Comparing outcomes between enhanced recovery after surgery and traditional protocols in total knee arthroplasty: a retrospective cohort study

Janus E Beukes,[1]* Reynard J Immelman,[2] Joachim H Venter,[3] Charl Janse van Rensburg,[4] Mthunzi V Ngcelwane,[5] Johannes N de Vos[2]

[1] Department of Orthopaedics, Tembisa Provincial Tertiary Hospital, Tembisa, University of Pretoria, South Africa
[2] Private orthopaedic surgeon, Life Wilgers Hospital, Pretoria, South Africa
[3] Specialist physician, Life Wilgers Hospital, Pretoria, South Africa
[4] Statistician, Medical Research Council, Pretoria, South Africa
[5] Department of Orthopaedics, Steve Biko Academic Hospital, University of Pretoria, Pretoria, South Africa

**Corresponding author: janus.eduard@gmail.com*

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Abstract

Background

Knee replacement surgery was traditionally associated with prolonged recovery and rehabilitation programmes in hospital. Enhanced recovery after surgery (ERAS) protocols have been shown to be cost effective while not compromising patient safety or functional outcome. Despite this proven efficacy, ERAS has not been widely adopted in South African orthopaedic practices. The aim of this study is to determine if it is possible to practise these guidelines in South Africa so as to decrease the length of stay (LOS) without an increase in complication rate or compromise in functional outcome.

Methods

Included in the study were 119 patients undergoing elective total knee arthroplasty between 2013 and 2017. They were divided into two cohorts. The first group was treated with a traditional protocol and included 59 patients. The second group was treated with ERAS and included 60 patients, following implementation of the ERAS protocol in 2015. The functional outcome was assessed using the Oxford Knee Score (OKS). The 30-day readmission rate was used to assess safety of early discharge. LOS and patient demographics were also collected to compare the cohorts.

Results

There was no clinically significant difference between the cohorts with regards to OKS or readmission rate. Two sample t-tests were used to compare these parameters. The mean OKS for the traditional group was 59.1 (SD 2.4), and for the ERAS group, 58.7 (SD 5.0) ($p = 0.73$). The readmission rate was 8.5% in the traditional group and 10% in the ERAS group ($p = 1.00$). The LOS was significantly decreased in the ERAS group, with a mean of 2.3 days (SD 1.8) compared to 5.0 (SD 2.2) in the traditional group ($p < 0.001$).

Conclusion

ERAS protocols used in the South African context in elective total knee arthroplasty significantly decrease the LOS without compromising patient safety or functional outcome.

Level of evidence: Level 3

Keywords: ERAS, total knee arthroplasty, length of stay

Introduction

Osteoarthritis is the leading cause of disability around the globe.[1] It is a major source of morbidity and an economic burden for the health system.[2,3] For end-stage disease, not responsive to conservative treatment, joint replacement is the best option. It has proven to be a reliable option for return of function and effectively improves health-related quality of life scores.[4] The primary total knee arthroplasty demand is estimated to grow by 673% from 2008 to 2030 in the United States.[5] Enhanced recovery after surgery (ERAS) protocols have been shown to be more cost effective and resource sensitive than traditional protocols. The future burden of disease worldwide emphasises the need for validating ERAS in countries such as South Africa as well as contributing to research in this field.

Recent treatment protocols favour shorter hospital stays with accelerated recovery. With ERAS, emphasis is placed on pre-, intra- and postoperative interventions specifically to decrease length of

stay (LOS), but we should be cognisant of the possible negative effects it can have on morbidity and mortality.[6]

The efficacy and safety of the ERAS protocol has been proven by studies done in developed world health systems. They speed up the recovery process, improve patient satisfaction and save medical resources without compromising patient safety or increasing the readmission rate.[7,8]

The short-term outcomes in joint arthroplasty are assessed in terms of function and complication rate. The Oxford Knee Score (OKS) and 30-day readmission rate is widely used internationally to quantify these parameters. Both of them are accepted and validated for this purpose. Common concerns and fears of the ERAS protocol is that these patients are discharged too soon, and thus, complications only present later that could have been prevented if picked up earlier and therefore now have a worse prognosis.[9,10]

The aim of this study is to determine if it is possible to practise ERAS in South Africa so as to decrease the LOS without an increase in complication rate or a worse functional outcome. The primary objective is to measure the LOS, postoperative OKS and 30-day readmission and compare the groups.

Materials and methods

Following approval from University of Pretoria's Ethics Committee, a retrospective cohort study was conducted in a private healthcare facility in Gauteng. The patients enrolled for the study underwent elective total knee replacements during the period 2013–2017. In 2015 the senior author (JNdV) changed his practice from the traditional protocol to the ERAS protocol. The patients were thus divided into two groups: traditional and ERAS. The statistician calculated that 40–60 patients would be required in each arm of the study to achieve statistical significance. The first 60 consecutive patients after implementation of the ERAS protocol on 1 March 2015, and the last 60 patients prior to the new protocol implementation, undergoing primary elective total knee replacement surgery, were included in the study. One patient had to be excluded from the traditional group as the data was insufficient.

The following data was captured from the patients' clinical records: patient demographics, comorbidity profile, anaesthetic type, 30-day readmission rate, OKS and LOS. We also recorded major and minor complications according to the American College of Surgeons' National Surgical Quality Improvement Program (NSQIP).[11] All the patients were followed up for a period of 30 days postoperatively for readmissions. The patients residing in different provinces who failed to follow up at the practice were followed up telephonically to obtain their OKS and enquire about admissions or complications requiring treatment in other units/hospitals. The readmission rate was determined by the number of patients, per cohort, that required readmission within 30 days postoperatively. The OKS was done at least six months postoperatively and is routinely done for all patients in the practice. No preoperative OKS was done.

The treatment protocols followed in treating the two groups of patients were as follows: Both groups had the same surgical procedure and technique performed, with the same prosthesis and manufacturer used. A cruciate-retaining, cemented, total knee prosthesis was used via a medial parapatellar approach. A tourniquet was used throughout the procedure and tranexamic acid was given intraoperatively for haemostasis.

The traditional group was fasted for eight hours preoperatively. Benzodiazepines were given preoperatively for sedation. A general anaesthetic was the preferred method of anaesthesia, with opioids

Table I: Differences between traditional and ERAS pathways[12]

Intervention	Traditional	ERAS
Preoperative	Informed consent	Informed consent Education session
Preoperative fasting	NPO for 8 hours preop	Clear fluids up to 2 hours preop
Preoperative medication	Benzodiazepine sedative	**Stat medication** • Ketorolac IVI (intravenous infusion) • Ondansetron IVI • Paracetamol IVI • Decadron IVI **Preadmission** • Pregabalin 2 days
Postoperative ward	High care 1–2 days	Standard ward
Postoperative diet	Day 0 clear fluids Day 1 full fluids Day 2 full diet	Full diet from day 0
Anaesthetic	General preferred Opioids Benzodiazepine Less emphasis on restoring fluid lost during fasting	Spinal No opioids No benzodiazepine Pre- and intraoperative fluid status NB
Mobilisation	Day 0 – nil Day 1 – bed programme, to chair Day 2 – in room Day 3 – out of room Day 4 – stairs	Day 0 – out of room Day 1 – stairs
Medication	Opioid containing, in hospital and upon discharge	Non-opioid containing* Local infiltrative anaesthetic** (*opioid-containing analgesia given after discharge on PRN basis **intraoperatively)
Other	Drain Catheter	Surgical drain PRN Catheter PRN *Drain and catheter removed before mobilisation on day 0

and benzodiazepines being used in theatre. All patients went to a high care facility postoperatively to be monitored for 1–2 days. A drain and catheter were used for all patients and only removed on day 1–2 postoperatively. Only clear fluids were allowed on the day of surgery with a return to full ward diet by day 2 postoperative. The patients were not mobilised on the same day of surgery; mobilisation out of room was only done on day 3. Opioid analgesia was used in hospital and given upon discharge.

Before a patient could be discharged, the C-reactive protein (CRP) needed to show a downward trend, which was usually by day 4 to 5. More reliance on blood results postoperatively guided the discharge process. CRP, renal function and haemoglobin was monitored daily.

The ERAS protocol is a multidisciplinary approach. An education session was held preoperatively between the patient, surgeon, anaesthetist, nurse and physiotherapist. During this session the protocol was explained in detail to manage expectations. An information leaflet was also given to the patient. This protocol was compiled by the senior author based on international literature at the time.

Pregabalin was started two days prior to admission. The patient was allowed to take clear fluids up to two hours before surgery. Medications given as a stat dose intravenously in theatre included: ketorolac, ondansetron, paracetamol and decadron. Spinal anaesthesia was preferred with no opioids or benzodiazepines used in theatre. Local infiltrative anaesthetic was used intraoperatively. Pre- and intraoperative fluid status was a point of focus and was managed more attentively. Postoperatively the patient was nursed in a standard ward with a full ward diet on the same day of surgery. A surgical drain and catheter were used only if deemed necessary by the surgeon and removed on the same day of surgery, before mobilisation out of the room on day 0 and on stairs on day 1.

Every team member reviewed the patient and made an assessment on readiness for discharge based on control of pain, ability to mobilise unaided and safely in the home environment and adequacy of wound and swelling. No medical reason to postpone discharge should be present. Less reliance was made on blood results to guide the discharge process. FBC and renal function were still monitored but CRP's downward trend was not used to establish readiness for discharge.

All patients were discharged home without utilisation of a stepdown facility. Postoperative analgesia included a three month prescription of the following on an as necessary basis: Celebrex 100 mg bd, Ecotrin 81 mg bd, Synaleve 1–2 6 hrly prn, Lyrica 75 mg nocte, Zopivane 1 nocte and Topzole 40 mg mane.

The differences between the two groups are summarised in *Table I*.

Statistical methods

The Department of Statistics at the Medical Research Council analysed the results. Descriptive statistics including mean, median, standard deviation (SD) and interquartile range was used to describe the continuous variables. Frequencies and proportions were used to describe the categorical variables. The two-sample proportions test was used to compare readmission rates between the traditional and ERAS groups. The t-test was used to compare the LOS between the two groups. Tests were evaluated at 5% level significance. STATA 15 was used for all analysis.

Table II: Patient demographics

Demographics	Traditional group	ERAS group
Sex	28 (47%) male, 31 (53%) female	29 (48%) male, 31 (52%) female
Age (years)	66.0 (SD 9.1)	65.6 (SD 8.7)
BMI	31.9 (SD 6.2)	31.7 (SD 6.7)
Smoking	10%	8%
Hypercholesterolaemia	61%	48%
Hypertension	34%	55%
Diabetes	15%	16%
Renal impairment	0%	5%
COPD	10%	7%
IHD	10%	13%
Hepatic impairment	0%	0%

Results

There were 119 patients enrolled into the study – 59 in the traditional group, and 60 in the ERAS group, the latter being the first consecutive patients to be treated by this method in the practice. There were 57 males and 62 females. Their ages ranged between 42 and 88 years with a mean of 65 in the ERAS group, and between 42 and 83 years with a mean of 66 in the traditional group. The BMI ranged between 18 and 47 with a mean of 31 in the ERAS group and 22 and 55 with a mean of 31 in the traditional group. There were five smokers in the ERAS group and six in the traditional group. The comorbidity profile was similar between the two groups, with no statistically significant difference present. We found that most patients had either one comorbidity (33 patients, 27%) or two comorbidities (32 patients, 27%). The patient demographics of each cohort are listed and compared in *Table II*.

Clinical outcomes

No significant difference in OKS was observed between the two groups. In the traditional group, the mean score was 59.1 (SD 2.4) and the ERAS group 58.7 (SD 5.0) ($p = 0.73$).

The LOS was less in the ERAS group and was statistically significant ($p < 0.001$). In the traditional group, the mean LOS was 5.05 days (SD 2.2), compared to the ERAS group with 2.3 days (SD 1.8).

Table III: Comparison of results between traditional and ERAS groups

Parameter	Traditional group	ERAS group	p-value
Anaesthetic type	57 (96%) GA, 2 (3%) regional	49 (82%) regional, 11 (18%) GA	$p < 0.001$
30-day readmissions	5 (8.47%)	6 (10%)	$p = 1.00$
Minor complications	3 (5.08%). 1 pain, 2 DVT	4 (6.67%). 1 pain, 2 DVT, 1 UTI	
Major complication	2 (3.39%). 1 SSI, 1 PE	2 (3.33%). 1 SSI, 1 haematoma	
OKS	Mean 59.1 (SD 2.4)	Mean 58.7 (SD 5.0)	$p = 0.73$
LOS	Mean 5.05 days (SD 2.2)	Mean 2.3 days (SD 1.8)	$p < 0.001$

GA: general anaesthesia; DVT: deep vein thrombosis; SSI: surgical site infection; PE: pulmonary embolus; UTI: urinary tract infection

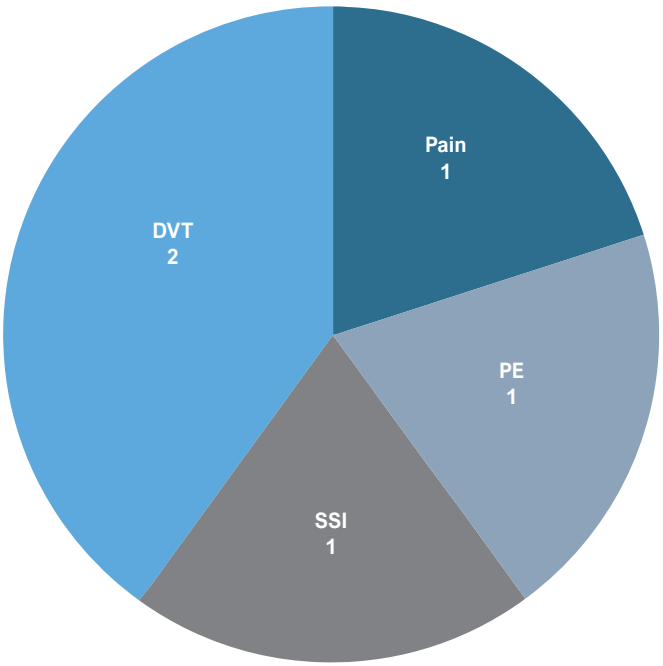

Figure 1. Reasons for readmissions in the traditional group

DVT: deep vein thrombosis; PE: pulmonary embolus; SSI: surgical site infection

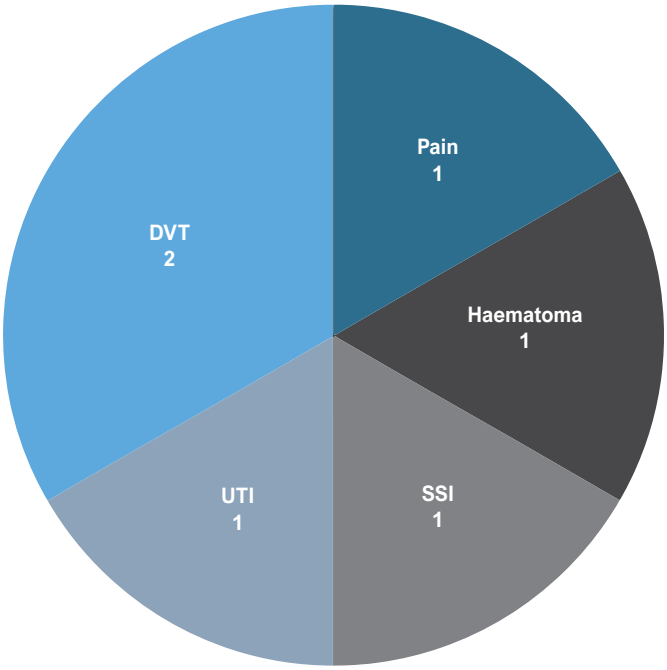

Figure 2. Reasons for readmissions in the ERAS group

DVT: deep vein thrombosis; PE: pulmonary embolus; SSI: surgical site infection; UTI: urinary tract infection

Complications

No significant difference in the 30-day readmission rate was observed between the two groups, with 8.5% (5) and 10% (6) in the traditional and ERAS groups respectively (p = 1.0). The reasons for readmission are indicated in *Figures 1 and 2* and classified as major or minor as indicated in *Table III*. A major complication is one that requires the patient to go back to theatre, for example, for surgical site infection (SSI) debridement, haematoma evacuation or the presence of a pulmonary embolus. A minor complication includes readmission for pain, deep venous thrombosis (DVT) or urinary tract infection (UTI). *Table III* summarises the results between the traditional and ERAS groups.

The type of anaesthesia given was a big change from the traditional to the ERAS protocol and forms one of the integral parts of change in enhanced recovery. In the traditional group, 57 (96%) had general anaesthesia and two (3%) regional anaesthesia. In the ERAS group, 49 (82%) had regional anaesthesia and 11 (18%) general anaesthesia.

Discussion

Research with a similar design to our proposed study was performed in Seattle, Washington, by Auyong et al.[8] They compared the evolution from traditional to ERAS protocols and found favourable LOS without an increase in readmission rates. This was also confirmed by a meta-analysis of Zhu et al., where the length of hospital stays decreased from between four and 12 days to between one and three days without an increase in complications or readmissions.[7] Khan et al. even found decreased reoperation and readmission rates with lower transfusion rates in the ERAS group.[14]

Gwynne-Jones et al. had 528 patients in their ERAS group and 507 in the traditional (historical) cohort; they found that the enhanced recovery protocols are effective for an unselected public hospital population that had significant comorbidities, without relying on rehabilitation or stepdown facilities.[15]

The study by Riemer et al. was also done in a private hospital setting in South Africa. They included both total knee and hip replacement surgery in 46 patients, without a comparative control. They excluded patients with a body mass index (BMI) > 40; patients they expected might need high care or intensive care postoperatively; those with cognitive impairment; and patients with poor social circumstances or no support. The ERAS protocol followed was similar to ours. Their study also concluded that ERAS is safe and that it is an effective way of managing arthroplasty patients without compromising rehabilitation.[16]

Determining the magnitude of the effect of different principles within an ERAS protocol is difficult. To optimise the most positive outcome, more research is needed to standardise these enhanced recovery protocols.[17]

Wainwright et al. investigated the individual components of the ERAS protocol and their efficacy perioperatively. They propose recommendations after compiling a consensus statement upon reviewing available literature. Some of their best practice components, with high level evidence, include patient education and preoperative optimisation; avoiding spinal opioids and an opioid-sparing multimodal analgesic approach; giving local infiltrative anaesthesia; administering tranexamic acid to decrease blood loss; and maintaining normothermia. All of these components correlate with the components in our ERAS protocol.[18]

Further research is required to standardise an anaesthetic protocol in enhanced recovery protocols. In general, neuraxial techniques are favoured over general anaesthesia but the results from large epidemiological studies by Memtsoudis et al. and randomised controlled trials by Harsten et al. are contradictory as to whether neuraxial anaesthesia is favoured over general anaesthesia.[19,20] The current recommendation by Wainwright et al. is that both modern general anaesthesia and neuraxial techniques may be used while avoiding routine spinal opioids in the ERAS setting. Further research is required to establish the detail of each technique.[18]

The study was done in a private healthcare facility which, in the South African context, usually means a well-resourced hospital and a patient population that lives in good social circumstances with access to personal transport and a home with all amenities. One cannot directly apply these results to all government facilities,

some of which have limited resources and patients with poor social circumstances. It does, however, indicate that it is possible to obtain advantageous results with the ERAS protocol in South Africa; this will have a significant and beneficial effect on the public sector if further investigated and implemented. Shorter hospital stays, without routine high care admissions postoperatively, may translate to increased bed availability, decreased overall waiting times and possibly a decrease in hospital-acquired infections and complications of recumbency.[16]

Implementing the ERAS protocol in the public sector is more challenging for various reasons. By gradually phasing in certain aspects of the protocol and doing regular audits, replacement surgery processes in public hospitals can be improved. This was also suggested and implemented by Riemer et al.[16]

From the senior author's experience with the ERAS protocol, we can advise that patient education is of utmost importance. Having an arthroplasty team taking care of these patients and understanding and implementing the protocol is as important. This team includes a physician and anaesthetist for preoperative assessment and optimisation, a physiotherapist for aid in early mobilisation, and trained nursing staff to care for and monitor these patients in a standard ward.

The following components can be phased in gradually to start implementing the ERAS protocol:

- Identify the patient that does not require high care admission postoperatively. By utilising a preoperative optimisation programme, which includes a risk assessment and prediction tool (RAPT), one can identify the patient that requires preoperative assessment and optimisation by a physician.[21,22]
- Ensure that the anaesthetist doing the preoperative assessment is the same doctor giving the anaesthesia.
- Allow clear fluids up to two hours prior to surgery.
- Avoid benzodiazepines perioperatively and opioids during surgery.
- Use adductor canal blocks and periarticular injection of local analgesia.
- Decisions as to whether it is necessary to use a surgical drain, urinary catheter and tourniquet are less important factors that can be phased in later.

The current ERAS protocol being used in the practice is similar to the one used during the study period, with the addition of adductor canal blocks for some patients.

This is a follow-up study of Immelman et al., done in the same private healthcare facility, who compared the outcomes of the ERAS protocol and traditional protocol followed in elective total hip arthroplasty. LOS was also decreased in the ERAS group, with no statistically significant difference noted with regard to readmission rate or functional outcome.[13] In the ERAS group, there were three (7.5%) readmissions for pain during early implementation of the protocol. More emphasis was placed on preoperative education, and discharge medication was adjusted. An amendment to the protocol was made to include oral opioids upon discharge on an 'as necessary' basis. After this adjustment, there were no more readmissions due to pain. Comparing this to the ERAS protocol in knee arthroplasty, only one patient was readmitted for pain.

The readmission rate for major complications in the hip study was 12.5% for the traditional group and 2.5% for the ERAS group. This rate was lower in the knee study, with 3.39% in the traditional group and 3.33% in the ERAS group. This is an interesting observation but does not correlate with international literature indicating that knee replacement surgery is generally associated with more complications than hip replacement surgery.[23]

When comparing the patient profile between the two studies, the female sex more commonly required knee replacement surgery, the patients were older and had a higher BMI. The mean LOS was shorter in the hip ERAS group, being 1.85 days compared to 2.3 days in the knee ERAS group.

The retrospective nature of the study is the primary limitation. The fact that the two cohorts did not run concurrently is another limitation. This could possibly have had an effect due to changes in unknown factors such as theatre or nursing staff co-managing patients. The rest of the team members were unchanged during the study period for continuity of treatment.

Although the ERAS protocol is beneficial, we cannot quantify the effect of individual principles within the protocol and can only state that the outcomes are associated with the ERAS pathway. The OKS obtained were not all done at the same time postoperatively but at least six months after surgery. Therefore, those where the scores were obtained later might possibly have higher scores as they had more time to recover and rehabilitate.

Conclusion

Based on our findings, we can recommend an ERAS protocol for elective total knee arthroplasty in a healthcare facility with the necessary resources in South Africa. Our study corresponds to international literature that an ERAS protocol is safe, feasible and acceptable.

By implementing the ERAS pathway in the management of elective total knee arthroplasty patients, the LOS can be significantly reduced without increasing the postoperative complication rate or impairing the functional outcome.

Ethics statement

The authors declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010.
Ethical approval was obtained from the University of Pretoria's Research Ethics Department, prior to data collection. Each patient at the private practice also signed a consent form for de-identified information to be used for research purposes.
All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Declaration

The authors declare authorship of this article and that they have followed sound scientific research practice. This research is original and does not transgress plagiarism policies.

Author contributions

JEB: data capture, first draft preparation, preparing manuscript
RJI: study conceptualisation, manuscript revision, design of study
JHV: preoperative assessment and record of patient demographics
CJvR: data analysis
MVN: manuscript revision
JNdV: study conceptualisation, design of study, design of testing set-up, manuscript revision

ORCID

Beukes JE https://orcid.org/0000-0002-9103-776X
Immelman RJ https://orcid.org/0000-0001-5087-4425
Janse van Rensburg C https://orcid.org/0000-0002-6539-7833
Ngcelwane MV https://orcid.org/0000-0001-7564-3308
De Vos JN https://orcid.org/0000-0002-0926-4526

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