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Decreasing hospital length of stay and enhancing recovery in Total Knee Arthroplasty

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ABSTRACT

Background: Patients undergoing Total Knee Arthroplasty (TKA) typically have early postoperative pain and decreased mobility, especially so in the first 24 h. Achieving a pain free knee in the immediate postoperative period and reducing complications using multimodal pain and blood management protocols forms a keystone in early mobilization and functional recovery. Enhanced Recovery after Surgery pathways (ERASp) since their inception, have significantly improved perioperative care and functional outcomes, thereby reducing the average length of stay (ALOS), complications and overall healthcare costs. ERASp modified suitably for TKA have had encouraging results. We have retrospectively analyzed the outcomes of the ERASp for TKA at our tertiary care centre with equal emphasis on pre-hospital preparations, in-hospital care, and post-hospital discharge.

Methods: All TKA patients operated by the senior author between July 2016 and January 2018 with a minimum one year follow up were included. The outcomes measured were: Visual Analogue Score (VAS) for pain at rest and on movement, milestones, transfusion requirements, postoperative complications, ALOS and functional scores at one year follow-up.

Results: 775 patients (392 unilateral TKA {UTKA} and 383 bilateral {BTKA}) met our inclusion criteria. Both groups were comparable demographically. Mean VAS pain scores at rest were 3.15 ± 2.15 on the day of surgery, 2.5 ± 1.86 on the first postoperative day and 2.08 ± 1.81 on the second day, and 6.2 ± 2.38, 5.77 ± 2.34 and 4.71 ± 2.48 on movement respectively in the UTKA group. In the BTKA group, the mean VAS pain scores at rest were 4.39 ± 2.25 on the day of surgery, 3.98 ± 2.36 on the first postoperative day and 3.05 ± 2.12 on the second day and 6.21 ± 2.38, 5.77 ± 2.34 and 4.71 ± 2.48 on movement respectively. 85.49% of UTKA and 77.22% of BTKA patients walked on the day of surgery. Decrease in haemoglobin and transfusion rates were 1.25 ± 0.41 g% and 0.5%, 1.85 ± 0.62 and 3.9% in the UTKA and BTKA groups respectively.

The average length of hospital stay (LOS) was 3.98 days. LOS was 3.17 and 4.78 days with 1.55% and 6.05% major complications in the UTKA and BTKA groups respectively.

There was a significant improvement in Oxford Knee and WOMAC scores at 3, 6 and 12 months in both groups.

Conclusions: Pain following TKA is a major deterrent in early mobilization thereby delaying functional recovery and increasing ALOS. We recommend our multimodal interdisciplinary protocol to achieve early mobilization, better pain scores and minimize complications, resulting in overall reduced LOS.

1. Introduction

The joints registry of the Indian Society of Hip and Knee surgeons noted that approximately 1, 70, 000 total knee arthroplasties (TKA) were done between 2006 and 2017.[1] This number is growing as osteoarthritis becomes widespread and more surgeons report to the registry. Unlike other surgeries, patients undergoing TKA typically have pain and decreased mobility postoperatively, especially so in the first 24 h which increases the morbidity and hospital average length of stay.[2,3] Achieving a pain free knee in the immediate postoperative period following TKA forms a keystone in early mobilization and functional recovery. In the past, pain after

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TKA was managed by epidurals, femoral nerve blocks and opioids. These techniques had side effects which hindered faster recovery.[4] Enhanced Recovery after Surgery pathways (ERASp) first described by Kehlet H[5] are being gradually modified and used for perioperative management of hip and knee replacements.[6] The advent of adductor canal block (ACB), local infiltration analgesia (LIA), other multimodal pain and blood management protocols have significantly enhanced the immediate recovery following TKA.[2,7,8]

We present an interdisciplinary ERASp for patients undergoing TKA at our tertiary care centre which address pre-hospital preparations, in-hospital care, and post-hospital discharge and has shown outstanding results.

2. Methods

We retrospectively analyzed data of all patients who underwent primary TKA (unilateral TKA {UTKA} and bilateral TKA {BTKA}) between July 2016 and January 2018 at tertiary care centre with a minimum follow up of 12 months. All patients were operated by the senior author, following the same perioperative protocol implemented by an interdisciplinary team. We excluded cases of revision arthroplasty.

- In the preoperative period, all the patients were educated about the surgery using visual aids and information brochures. Prehabilitation was done through quadriceps strengthening exercises and hamstring stretching. Comorbidities such as diabetes, hypertension, asthma and anaemia were optimized. The Preoperative protocol is described in Table 1.
- Most patients were given spinal anaesthesia, while general anaesthesia was given to those patients who had a contraindication to spinal anaesthesia or refused spinal anaesthesia.
- After the spinal or general anaesthesia was in place, an ultrasound guided Adductor canal block (ACB) was given and urinary catheterization was done.

Table 2
Patient characteristics.

Characteristic	Unilateral	Bilateral
Age (years)	62.74 ± 8.965	64 ± 8.68
Male	145	81
Female	247	299
Osteoarthritis	365	353
Rheumatoid arthritis	27	27
ASA class 3	17	17
Diabetes	86	85
Hypertension	91	88
Cardiac morbidity	41	41
COPD	10	9
Other comorbidities	4	3

Table 1
Preoperative and postoperative protocol for TKA.

Intervention by time point	Dose		Route	Frequency	Notes
Preoperative					
Gabapentin	300 mg		Oral	3 doses	Given at night, starting on night before surgery
Intraoperative					
Subarachnoid block	15–20 mg		Intrathecal		Contraindication/failure of subarachnoid block, standard general anaesthesia with endotracheal intubation
0.5%Bupivacaine Heavy + Buprenorphine	1 μg/kg		Intrathecal		
General Anaesthesia					
Antibiotic Cefuroxime	1.5 g		Iv		Prior to surgery, prior to 2nd knee, 2 doses thereafter, 12 hourly
Adductor canal block Ropivacaine	12 ml of 0.2%		Adductor canal	1 dose	Ultrasound guided, prior to surgery, on each side for bilateral TKA
Midazolam	0.02 mg/kg		Iv	1-2 doses	
Pantaprazole	40 mg		iv/oral postop	1 dose	Continued I dose daily before breakfast
Paracetamol	1 g		Iv	1 dose	
Tranexamic acid	500–1000 mg (10 mg/kg)		Iv	1 dose	
Methylprednisolone	500 mg		Iv	1 dose	
Ondansetron	4–8 mg		Iv	1 dose	
Local infiltration	Unilateral	Bilateral Each Knee	Intra articular		The mixture is diluted to 100 ml and infiltration is done with 20 ml syringes and 18 g needles
Levobupivacaine 0.5%	30 ml	15 ml			
Clonidine	75 μg	75 μg			
Fentanyl	100 μg	100 μg			
Adrenaline 1:1000	2 drops	2 drops			
Ketorolac	30 mg	30 mg			
Tranexamic acid	1 g	500 mg			
Postoperative on day of surgery					Drain kept clamped for 4 h, then released
Paracetamol	1 g		Iv	2-3doses	
Ice application			Locally	4 times a day	For 2 days
Postoperative day one					
Paracetamol	1 g		Oral	2-3 times	
Tramadol	50 mg		IV		Rescue analgesic
Dalteparin sodium	5000U		Sc	Once daily	Till discharge
Buprenorphine patch	10 μg/h		Transdermal	once	
Decadurobolin	100 mg		Im	1 dose	
Vitamin C	2 g		Oral	5 doses	One dose a day
Multivitamin with Zinc			Oral	5 doses	One dose a day

Table 3
Visual analogue scale pain scores.

Unilateral		6			12			18			24			36			48		
		Mild	mod	sev	mild	mod	sev	mild	mod	sev	mild	mod	sev	Mild	mod	sev	mild	Mod	sev
393	VAS r	3.0 ± 1.76	5.81 ± 2.62	7.85 ± 1.72	2.94 ± 1.83	5.22 ± 1.9	8.34 ± 1.32	3.67 ± 1.19	5.64 ± 0.67	7.23 ± 2.61	2.78 ± 1.74	4.88 ± 2.01	7.9 ± 0.55	2.01 ± 1.56	3.68 ± 1.89	6.78 ± 2.04	1.85 ± 1.24	3.98 ± 2.33	6.8 ± 0.83
	%	61.5	32.9	5.6	54.0	31.8	14.2	61.4	28.9	9.7	65.8	26.6	7.6	72.5	23.7	3.8	78.5	18.9	2.6
	VAS m	2.66 ± 2.23	5.78 ± 2.50	7.64 ± 2.06	3.22 ± 1.56	6.02 ± 1.48	7.88 ± 1.80	3.22 ± 1.65	5.8 ± 1.55	7.68 ± 2.07	3.05 ± 1.66	5.12 ± 2.31	7.99 ± 1.59	2.55 ± 1.17	3.84 ± 1.44	6.51 ± 2.64	2.11 ± 1.66	3.77 ± 2.41	6.88 ± 1.41
	%	50.8	42.5	6.7	52.5	33.6	13.9	58.3	35.6	6.1	63.4	28.3	8.3	69.9	25.4	4.7	77.3	17.2	5.5
Bilateral		Mild	mod	sev	mild	mod	sev	mild	mod	sev	mild	mod	sev	Mild	mod	sev	mild	Mod	sev
382	VAS r	2.38 ± 1.58	4.54 ± 0.61	7.54 ± 1.74	2.94 ± 1.83	4.64 ± 2.08	7.5 ± 1.6	3.32 ± 0.9	5.88 ± 1.42	7.41 ± 2.48	2.5 ± 1.08	4.18 ± 2.04	8.01 ± 1.1	3.4 ± 1.78	2.45 ± 1.47	7.03 ± 1.22	2.23 ± 1.29	4.55 ± 2.13	7.53 ± 1.22
	%	64.2	29.5	6.3	61.3	26.0	12.7	62.5	30.2	7.3	58.5	29	12.5	64.3	27.5	8.2	72.4	23.1	4.5
	VAS m	2.33 ± 2.1	4.44 ± 2.31	7.12 ± 1.6	3.66 ± 1.9	5.77 ± 1.76	7.25 ± 1.77	2.9 ± 1.81	5.34 ± 1.62	7.28 ± 2.12	3.22 ± 1.81	5.12 ± 1.9	7.4 ± 1.22	2.8 ± 1.65	3.66 ± 1.8	7.02 ± 2.75	2.38 ± 1.62	3.42 ± 1.82	7.1 ± 1.8
	%	57.8	35.2	7.0	56	34.5	9.5	60.5	33.4	6.1	55.6	32.54	11.86	60.8	28.0	11.2	68.5	24.8	6.7

- Posterior stabilized/posterior cruciate substituting prosthesis was implanted using a midvastus approach. Patellaplasty was done in all.[9] After checking the trial implant, periarticular local infiltration analgesia (LIA) was injected in the posterior capsule, collateral attachments, synovium, Hoffa's fat pad, tissue adjoining the arthrotomy incision and subcutaneous tissue. The drug mixture is detailed in Table 1. Final implantation was done with cement and the wound was closed in layers over a negative suction drain. Entire surgical procedure was done with a pneumatic tourniquet (>100 mm Hg from baseline systolic blood pressure). The drain was clamped for 4 h after release of the tourniquet as we did not release tourniquet prior to closure. Subsequently the drains were removed 4 h after opening the clamps (8 h postoperative).[10] Urinary catheter was removed 6 h after surgery. Postoperative protocol is as described in Table 1.
- All patients were shifted to the recovery room in the theatre complex which functioned as a post-anaesthesia care unit (PACU). They were observed for complete recovery from anaesthesia, adequate blood and fluid management.[11] This

Fig. 1. a: Postoperative Visual analogue pain scores in Unilateral TKA at rest.
Mild is VAS score 0–3, Moderate is VAS score 4–6 and Severe is VAS score 7–10.
1b: Postoperative Visual analogue pain scores in Unilateral TKA on movement.
1c: Postoperative Visual analogue pain scores in Bilateral TKA at rest.
1d: Postoperative Visual analogue pain scores in Bilateral TKA on movement.

functioned as a careful transition between the operation theatre and the patient ward.

- Visual analogue pain scores (VAS) were monitored for the first 48 h. DVT socks and intermittent compression devices were applied to the lower limbs along with low molecular weight heparin till discharge.
- All patients were encouraged to sit, stand, walk and climb stairs on the day of surgery as well as on subsequent postoperative days.
- Patients were assessed for functional status using the Oxford knee (OKS) score and Western Ontario and McMaster's Universities Osteoarthritis index (WOMAC) score. OKS and WOMAC scores and any complications were noted at follow up of patients up to 1 year and analyzed using Paired T test.

3. Results

775 patients, 392 UTKA and 383 BTKA met our inclusion criteria. Both groups were comparable demographically, including ASA physical status and comorbidities as shown in Table 2. Spinal anaesthesia was administered in 708 patients and 67 patients received general anaesthesia.

In the UTKA group the mean VAS pain scores at rest were 3.15 ± 2.15 on the day of surgery, 2.5 ± 1.86 on the first postoperative day and 2.08 ± 1.81 on the second day, and 6.2 ± 2.38, 5.77 ± 2.34 and 4.71 ± 2.48 on movement respectively. In the BTKA group the mean VAS pain scores at rest were 4.39 ± 2.25 on the day of surgery, 3.98 ± 2.36 on the first postoperative day and 3.05 ± 2.12 on the second day and 6.21 ± 2.38, 5.77 ± 2.34 and 4.71 ± 2.48 on movement respectively. Further details are as described in Table 3 and Fig. 1a, b, 1c and 1d. Mobilization on the day of surgery was achieved in 85.49 and 77.22% cases of UTKA and BTKA groups respectively; details are displayed in Figs. 2 and 3.

Postoperative Hemoglobin (Hb) levels and drop in Hb were 11.56 ± 1.22 and 1.25 ± 0.4, 10.96 ± 1.43 and 1.85 ± 0.62 in the UTKA and BTKA groups respectively. Two patients (0.51%) in the unilateral group needed blood transfusions and 15 (3.94%) patients in the bilateral group required transfusions.

Average hospital length of stay (ALOS) was 3.98 days. LOS was 3.17 days with 79.38% patients getting discharged by postoperative day 3 in the UTKA group. LOS was 4.78 days with 82.39% patients getting discharged by postoperative day 5 in the BTKA group. The distribution of LOS is shown in Fig. 4.

Table 4 details the major and minor postoperative complications. Major complications were seen in 1.55% and 6.05% of unilateral and bilateral cases respectively.

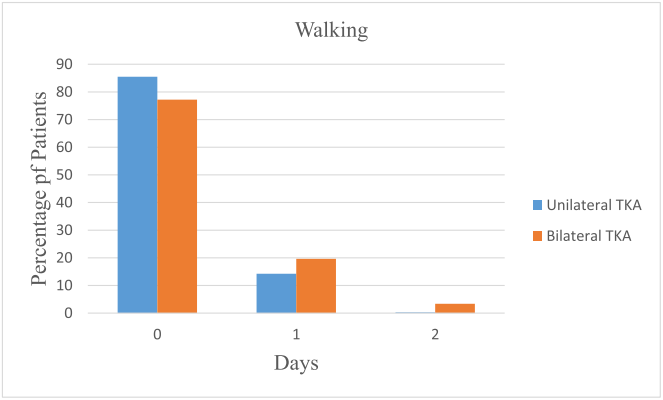

Fig. 2. Post-operative mobilization.

Fig. 3. Post-operative mobilization.

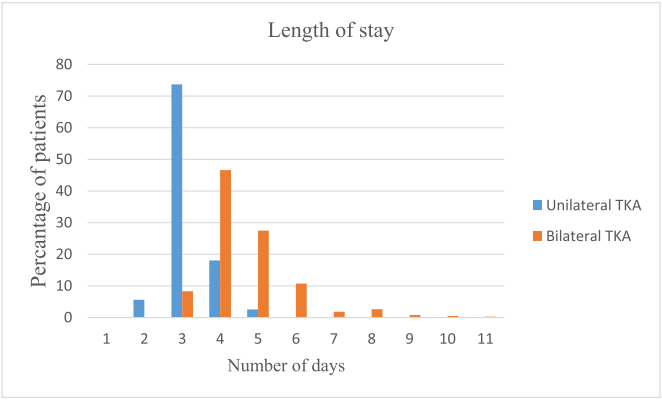

Fig. 4. Hospital length of stay.

Table 4
Complication rates.

Complication	Unilateral TKA No. of patients	Bilateral TKA No. of patients
Major		
Cardiac complications	1 (0.26%)	6 (1.58%)
Pulmonary complications	0	1 (0.26%)
Infection	2 (0.51%)	6 (1.58%)
Periprosthetic fracture	1 (0.26%)	1 (0.26%)
Revision	0	2 (0.53%)
Mortality at 1 year	0	3 (0.79%)
Deep vein thrombosis	1 (0.26%)	4 (1.05%)
Minor		
Electrolyte imbalance	5 (1.28%)	7 (1.84%)
Urine retention	6 (1.53%)	14 (3.68%)
Urinary tract infection	0	2 (0.53%)
Blood transfusion	2 (0.51%)	15 (3.95%)
Postoperative ICU	8 (2.04%)	33 (8.68%)

Table 5 shows a significant improvement in the follow-up OKS and WOMAC scores.

4. Discussion

ERASp have proven their efficacy in various surgical fields.[12] They effectively reduced perioperative morbidity, pain, complications and thereby improved the functional outcomes. This led to reduced ALOS and healthcare costs.[13]

The patient and surgeon expectations following TKA have

Table 5
OKS and WOMAC scores preoperatively and at follow up.

Time	OKS						WOMAC Score					
	Unilateral TKA		Bilateral TKA				Unilateral TKA		Bilateral TKA			
			Right knee		Left knee				Right Knee		Left knee	
Preoperative	15.33 ± 2.94		14.24 ± 2.95		13.97 ± 3.00		43.54 ± 4.41		43.48 ± 4.40		44.93 ± 5.15	
3 months postoperative	36.78 ± 4.80	P < 0.001	36.18 ± 4.131	P < 0.001	36.49 ± 2.57	P < 0.001	80.55 ± 7.69	P < 0.001	78.40 ± 5.49	P < 0.001	78.66 ± 5.36	P < 0.001
6 months postoperative	43.01 ± 1.71	P < 0.001	42.87 ± 2.38	P < 0.001	42.62 ± 2.22	P < 0.001	92.06 ± 2.05	P < 0.001	91.53 ± 3.48	P < 0.001	91.35 ± 3.27	P < 0.001
12 months postoperative	46.79 ± 0.94	P < 0.001	46.51 ± 1.80	P < 0.001	46.32 ± 1.71	P < 0.001	97.57 ± 1.02	P < 0.001	96.96 ± 3.02	P < 0.001	96.80 ± 2.89	P < 0.001

Statistically significant improvement in OKS and WOMAC scores at 3, 6 and 12 months when compared with scores at previous follow up (P < 0.001).

undergone a major change with prime focus on early mobilization, discharge from hospital and return to function.[14] There are a few studies which describe utilizing the ERASp and modifying them to enable fast tracking of individuals undergoing TKA.[6,15–17] At our institute, we have implemented an interdisciplinary pathway focusing on preoperative patient education and optimization, anaesthesia and surgical technique, multimodal pain and blood management, early mobilization and reducing ALOS and complications.

1. *Preoperative patient education and prehabilitation* form a key component to allay anxiety.[15] Wang et al. showed that though prehabilitation can slightly improve early postoperative pain and function in patients undergoing joint replacement, their effects remain too small and short-term to be considered clinically-important, and did not affect key outcomes such as length of stay and costs.[18] This may be due to the fact that patients with osteoarthritis which is severe enough to need surgery may be unable to achieve the exercise levels needed to show large benefits. However we considered even the small benefit valuable enough to prehabilitate our patients and do so with visual aids and information brochures.
2. *Preoperative optimization* of anemia, hypertension, diabetes mellitus, asthma and nutritional status when optimized give a good outcome. Cessation of smoking 4 weeks before surgery lowers the risk of a poor outcome to the level of non-smokers.[15] All our patients underwent a medical, cardiac, endocrinology and anaesthesia fitness prior to surgery and were optimized as indicated.
3. *Spinal and regional anaesthesia* have proven benefits in fast tracking over general anaesthesia.[4] We encouraged all our patients to undergo spinal anaesthesia and used general anaesthesia only where spinal was contraindicated or on patient refusal for the same. We added 1 μg/kg of Buprenorphine to 15–20 mg of 0.5% Bupivacaine to prolong the duration of anaesthesia as it acts at the spinal and supra spinal level.[19]
4. *Modifications in the surgical technique* such as a midvastus approach and circumferential electrocautery with Patellaplasty have also helped reduce pain and an earlier return to normal functional status.[20–22] Our drain clamping technique has shown a significant reduction in drop in Hb and transfusion rates.[10]
5. *Multimodal blood management* protocols included drain clamping for 4 h and the use of tranexamic acid both in the LIA and intravenously.[10,23] We were able to keep the number of blood transfusions down to 0.51% patients in the UTKA group and 3.94% patients in the BTKA group. Morais et al. reported no transfusions using a multimodal blood loss prevention approach in their study.[24]
6. *Multimodal analgesia* combines analgesics with different mechanisms or sites of action in order to improve analgesia, reduce opioid requirements and/or reduce adverse effects. It is the synergistic effects of combinations of systemically and locally administered analgesic drugs that improves pain relief.[25] All our patients received perioperative doses of Gabapentinoids, Nonsteroidal anti-inflammatory drugs, intravenous Methylprednisolone and intravenous Paracetamol, the benefits of which have been well established in literature.[26–28] ACB and LIA were used in all our cases. Numerous studies have cited the benefit of these modalities.[29–31] Acute pain has various deleterious effects such as hypercoagulability, immunosuppression, poor wound healing, myocardial ischaemia, paralytic ileus and potential to develop chronic pain.[11] Reduction in pain scores in the first 24 h significantly improves the short to medium term functional outcomes as well as reduces the incidence of deep vein thrombosis.[31] Ice application around the wound helps in the control of pain and may increase range of movement.[32] A 10 μg/h Buprenorphine transdermal patch was applied on the first postoperative day as it is an ideal drug for use in a transdermal patch and provides adequate analgesia without the systemic adverse effects of opioids.[33]
7. *Mobilizing* patients on the day of surgery results in higher functional outcomes, improved pain control and shorter hospital stay. A robust multimodal pain management protocol ensures better mental and physical readiness to participate in early mobilization and physiotherapy.[11] The majority of our patients in both the unilateral and bilateral groups were able to mobilize postoperatively on the day of surgery.[34]
8. *Visual Analogue Score:* The use of a multimodal technique for postoperative pain management helped in keeping the Visual analogue scores down and a high percentage were mobilized on the day of surgery itself. Our VAS score findings were similar to those found by Danoff et al., where their overall mean and average highest visual analogue scale for pain during the postoperative stay were 42.6 mm and 66.1 mm on a scale of 0–100.[35]
9. *Our ALOS* of 3.98 days- 3.17 and 4.78 days in UTKA and BTKA groups respectively was significantly low and comparable with international literature. 79.38% patients in the UTKA group were discharged by day 3 and 82.39% in the BTKA group were discharged by day 5. Medicare in the USA recognizes a 3 day hospital length of stay as a standard of care after TKA.[36] Gwynne Jones et al., recently reported an average LOS of 4.8 days following TKA using ERASp.[8]
10. *Major complications* were minimized by implementing multimodal blood a nd pain management protocols. The observed types of complications were similar to other studies done on total joint arthroplasties. Berger et al.

reported 7 medical complications {gastrointestinal bleed, deep vein thrombosis (DVT), anemia} within 3 months of outpatient TKA in 86 patients at a rate of 8.1%.[37] Lovecchio et al. had an overall complication rate of 7.1% in inpatient and 10.1% outpatient TKA and THA patients.[7] A meta-analysis done by Zhang et al. found that an indwelling urinary catheter, removed 24–48 h postoperatively in patients undergoing total joint arthroplasty was better than intermittent catheterization in preventing postoperative urinary retention. Moreover the indwelling urinary catheter removed 24–48 h postoperatively did not increase the risk of urinary tract infection.[38] We catheterised all our patients which were removed 6 h after surgery. DVT socks and intermittent pneumatic compression (IPC) devices are known to reduce the incidence of DVT and were combined with Dalteparin in all our cases and thus could keep the rates of DVT at 0.26% in the unilateral TKA group and 1.05% in the bilateral TKA group.[39] Wound healing and patient outcomes were enhanced with supplemental oral Vitamin C and multivitamins with Zinc.[40–42]

11. *The WOMAC score* is an outcome measure that has validated responder definitions and cut-off points which are specific for TKA and the OKS is a simple and brief one.[43] We had a significant improvement in both the OKS and WOMAC scores at follow up which showed that our protocol had long lasting and positive effects on our patients.

Our study is not without limitations. It is a retrospective analysis with no comparative group. The strength of the study would be much better with a randomized controlled trial between ERASp and non- ERASp groups. This however at times is not clinically feasible. Moreover, a longer follow up would be needed to know the morbidity and mortality rates over a medium to long term period.

5. Conclusion

Pain following TKA is a major deterrent in early mobilization thereby delaying functional recovery and increasing ALOS. We recommend our multimodal interdisciplinary protocol to achieve early mobilization, better pain scores and minimize complications, resulting in overall reduced average length of hospital stay.

Conflicts of interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcot.2019.05.007.

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