

Enhanced recovery after surgery for hip and knee arthroplasty: Our experiences at the department of orthopedic surgery in GH Jesenice

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Abstract

Population ageing has led to a growing number of total joint arthroplasty procedures in patients with degenerative joint diseases. At the same time, the financial resources for healthcare budget are limited or even decreasing. The enhanced recovery after surgery (ERAS) protocol can decrease patients' length of stay (LOS) without compromising the quality of treatment, thus being beneficial both for the patients and the hospital budget.

ERAS protocol for patients undergoing primary total knee or hip arthroplasty was partially implemented at the Jesenice General Hospital in 2014. It was then optimised and upgraded with preoperative education for patients and their relatives, with all patients treated according to the comprehensive ERAS protocol since 2015.

Analysed outcome measures included LOS and readmissions in the first 30 days after discharge. Before the implementation of ERAS, the median LOS in 2013 and 2014 was 6.45 and 6.4 days, respectively. This was significantly reduced after ERAS implementation, with the median LOS of 4.4 days in 2015 and 2016, and 3.5 days in 2017. Readmission rate in the first 30 days after discharge showed no significant differences before and after the implementation of the ERAS protocol.

The ERAS protocol has been successfully and effectively implemented by our department, with LOS being significantly reduced without an increase in the rate of postoperative complications. This was achieved with several multidisciplinary changes before (preoperative education) and during hospitalisation, with peri- and postoperative optimisation of blood management (regular use of tranexamic acid), pain control (multimodal opioid sparing analgesia) and especially with optimisation in physiotherapy.

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1 Introduction

1.1 Total joint arthroplasty surgery

Population ageing has led to a growing number of patients with degenerative joint diseases. However, their demands and expectations for a better quality of life in more advanced age have been growing. Total joint arthroplasty surgery is regarded as one of the most successful and routinely performed procedures of the 20th century, as it is used to effectively eliminate pain, restore mobility and correct joint deformity, thus improving the patient's quality of life (1). In Slovenia, approximately 3,500 primary hip endoprosthesis and 2,200 primary knee endoprosthesis are implanted every year, i.e. a total of approximately 5,700 procedures (2). Some 450 of these implantations are performed in Jesenice General Hospital every year. The growing number of total major joint arthroplasties represents an increasing financial burden for the healthcare budget both at the hospital and state levels. Combined with the patients' expressed desire for recovery in the home environment and its confirmed effectiveness, this had led to the concept of enhanced recovery after surgery (ERAS), without compromising the quality of treatment.

1.2 Enhanced recovery after surgery (ERAS)

KSPO (*angl.* Fast-track surgery ali enhanced recovery after surgery, ERAS) je večdisciplinaren, na dokazih temelječ koncept, s katerim učinkovito in brez ogrožanja bolnika skrajšamo ležalno dobo po operaciji (3-5). The concept was developed by Danish surgeon Henrik Kehlet, who initially introduced ERAS into the field of colorectal surgery. In the

last decade, its implementation in orthopedic surgery, especially in major joint arthroplasty, has become increasingly widespread. The basic principles of ERAS are to improve preoperative preparation, and reduce physical stress during surgery and postoperative discomfort, resulting in earlier mobility and hospital discharge. Achieving this goal requires the coordinated effort of a multidisciplinary team consisting of orthopedic surgeons, anesthesiologists, physiotherapists, nurses and other nursing staff, while equally including the patient in the process (6). The ERAS concept is used to effectively reduce the number of perioperative complications, shorten the time needed for full recovery, as well as reduce morbidity and mortality of patients in the postoperative period (7). This shortens length of stay and ultimately reduces the cost of treatment (8,9).

2 The concept of enhanced recovery after surgery at the department of orthopaedic surgery at Jesenice GH

The implementation of ERAS elements was gradually initiated in 2014 for patients undergoing primary knee and hip joint arthroplasty. The concept was then upgraded, standardized and fully implemented in 2015. Successful implementation of the ERAS concept requires collaboration within a multidisciplinary team and strict adherence to the protocol to ensure high-quality treatment of the highest professional standard. Preoperative evaluation of patients undergoing total knee and hip joint arthroplasty at the orthopedic department of Jesenice GH follows a protocol consisting of the following key elements:

- optimization of the process of educating and informing the patient and their relatives,
- optimization of anesthetic techniques and fluid balance,
- optimization of pain management,
- optimization of transfusion therapy,
- optimization of physiotherapy and rehabilitation,
- reduction of cognitive impairment after surgery, and
- strict compliance with functional criteria for hospital discharge.

2.1 Optimisation of the process of educating and informing the patient and their next of kin

By properly educating the patient before surgery, they are informed of the events before, during and after surgery, thereby reducing the patient's anxiety, while contributing to a shorter recovery period and better treatment outcome (10).

The process of education begins before admission to hospital. A so-called preoperative school for patients undergoing total knee and hip joint arthroplasty is organized almost every week. The orthopedic surgeon, anesthesiologist, floor nurse, dietitian, and clinical case coordinator present the entire course of treatment to the patient and their next of kin. They also address any questions or doubts that arise at this time. One of the more important pieces of information is also the length of stay. Thereby, patients are fully informed when admitted to hospital and at ease concerning their treatment.

2.2 Optimisation of anesthetic techniques and fluid balance

Studies report conflicting results regarding the choice of the optimal anesthetic technique within the ERAS concept. Results of some studies, particularly less recent ones, support the use of spinal anesthesia (11). Some recent studies give somewhat preference to general anesthesia (12). Nevertheless, due to the lack of large-scale randomized studies, there are no clear recommendations concerning the choice of anesthesia techniques within the ERAS.

In Jesenice GH, spinal anesthesia is generally used as the technique of choice in patients undergoing total knee or hip joint arthroplasty. A femoral nerve block is supplemented to SA preoperatively in patients undergoing total knee arthroplasty, in order to provide additional analgesia. In case of any contraindications, general anesthesia combined with femoral nerve block is used instead of spinal anesthesia in patients undergoing knee arthroplasty.

Patients are admitted on the day of surgery and should be fasted, mainly due to the possibility of general anesthesia in case of spinal anesthesia fails or is impossible. Patients undergo routine examinations prior to admission, including basic laboratory blood tests and coagulogram, chest radiograph and an electrocardiogram. During the pre-anesthesia evaluation, the anesthetist may order additional tests if necessary.

2.3 Optimisation of pain management

Optimal pain management after knee and hip joint arthroplasty is important for early mobilisation and rehabilitation, which will contribute to early hospital discharge (13). This is achieved through

a multimodal pain prevention approach, comprising:

- a high dose of glucocorticoid 1-2 hours before the start of the procedure (20 mg dexamethasone or 125 mg methylprednisolone), which effectively reduces postoperative pain and improves postoperative recovery (14),
- local infiltration analgesia with a mixture of ropivacaine and noradrenaline (250 mg ropivacaine and 0.5 mg noradrenaline in 100 ml of saline), which effectively relieves pain in the early postoperative period and reduces the need for pain relief with systemic analgesics, especially in patients undergoing total knee arthroplasty (15),
- postoperative pain relief with a combination of paracetamol and non-steroidal anti-inflammatory medication. Opioid analgesics are avoided and are administered only for breakthrough pain relief. Patients receive intravenous analgesic therapy for the first 24 hours and then change to per os analgesia.

2.4 Optimisation of transfusion therapy

Minor blood loss during surgery reduces the need for postoperative blood transfusion and significantly contributes to early recovery and rehabilitation after total knee or hip joint arthroplasty (16). In order to reduce blood loss during surgery and prevent postoperative anaemia, patients without known contraindications receive 1g of antifibrinolytic agent (tranexamic acid) intravenously once anesthesia is induced and the second time upon arrival at the ward after surgery. There are different routes of administration of tranexamic acid (intravenous, topical, per os). However,

studies have not shown significantly different outcomes based on the route of administration (17). Research shows that tranexamic acid effectively reduces perioperative blood loss and the need for postoperative blood transfusion in patients who have undergone total joint arthroplasty (18). Since the introduction of tranexamic acid therapy at our department, we have noticed a significantly lower rate of postoperative anaemia, virtually eliminating the need for blood product therapy. Routine reservation of red blood cell concentrates before surgery is not necessary either. In the event of good hemostasis, postoperative antithrombotic prophylaxis is introduced approximately 12 hours after surgery; initially with low-molecular-weight heparin applications, and converting to oral anticoagulant therapy in the following days. This therapy is continued for 15 days in patients after total knee arthroplasty and for 30 days in patients after total hip arthroplasty.

Patients who have risk factors for thrombotic complications (history of thrombotic events: CVI, PE, DVT, MI, atrial fibrillation ...) are treated according to the latest joint guidelines of AAOS (American Academy of Orthopaedic Surgeons) and ASRA (American Society of Regional Anesthesia and Pain Medicine) (17).

2.5 Optimization of physiotherapy and rehabilitation

Early mobilization of patients after surgery is an important element of the ERAS concept. With good pain management, mobilization of patients after total hip or knee arthroplasty is possible on the day of surgery. At Jesenice GH, this is not feasible yet due to the lack of physiotherapy staff. At our hospital, the patient

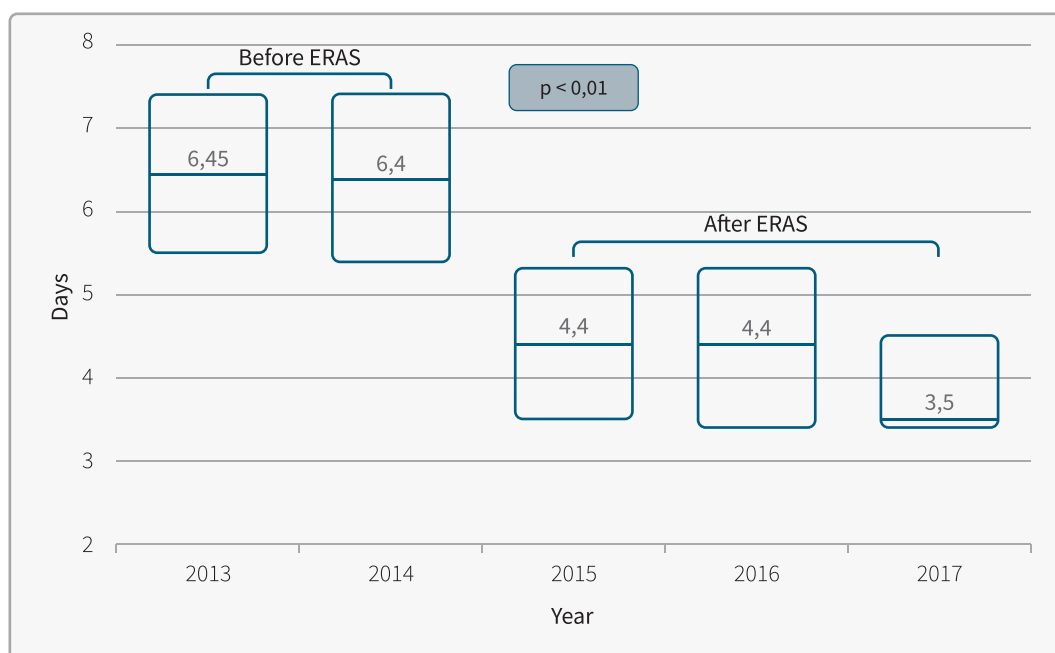


Figure 1: Patients' length of stay following total hip arthroplasty before and after the introduction of enhanced recovery after surgery (ERAS) in days. Numerical data are expressed as median value and the first and third quartile. The p-value between the groups before and after the introduction of ERAS (Mann-Whitney U test)

begins the process of mobilization and physiotherapy on the morning following their procedure.

2.6 Reduction of postoperative delirium and cognitive impairment

Postoperative delirium and cognitive impairment are frequently reported in literature on endoprosthetic reconstruction surgery. They are associated with the duration of hospitalization. Risk factors include pain, use of opioid analgesics, sleep disorders, and postoperative inflammatory response (19). Applying the ERAS concept, the incidence of postoperative delirium and cognitive impairment is significantly reduced, since the aim of the ERAS protocol itself is to shorten the length of stay and to avoid potential risk factors (20).

2.7 Strict compliance with functional criteria for hospital discharge

The patient is discharged to home care when they meet the functional criteria for discharge. These are achieved considerably faster by following the aforementioned elements. The functional criteria include:

- consent to discharge (both by the patient and the orthopedic surgeon)
- appropriate pain prevention
- familiarization with the process of medication cessation,
- awareness of restrictions,
- the ability to properly stand up from a supine and seated position,
- safe walking with or without a mobility aid,
- the ability to ascend and descend stairs, if necessary,

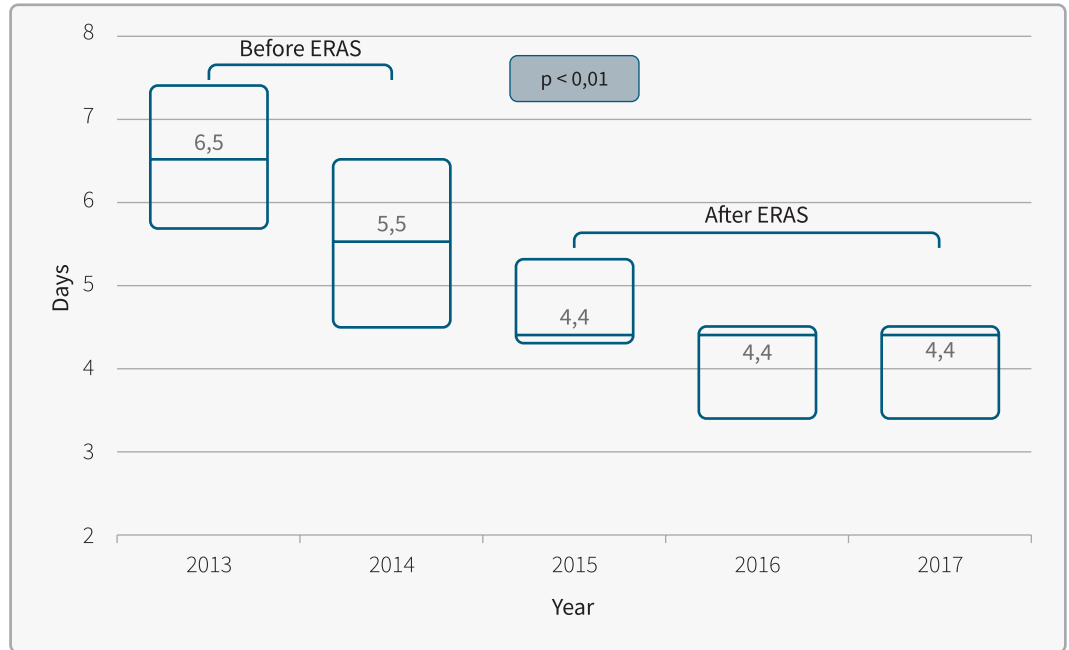


Figure 2: Length of stay following total knee arthroplasty before and after the introduction of enhanced recovery after surgery (ERAS) in days Numerical data are expressed as median value and the first and third quartile The p-value between the groups before and after the introduction of ERAS (Mann-Whitney U test) .

- the ability to continue specific exercises at home,
- self-reliance regarding personal hygiene and
- surgical wound with no signs of infection.

The basis for protocol adherence is the clinical pathway for total knee and hip joint arthroplasty. This is a document that accompanies the patient from hospital admission to discharge, documenting all events concerning this patient. Only deviations from the standard course of

Table 1: The number of patients who underwent primary total hip arthroplasty between 2013 and 2017.

Year	Before the introduction of ERAS		After the introduction of ERAS		
	2013	2014	2015	2016	2017
No of procedures	142	157	180	168	204
Total	299		552		

Table 2: The number of patients who underwent primary total knee arthroplasty between 2013 and 2017.

Year	Before the introduction of ERAS		After the introduction of ERAS		
	2013	2014	2015	2016	2017
No of procedures	156	171	180	228	247
Total	327		655		

treatment, nursing care and physiotherapy of the patient are recorded separately.

3 Experience in enhanced recovery after surgery at the department of orthopaedic surgery at Jesenice GH

We wanted to verify the safety and efficacy of the implementation of the ERAS concept in patients undergoing primary knee and hip joint arthroplasty. Therefore, we analysed patients who underwent primary total knee and hip arthroplasty between 2013 and 2017. We divided patients into two groups. The first group comprised patients treated before the full implementation of the ERAS concept (in 2013 and 2014). The

second group comprised patients treated according to the ERAS principles (from 2015 to 2017). We compared the two groups in terms of in-hospital length of stay as well as the incidence and cause of readmission within 30 days of hospital discharge. We also examined the need for postoperative blood product therapy.

Between 1 January 2013 and 31 December 2017, 982 primary knee and 851 primary hip arthroplasty procedures were performed. The number of procedures in the years before and after the introduction of ERAS is shown in Table 1 in Table 2, respectively. The mean age of the patients in this period was 68 years and 5 months for primary total hip arthroplasty and 70 years and 1 month for primary total knee arthroplasty.

Table 3: Readmission in 30 days following discharge from hospital after primary total hip and knee arthroplasty

	2013	2014	2015	2016	2017
Infection	6	5	2	2	1
Local swelling, pain	3	0	0	2	3
Mechanical complication (periprosthetic fracture, prosthetic dislocation)	1	2	2	0	1
Non-surgical complications (AMI, pneumonia, GI bleeding, etc.)	0	5	3	4	2
Total number of readmitted patients / no of operations (share)	10/298 (3.4%)	12/328 (3.7%)	7/360 (2.0%)	8/396 (2.0%)	7/451 (1.5%)

AMI – acute myocardial infarction

A comparison of patient's length of stay following primary total hip and knee arthroplasty before and after the introduction of ERAS is shown in Figure 1 and Figure 2.

We also examined the need for blood product therapy. Prior to the introduction of ERAS, blood product therapy was required in 5.8% of patients. The proportion of patients requiring blood product therapy decreased significantly to 2.9% after complete implementation of ERAS ($p < 0.05$). The frequency of readmission within the first 30 days of discharge and the cause for readmission is presented in Table 3.

4 Discussion

The approach to the ERAS principle should be multidisciplinary, with cooperation between surgeons, anesthesiologists, nurses, physical therapists and others. A coordinated effort between members of this team is necessary to achieve the optimal effect, which is facilitated by standardizing hospital treatment. In this respect, a treatment protocol containing the elements of the ERAS concept is important. The protocols used by hospitals to implement the ERAS concept differ slightly. Nonetheless, they all follow the same basic set of ERAS principles (6,23,24). The protocol used at the orthopedic department of Jesenice GH is in most aspects comparable to the protocols of other major orthopedic centers that have successfully implemented the ERAS concept. The clinical pathway provides the basis for adherence to protocol and procedure standardization within the ERAS concept. Our department was the first in Slovenia to implement a clinical pathway for patients undergoing knee and hip joint arthroplasty. The purpose of a clinical pathway is to use standardized and streamlined procedures and

protocols to improve the quality of treatment, minimize unnecessary deviations in patient treatment, and consequently reduce treatment costs.

One of the differences observed with regard to the protocols used in other centers is the time needed to achieve postoperative patient mobilization. In certain centers, this is achieved in the first hours after the procedure, which is not yet feasible at our department due to organizational and personnel issues. In the future, we wish to make progress in this respect and follow the relevant trends relying on ERAS concepts.

Additionally, our protocol differs from the rest with regard to the anesthesia technique used during total knee arthroplasty, as we use the femoral nerve block to extend the analgesic effect. A possible complication of performing the femoral nerve block is the weakening of the quadriceps muscle, which can lead to falls while attempting mobilization and may prolong the time needed for verticalization of the patient (25). Studies show that the efficacy of perioperative local infiltration analgesia is comparable to that of the femoral nerve block (26,27). Therefore, further research is needed to determine the feasibility of the femoral nerve block. The introduction of physiotherapy and mobilization on the day of surgery would enable the femoral nerve block procedure to discontinue.

The successful implementation of the ERAS concept and the subsequent reduction of the length of stay allows for more procedures to be performed. Since the introduction of the ERAS concept, certain other centers have seen an increase in the number of performed procedures too (24). Following the introduction of the ERAS concept at the orthopedic department of Jesenice GH, we have observed the potential for increasing the number of total knee and

hip joint arthroplasties. However, an increase also depends on adequate infrastructure and staff policy, and above all on the financial resources allocated to this purpose.

Although we have not conducted a thorough analysis of the reduction in treatment costs following the introduction of the ERAS concept, published studies have reported a reduction in the total cost of treatment (8,9). The cost of an inpatient day is EUR150 per patient, which indicates that reducing the length of stay of 400 patients by two days translates into EUR120,000 in annual savings. However, an analysis of the cost reduction in patient treatment should not be limited to the incidence of hospital readmissions, as the number of specialist reexaminations at the emergency care department following hospital discharge into home care should also be considered. These are relatively common in patients following total knee or hip joint arthroplasty, though in most cases unnecessary and rarely leading to hospital readmission (28,29). With proper patient education and comprehensive information on the course of treatment, which should continue even after hos-

pital discharge, unnecessary visits to the emergency care facilities can be reduced to some extent. Further research is needed to thoroughly clarify this issue.

In order to maintain adequate quality of treatment, it is essential to monitor the quality indicators concerning the primary total joint arthroplasty surgery procedure. These include hospital readmission within 30 days after surgery, early periprosthetic infection and mechanical complications (prosthesis dislocation, loosening) (21,22). Conscientious adherence to the ERAS concept has led to a reduction in the length of stay, with no observable increase in the number of perioperative complications or hospital readmissions.

5 Conclusion

Despite the relatively short amount of time since the introduction of the ERAS protocol for primary total knee and hip joint arthroplasty, we have observed a significant reduction in the length of stay, without observing an increased number of complications or postoperative readmissions to hospital.

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