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Intra- operative fractures in primary Total Knee Arthroplasty

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A B S T R A C T

Background: Intraoperative fracture during primary Total Knee Arthroplasty (TKA) is very rare and there is little literature available which has defined the possible reasons for the occurrence of these fractures. Further, no study till date has defined the various management options available to treat these fractures. This study aims to define (1) the possible reasons for different fracture patterns occurring intra-operatively, (2) the ideal management options for each type of fracture geometry, (3) whether this intraoperative complication affects the physiotherapy protocol and long term outcomes.
Methods: Out of 3168 primary TKA done between 2010 and 2017, 19 patients developed intraoperative fracture, whose data was evaluated retrospectively. Patients were assessed radiologically to determine the time to union and clinical outcomes were assessed using Knee Society Score.
Results: Out of the 19 intraoperative fractures, 19 were in Tibia and 4 in Femur. Majority of fractures occurred during cementing and final implantation (8 cases), followed by exposure and bone preparation (6 cases) and the least during trialing (4 cases). Out of 15 Tibia fracture, 9 fractures involved the Tibial cortex which were managed with screws (4 cases), sutures and bone cement (5 cases). Stemmed tibial component was used for all Plateau type fracture patterns (6 cases). Out of 4 distal femur fractures, condylar type fracture pattern were fixed with plates and screws (3 cases) and epicondyle avulsion with screws alone (1 case). All the cases showed union (average union time 8.9 weeks) and good KSS scores which remained till their last follow-up. None of the patient developed any other complications or required revision surgery.
Conclusions: Intraoperative fracture during TKA, although rare but a significant complication which can affect the outcome, if not managed properly. We have shown methods of management for such cases, which have given excellent results.

1. Introduction

Intraoperative fractures during Primary Total Knee Arthroplasty is a rare complication with a prevalence of 0.39–2.2%.[1,2] The risk factors associated are advanced age, osteoporosis, steroid abuse, anterior cortical notching and female sex. These fractures can occur during any step of TKR including exposure & bone preparation, during trialing, cementing or inserting of the final components.[3] The guidelines for the management of these fractures occurring intraoperatively are lacking with little literature evidence on the management options. Some authors have described the following treatment modalities to treat these fractures which include plate & screw fixation, stemmed prosthesis, screw fixation, suturing or bone grafting and cementing.[1,4] However, no study till date has managed to define an algorithm to manage the different fracture patterns occurring intraoperatively. Further, there has been no study which has described these rare intraoperative complications in subcontinental population. In this study, we review 19 (4 femur and 15 tibia) fractures occurring intraoperatively in Primary Cemented Total Knee Arthroplasty and determine if the treatment methodology adopted affects the outcome of recovery and rehabilitation.

2. Materials & methods

In our record of 3168 primary cemented TKA using Smith and Nephew Legion components operated between 2010 and 2017 at a tertiary care center by a single surgeon, 19 patients with intra-

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operative fractures were identified and evaluated retrospectively giving a prevalence of 0.6% (Table 1). Of the 19 fractures, 15 were in the tibia, 4 in the femur with no fractures in the patella. Out of the 19 fractures, 7 occurred in men and 12 in females with a mean age of 68.9 years. All 4 fractures of the femur were in women while 8 of 15 tibial fractures were also in females. 14 (73.6%) patients had primary Osteoarthritis of the knee while 4 (21.2%) had Rheumatoid Arthritis. 1 patient had post-traumatic arthritis due to a previous fracture. All patients presented with varus deformity of their knee with a Tibial femoral angle ranging between 6 and 30°. The mean follow-up of these patients was 28.7 months (Range 6–73 months).

All TKA were cemented posterior stabilized Genesis II (Smith & Nephew, Memphis, Tennessee, USA) with no cruciate retaining system being used by the chief surgeon for primary Total Knee Arthroplasty. Standard mid-vastus approach was used in all the cases, without the use of computer navigation by the same senior surgeon. An intramedullary jig was used for femoral preparation, extramedullary jig for the Tibial preparation with no patellar replacement done in any case. Patellaplasty was done in all cases as described by the senior surgeon.[5] Cement was applied to the tibial base plate, tibial plateau and proximal tibial canal with the final tibial component inserted half way by hand to confirm orientation followed by the hammering of the components. Similarly, cement was applied to the cut femoral surface and the final implant was hammered in place after proper medio-lateral orientation of the final component. Intraoperative fracture occurred during any steps of TKA from exposure and bone preparation to cementation of final components. Using intraoperative direct visualization and post-operative X-rays as a guide, these fractures were classified. After immediate identification, fractures occurring during bone preparation and exposure were identified and held with bone holding clamps. Depending on the location of the fracture, the fractures were surgically managed using screws and or plates or stemmed implants. The rest of steps followed routine primary TKA protocol. If the fractures were identified during trialing, the same method was adopted and the fractured were surgically fixed before final component placement. For fractures occurring during final component placement in the tibia, the extent of the fractures was determined. If the fracture extended beyond the tibial keel, immediate removal of the tibial component followed by replacement of long Tibial Stemmed component was done to bypass the fracture. Thereafter, the fracture was held with bone holding clamps to maintain reduction till cement sets-in.

Patients were allowed full range of motion of the operated knee with full weight bearing using a walking frame from the day of surgery. Walking without a walking frame was allowed from first follow up visit usually at 10 days. Fracture healing was judged radiographically using serial radiographs showing trabeculation across the fracture site in healed fractures and clinically with an absence of tenderness at the fracture site. Preoperative and Post-operative clinical functions were assessed using the Knee Society Score Criteria [6] at their first follow-up, 6 months and subsequently yearly thereafter.

Table 1
Etiology of patients undergoing TKA during the study period compared to those who developed intraoperative fracture.

Cause	Fracture group	Total TKA done
Osteoarthritis	14	2745
Rheumatoid Arthritis	4	142
Post-traumatic Arthritis	1	281
Total	19	3168

3. Results

The intraoperative fracture rate in a total of 3168 Primary TKA was 0.6% with 19 cases of intraoperative fractures. Of the 19 cases of intraoperative fractures, 15 were in the Tibia and 4 in the Femur with no incidence of Patella fractures (Table 2). 6 fractures occurred during exposure and bone preparation; 4 fractures occurred during trialing of components; 8 fractures during cementing and final implantation & 1 occurred at an unknown time during the surgical procedure.

Of the 15 tibial fractures, 6 were in the lateral tibial cortex which required screw fixation (3 cases) and 3 cases requiring repair with sutures. 4 fractures were of the medial tibial plateau all requiring fixation with stem tibial component insertion (Figs. 1 and 2). 2 cases of lateral tibial plateau fractures required stem tibial component fixation as they extended below the base plate. 3 cases of fractures of anterior tibial cortex required screw fixation (1 case) and suture repair in the remaining 2 cases.

Of the 4 femoral fractures, 2 cases were of medial condyle avulsion fracture in the coronal plane and occurred during the removal of the intercondylar notch and trialing. Both these fractures required plate and screw fixation intraoperatively. 1 medial femoral epicondyle fracture occurred during osteophyte removal which was repaired with screw alone. 1 case of lateral femoral condyle fracture occurred during trialing and was treated with plate and screw fixation.

All patients achieved bony union at a mean duration of 8.9 weeks (range 5–16 weeks) and a good range of motion. Mean duration of follow-up was 28.7 months (range 6–73 months). The mean Knee Society Score (KSS) preoperatively in our cases was 35.7. Postoperatively, KSS at first follow up was 81, at 6 months follow up was 87.6 and last follow up was 92. No patients required revision surgery over the follow-up period with no incidence of instability, infection, patellar maltracking, loosening or osteolysis.

4. Discussion

Intraoperative fractures during primary Total Knee Arthroplasty is a known complication with limited literature regarding its management and outcome due to its relatively rare occurrence. We, therefore, described the incidence, location, timing, and outcome of intraoperative fractures during primary TKA in our case population.

Stuart & Hansen reported 4 intraoperative fractures of lateral tibial condyle during primary TKA.[7] Pun et al. reported 17 intraoperative fractures during primary TKA in 1346 primary TKA with 12 in tibia during final component hammering. Remaining 5 occurred in femur during removal of intercondylar notch.[8] The incidence of intraoperative fractures in our case study was 0.6% out of 3168 TKA patients. The risk factors for intraoperative fractures can be attributed to osteoporosis, rheumatoid arthritis, increased age and in females.[9] Majority of the fractures (12 out of 19) in our study, were in females and all in osteoporotic or patients suffering from rheumatoid arthritis barring one case with post-traumatic arthritis. A majority of the tibial fractures in our study occurred during final cemented component placement, overstuffing of the tibia with cement during implantation and hammering can be attributed as a cause for these fractures. This postulation has also been described by Stuart et al. As both the trial and final tibial components are of the same dimensions, excessive cement packing during final implantation may be a cause of intraoperative fractures in the tibia. Zealous final component placement of the tibia with overstuffing of the tibia with cement should be avoided to avoid tibial fractures during final implant placement. Other cause may be hammering during trialing which possibly led to buckling or shearing of bone due to the excessive force generated during canal

Table 2
Master chart of patients who developed intraoperative fracture and their specifications.

S.NO.	Region of Fracture	Age/ Sex	Timing of Fracture	Surgical management	Implant used	Femur size	Tibia size	Follow up duration	Range of Motion	Preoperative KSS	Postoperative KSS at First follow up.	Postoperative KSS at 6 months.	KSS at last follow up.	Fracture union/Clinical Union
1	LFC	74/F	TRIALING	PLATE + SCREW	PS	2	2	6	0–110	38	75	81	81	16 weeks
2	MFC	73/F	TRIALING	PLATE + SCREW	PS	2	3	14	0–120	29	77	83	91	12 weeks
3	MFC	81/F	BONE PREPARATION	PLATE + SCREW	PS	3	3	68	0–90	13	66	78	86	12 weeks
4	MFE	68/F	BONE PREPARATION	SCREW	PS	3	3	73	0–110	42	80	81	89	8 weeks
5	LTC	72/M	FINAL	SUTURE	PS	4	3	24	0–120	44	85	88	92	Clinical Union at 6 weeks with No local tenderness
6	LTP	66/M	FINAL	STEM	PS	4	4	46	0–110	39	79	86	90	16 weeks
7	LTC	63/M	BONE PREPARATION	SCREW	PS	3	2	17	0–130	53	82	89	97	Clinical Union at 4 weeks with No local tenderness
8	LTC	71/M	FINAL	SUTURE	PS	5	4	18	0–130	49	87	89	94	Clinical Union at 5 weeks with No local tenderness
9	MTP	72/F	FINAL	STEM	PS	3	3	41	0–120	30	81	92	96	12 weeks
10	ATC	58/M	UNKNOWN	SCREW	PS	4	3	63	0–110	33	79	90	94	Clinical Union at 6 weeks with No local tenderness
11	LTC	70/F	FINAL	SCREW	PS	3	2	12	0–100	9	69	88	93	Clinical Union at 6 weeks with No local tenderness
12	LTC	79/F	FINAL	SUTURE	PS	2	3	18	0–120	46	84	91	96	Clinical Union at 6 weeks with No local tenderness
13	ATC	68/M	BONE PREPARATION	SUTURE	PS	4	3	23	0–130	47	92	95	97	Clinical Union at 5 weeks with No local tenderness
14	MTP	63/F	BONE PREPARATION	STEM	PS	3	2	10	0–120	37	90	94	96	10 weeks
15	MTP	71/F	TRIALING	STEM	PS	3	3	54	0–130	35	87	94	91	12 weeks
16	MTP	58/M	TRIALING	STEM	PS	5	4	21	0–120	37	82	89	92	12 weeks
17	LTC	68/F	FINAL	SCREW	PS	3	2	8	0–130	40	86	90	97	Clinical Union at 8 weeks with No local tenderness
18	LTP	71/F	FINAL	STEM	PS	3	3	11	0–120	32	82	85	87	8 weeks
19	ATC	63/F	BONE PREPARATION	SUTURE	PS	4	3	18	0–110	27	76	82	89	Clinical Union at 5 weeks with No local tenderness

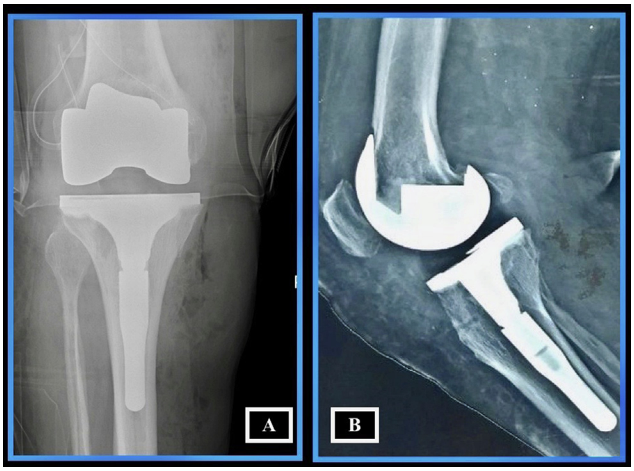

Fig. 1. Immediate postoperative Anteroposterior (A) and Lateral radiograph (B) of a 72 year old female who developed intraoperative Medial Tibial plateau type fracture intraoperatively, which was managed by Tibial stem insertion.

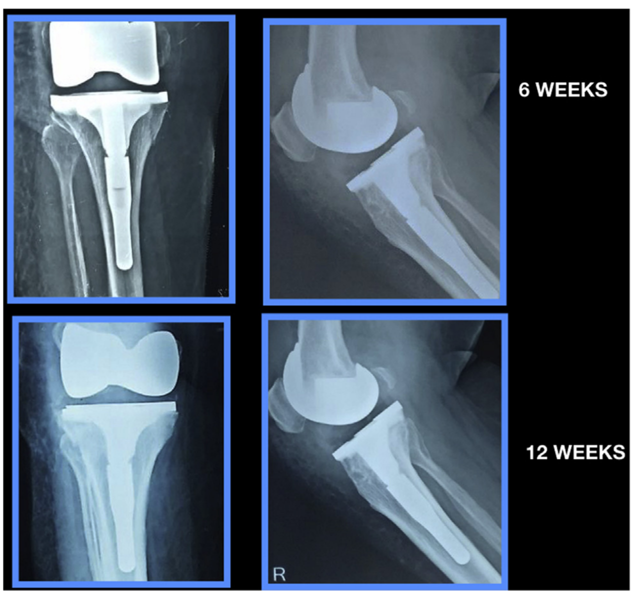

Fig. 2. Anteroposterior and Lateral radiographs at 6 weeks (A,B) showing obliteration of fracture gap and at 12 weeks (C,D) showing complete fracture union.

filling of the prosthesis leading to the fracture in an already weak osteoporotic bone.

As all patients with femoral fractures were females with relatively narrow distal femurs, a relatively wide box cuts along with excessive medial or lateral placement of trail or final implant weakened the respective condyle leading to fractures. Lombardi et al. reported 40 distal femur intercondylar fractures in 898 primary posterior stabilized knees and attributed such high incidence to the wider box cut in their implant and these fractures incidence reduced once they have changed their implant which has a smaller box-cut.[10] As all the fractures occurred in posterior stabilized knee designs, caution with box cuts and proper medic-lateral placement of trial and final components is warranted.

Principles of managing these intraoperative fractures are based on attaining a stable construct which can prevent any shear, axial or rotational forces across the final component. These can be obtained by using plates, screws or stemmed component based on the fracture pattern. The decision making, however, depends on the fracture configuration, quality of bone and the surgical acumen of the chief surgeon. Out of the 15 tibial fractures, 6 were tibial plateau fractures (4- MTP, 2 LTP) which were managed by stemmed prosthesis to bypass the fracture site. Diaphyseal fixation of the stem prevented any forces occurring at the level of component, thus providing stability in intraoperative tibial plateau type fracture pattern. However, with fractures of the tibial cortex, the amount of distractive forces to the final component, are not so significant. Therefore, all the fractures of the Tibial cortex were very well managed with either, screws, sutures or combination. Out of the 4 femoral fractures, the condylar fractures (3 cases) were managed with plate and screw fixation as we believe that using stemmed femur alone would not have given good stability to the final component. All those fractures healed well and had good clinico-radiological outcomes till their last follow-up. In patients with intraoperative fractures, KSS increased from 35.7 preoperatively to 81 postoperatively at first visit, 87.6 at 6 months postoperatively and 92 at their last follow up. The score in the fracture group is significantly higher compared to their own preoperative scores. Compared to other studies with scores of 96 at 4 years,[11] 94.7 at 5 years[12] & 73.3 at 10 years[13] respectively, the results are good.

The limitations of this paper are a lack of large cohort and retrospective analysis of data without a control group. Also, no specific study was done to study the confounding effect of comorbidities on the incidence of intraoperative fractures.

5. Conclusion

Intraoperative tibial fractures are more common than femoral fractures. The incidence of intraoperative fractures was 0.6% in primary Total Knee Arthroplasty with fractures more common in elderly osteoporotic females, patients with rheumatoid arthritis and with the use of Posterior Stabilized knee systems during bone preparation in the femur and final component implantation in tibia. Intraoperative fractures in primary Total Knee arthroplasty can be avoided by exposing the joint adequately. While using the Posterior stabilized knee system, correct medio-lateral placement of trial and final implants in the femur can avoid fractures in weekend osteoporotic bones. Gentle trailing and final component placement can also help in reducing the incidence of intraoperative fractures in the tibia. Principles of fracture management and implant stability are to be followed and fracture either are to be fixed using plates, screws, sutures or bypassed using stemmed components.

Disclosure

No conflict of interest to be disclosed.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcot.2018.10.009.

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