femur (lat) | Tibia (ap) | Tibia (lat) |
| Group 1 | 2.0 | 1.4 | 1.0 |
| Group 2 | 2.1 | 1.4 | 0.8 |

Table VI. — Evidence table

| | | | | | | | | |
|------|-----------------------|--------------------------------|---------------------------|---|--------------------------------|------------------------------------|---|--------------------------------------|
| A | Niskanen | Ververeli et al. | Moussa et al. | Moskal and Diduch | Glaser and Lotke | Lee et al. | Kosashvilli et al. | Hassan et al. |
| Yr | 1997-98 | 1996 | 2000-2011 | 1987-93 | 1994-98 | 2001 | 2009 | 2007-2010 |
| Pl | Lahti, Finland | Philadelphia, Pennsylvania, US | Boston, Massachusetts, US | Charlottesville, Virginia, US | Philadelphia, Pennsylvania, US | West Orange, NJ, US | Mount Sinai Hospital, Toronto, ON, Canada | Blackpool Teaching Hospitals NHS, UK |
| Des | R | P | R | R | R | R | Questionnaire based and cadaveric | R |
| n | 100 | 124 | 6603 | 646 | 750 | 592 (209 after TKR) | Estimated 65,910 pts annually | 624 |
| Sav | N/A | \$63 | \$423.29 | \$246.5 (hosp) \$198.45 (private insurance) \$26 (Medicare) | \$36,000 for 200 patients | - | - | - |
| PP# | None | | 0 | 2 – recognized intraop | - | 1 (209) – minimal tib cortex break | 1 – undisplaced medial condyle fracture, | 2 |
| Rad | Well placed - 87 | | - | 12(2%) | - | 2 (209) (0.95%) | 8 (estd 65,910) (0.01%) | 2 out of 624 |
| Qual | Acceptable - 83 cases | 92% | 19 (43%) | - | 146(26%) | - | Neutral alignment – better interpreted | - |
| Reha | N | N | N | N | N | 0 | - | 0 |
| Reop | N | N | none based on Rad | N | N | 0 | - | 0 |
| MLU | N | N | - | - | N | 0 | - | - |
| DD | - | - | - | - | - | Not significant | - | - |
| LTI | N | - | - | N | N | - | - | 0 |

Sn – S.No
 A – Author(s)
 Yr – Year
 PI – Place
 Des – Study Design
 n – No. of patients
 Sav – Savings per patient
 PP# – No. of periprosthetic fractures
 Rad – Radiographic findings

Qual – Radiographic quality of immediate postoperative film
 Reha – Changes in Rehab
 Reop – Reoperations based on radiographs
 MLU – Medicolegal Utility
 DD – Delay in discharge due to radiographs
 LTI – Impact on long-term outcome
 R – Retrospective
 P – Prospective
 N – None

and Diduch from Roanoke, Virginia have reported their cohort of 646 TKRs done over 6 years in whom they eliminated the pre-discharge radiograph postoperatively (15). They confirmed the findings of previous retrospective reports including no abnormal findings in the 2 to 6 weeks follow-up radiographs, no postoperative complication attributable to not obtaining pre-discharge radiograph, significant cost saving (\$ 246 per case) and no benefit with routine radiologist interpretation. Similarly, Glaser and Lotke prospectively studied the impact of eliminating the pre-discharge radiograph in 550 patients (6). However, before initiating a practice change they retrospectively reviewed 192 pre-discharge radiographs and noted that the radiographs did not alter the postoperative care and only 36% radiographs had acceptable quality. As a second part of their study, the authors eliminated the pre-discharge radiograph in the next 550 uncomplicated TKR and found no adverse outcomes. Based on the prospective data the authors even questioned the practice of obtaining recovery room teaching films.

The findings of our study agree with previous reports. A retrospective review of group 1 pre-discharge radiographs revealed no abnormal radiographic findings, no redo surgery, no change in weight bearing status, adequate quality radiographs in only 58% patients and no medicolegal issues based on those radiographic findings. A statistically significant number of patients (30 out of 44) having pain among both groups belonged to group 1 ($p = 0.01$). Although this could be attributed to subtle technical differences among the 2 surgeons, the pain was reported after the radiographs were obtained. Review of Group 2 data showed pre-discharge radiographs were not needed for clinical or medicolegal reasons. Weight bearing radiographs performed at 6 weeks postoperatively were of better quality and hence could serve better as baseline radiographs. Our hypothesis, eliminating the pre-discharge film would not have any effect on the postoperative patient outcomes appears to be correct.

Despite mounting evidence from various surgeons from diverse practice setups (Table VI) over the last two decades questioning the role of routine pre-discharge radiographs, surgeons worldwide

continue to show enormous reluctance towards a practice change. They quote various reasons including teaching, medicolegal reasons, unfounded fear of missing something (11). Such attitudes of orthopedic surgeons in terms of failure to revise ones practice based on mounting evidence is quite comparable to difficulties noted in other specialties like gastrointestinal and general surgery. Melis et al. noted only 60% of the respondent's answers were concordant with existing data and evidence based medicine does not uniformly transform into practice (14).

We agree that our results are based on an uncalculated small number of patients and a non-blinded, non-randomized, retrospective study. The presence of 2 surgeons could have also been a source of bias. However, the importance of the findings and concurrence with previous published literature cannot be ignored.

In conclusion, our study reopens the case for eliminating routine pre-discharge radiographs based on our limited data and review of literature. We agree that a high quality randomized study with a good power from a large volume research center is required to confirm these findings. In the absence of randomized trials, we propound that it would be safe to adopt a practice that involve eliminating pre-discharge radiograph in at least uncomplicated TKR thereby reducing patient discomfort and health care costs.

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