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Surgical preparation and draping prior to induction of total intravenous anaesthesia

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ABSTRACT

Introduction. Day surgery is increasing, making efforts to improve safe and effective patient turnover of importance. We hypothesised that the introduction of a simple protocol, dictating that anaesthesia should be induced only immediately prior to surgical incision (after surgical preparations) would lead to reduced duration of anaesthesia and postanaesthesia care unit (PACU) stay.

Methods. This was a retrospective, single-centre, procedure-specific, explorative feasibility study of patients undergoing anterior cruciate ligament surgery. Timestamps were collected from the electronic patient records within a three-month period before and after introduction of the protocol at the Copenhagen University Hospital, Bispebjerg and Frederiksberg. Clinical outcomes were assessed using the PACU score, based on the modified Aldrete discharge criteria.

Results. A total of 44 patients were included in the after-, and 74 in the before-new-protocol group. The protocol was feasible in 44/59 patients (75%). The duration of anaesthesia was significantly reduced: 113 (± 26) versus 135 (± 32), mean difference 22 (11-33) minutes, $p < 0.001$. The duration of the PACU stay was significantly reduced: 103 (± 54) versus 80 (± 35), mean difference 23 (6-40) minutes, $p = 0.01$. No difference was observed in clinical outcomes.

Conclusions. A simple protocol by which total intravenous anaesthesia was induced immediately prior to surgical incision was feasible, reduced the duration of anaesthesia and yielded a significant reduction in the PACU stay. Further studies with a randomised design are needed to confirm these preliminary findings.

Funding. departmental only.

Trial registration. not relevant.

Day surgery is increasing, and care principles intending to reduce stress responses and facilitate rapid recovery may translate into improved outcomes [1-3]. In day surgery, being the ultimate form of enhanced recovery, efforts to improve safe and effective patient turnover are of importance [1-3]. Shortening the duration of anaesthesia merely by providing anaesthesia only when required may possibly be a simple way to enhance care.

However, the traditional procedure in the operating theatre (OT) includes induction of anaesthesia before surgical preparation and draping of the patient. This may result in the patient being anaesthetised for an extended period prior to surgery, which may possibly in turn lead to a prolonged postanaesthesia care unit (PACU) stay [4-6], higher levels of postoperative nausea and vomiting (PONV) [7-11], and increased healthcare

costs [4, 5, 9-11]. Therefore, a simple protocol was introduced, dictating that anaesthesia should be induced only immediately before surgery. Anecdotally, this practice has – to some extent – been used in both public and private hospitals, but data systematically investigating its significance are extremely sparse.

Thus, the primary aim of this study was to examine the feasibility of the protocol as related to its effect on the duration of anaesthesia in elective anterior cruciate ligament (ACL) surgery under total intravenous anaesthesia. Secondarily, we aimed to explore the impact of the protocol on patient recovery, specifically on the duration of the PACU stay and clinical patient outcomes evaluated by the PACU score. We hypothesised that the protocol would lead to reduced duration of anaesthesia and to a shorter PACU stay following surgery.

METHODS

Study design

This was a retrospective, single-centre, procedure-specific, explorative feasibility study with comparable before- and after-new-protocol groups conducted at the Copenhagen University Hospital, Bispebjerg and Frederiksberg, Denmark. It was considered a quality assurance study by the Executive Board of the hospital and approved by journal number 19072167.

The new protocol

A new protocol was introduced in March 2019 in a variety of elective orthopaedic surgeries at the Copenhagen University Hospital, Bispebjerg and Frederiksberg, Denmark: *surgical preparation and draping prior to induction of anaesthesia*. Until implementation of the new protocol, patients would arrive in the OT to be anaesthetised shortly thereafter. The new protocol dictated that total intravenous anaesthesia was induced just prior to commencement of surgery (i.e., following all preparations of the patient, including surgical preparation and draping) unless contraindicated (in case of patient anxiety, a wish to have the adductor canal block administered while anaesthetised, and in case of pain upon patient positioning).

Both before and after introduction of the new protocol, anaesthesia was standardised with induction with propofol and maintenance with propofol and remifentanil. Pre- and intraoperative analgesics, adductor canal block, and PONV prophylaxis were administered according to the standardised usual practice and at the discretion of the anaesthesiologist and the surgeon. This included preoperative oral administration of paracetamol 1 g and ibuprofen 400 mg, which was continued at set intervals after surgery. If not administered preoperatively or if an additional dose was due, ketorolac was given intraoperatively. Moreover, intravenous morphine 0.2-0.3 mg/kg was administered one hour before end of surgery. Alternatively, an equivalent opioid was given. PONV prophylaxis was administered when indicated and consisted of dexamethasone 4 mg and ondansetron 4 mg. The new protocol neither affected the surgical technique nor the PACU care principles or discharge criteria.

Subjects

The effect of the new protocol was investigated in patients undergoing ACL surgery at the Copenhagen University Hospital, Bispebjerg and Frederiksberg, Denmark, in a three-month period from April to June 2019, after the new protocol had been implemented. The before-new-protocol group consisted of patients undergoing the same surgical procedure in the three-month period from September to November 2018.

All patients undergoing ACL surgery in the study periods were evaluated for inclusion. Patients were excluded if they were not ≥ 18 years, if they were not anaesthetised using total intravenous anaesthesia, and if they were unable to follow the protocol (see above).

Outcome measures

The primary outcome was the duration of anaesthesia (from induction until removal of laryngeal mask). The secondary outcomes were the duration of the PACU stay and clinical patient outcome evaluated by the PACU score (upon arrival to the PACU).

In measuring the duration of the PACU stay, readiness for discharge was used instead of the time of actual discharge to avoid the influence of external factors delaying PACU discharge. As recommended by the Danish Society of Anaesthesiology and Intensive Care Medicine (DASAIM) [12], the modified Aldrete discharge criteria [13] had to be met for the patient to be ready for discharge from the PACU (https://ugeskriftet.dk/files/a06210497_-_supplementary.pdf). The same criteria were evaluated by the nurse when the patients arrived in the PACU.

Furthermore, we evaluated the time spent in the OT before commencement of surgery, the duration of surgery, the duration of anaesthesia before commencement of surgery, emergence, and the time spent in the OT in total.

Data collection and registration

By reviewing all surgical cases in the study periods, we manually identified patients using the electronic operation schedule called the *Snapboard* in Sundhedsplatformen, Epic Systems Corporation. The following data were collected from the electronic patient records in both groups:

Timestamps: patient arrival in the OT, induction of total intravenous anaesthesia, surgical incision, last suture, waking up the patient, extubation or removal of laryngeal mask, patient leaving the OT, arrival in the PACU, and ready for discharge from the PACU.

Clinical outcomes: PACU score upon arrival in the PACU as recommended by the DASAIM [12] (https://ugeskriftet.dk/files/a06210497_-_supplementary.pdf).

Patient characteristics: age, gender, weight, height, body mass index, American Society of Anesthesiologists (ASA) score.

Medications: anaesthetic agents, intraoperative analgesics, PONV prophylaxis, preoperative analgesics, and whether adductor canal block was administered. In case oxycodone or sufentanil was given, this was registered in morphine equivalent doses [14].

Statistical analysis

No formal sample size calculation was performed due to the explorative nature of the study. A comparative analysis between the before- and after-new-protocol group was performed. To be able to evaluate the effect of the protocol on the primary outcome (the duration of anaesthesia) and secondary outcome (the duration of the PACU stay), patients were excluded from the primary analysis if they were not able to follow the protocol. To investigate introduction of bias by excluding these patients (such as patients with anxiety), a supplementary post-hoc analysis of the duration of the PACU stay was conducted including all patients. Likewise, a post-hoc analysis based only on patients receiving adductor canal block was performed. Continuous data were tested for normality of distribution with the Kolmogorov-Smirnov's and the Shapiro-Wilk's tests and by visual inspection of QQ-plots. There was no substantial deviation from normal deviation. Data are presented as means with standard deviation. Data on the differences between the two groups are presented as differences between means with 95% confidence intervals (CIs). Categorical data are presented as percentages. Unpaired t-test was used to compare continuous data on time and medication. The Mann-Whitney U test was used to compare ordinal data concerning clinical outcomes (PACU score). The association between the total PACU score and the duration of the PACU stay was analysed with Pearson's correlation coefficient. Two-sided p-values < 0.05 were judged to

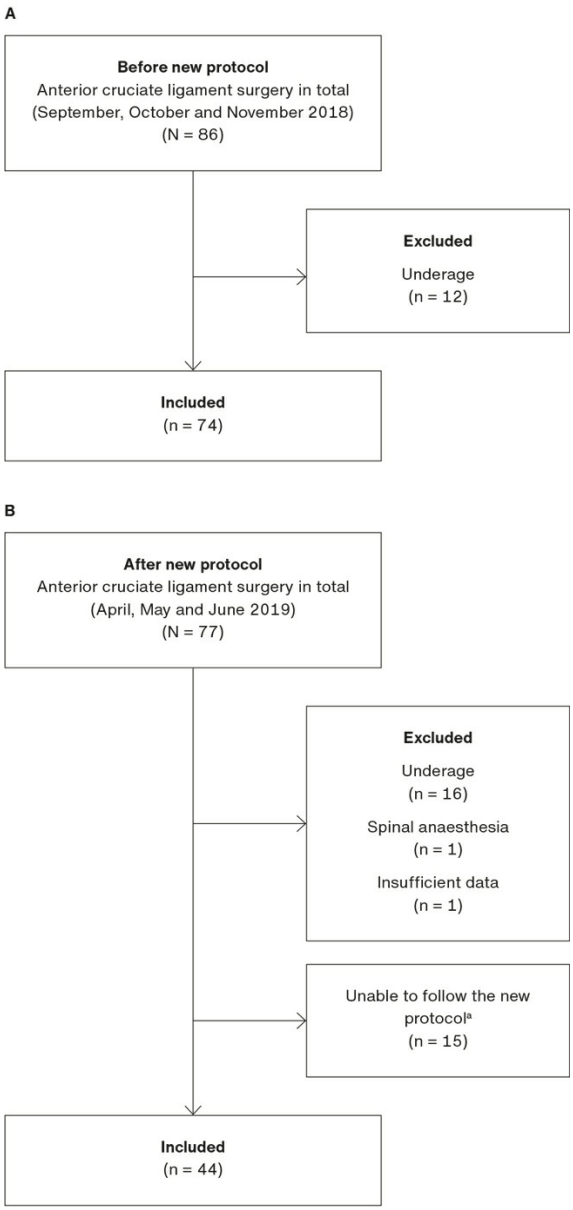
indicate statistical significance. Data were analysed using IBM SPSS Statistics for Mac version 24.

Trial registration: not relevant.

RESULTS

A total of 44 patients were included in the after-new-protocol group; 74 in the before-new-protocol group. The protocol was feasible in 44 out of 59 patients (75%) (**Figure 1**). Patient characteristics in the groups were quite similar. However, the proportion of males was slightly lower in the after-new-protocol group, whereas the proportion of patients receiving adductor canal block was slightly larger in the after-new-protocol group (**Table 1**).

FIGURE 1 Flow chart of before (**A**) and after new protocol (**B**): patients undergoing anterior cruciate ligament surgery in the predefined months before and after implementation of the new protocol and reasons for exclusion of patients.



a) Reasons for not following the new protocol were anxiety, a wish to have the adductor canal block administered while anaesthetised, and pain upon patient positioning.

TABLE 1 Patient characteristics, preoperative analgesics and adductor canal block.

	Before new protocol: 2018 (N = 74)	After new protocol: 2019 (N = 44)
Males, %	68	57
Age, mean ± SD, yrs	29.5 ± 9.7	30.2 ± 8.1
ASA classification, %[a]		
1	73	71
2	26	30
3	1	0
4	0	0
BMI, mean ± SD, kg/m^2	24.3 ± 3.3	23.5 ± 2.6
Preoperative analgesics[b], %	91	96
Adductor canal block, %	88	98

ASA = American Society of Anesthesiologists; BMI = body mass index; SD = standard deviation.
a) Because of rounding, percentages may not total to 100.
b) Consist of oral administration of ibuprofen 400 mg and paracetamol 1 g.

The duration of anaesthesia and the PACU stay was significantly reduced in the after-new-protocol compared with the before-new-protocol group (**Table 2**). A post-hoc analysis of the duration of the PACU stay including all patients (also the patients not following the new protocol) yielded similar results. Furthermore, a post-hoc analysis only comprising patients receiving adductor canal block showed similar results. As to clinical outcomes, we did not observe differences between the groups (**Table 3**). Also, no significant difference in the total PACU score was observed. The duration of the PACU stay was associated with the total PACU score in both groups.

TABLE 2 Duration of general anaesthesia in total and postanaesthesia care unit stay before and after implementation of the new protocol.

	Mean ± SD			
Outcome	before new protocol: 2018 (N =74)	after new protocol: 2019 (N = 44)	Difference, mean (95% CI)	p-value
Primary: duration of general anaesthesia in total, min.[a]	135 ± 32	113 ± 26	22 (11-33)	< 0.001
Secondary: duration of postanaesthesia care unit stay, min.[a]	103 ± 54	80 ± 35	23 (6-40)	0.01

CI = confidence interval; SD = standard deviation.
a) Data are rounded and shown in whole minutes.

TABLE 3 Evaluation of discharge criteria in PACU score[a] as recommended by the Danish Society of Anaesthesiology and Intensive Care Medicine upon arrival in the PACU[b]. Each parameter is assigned a score of 0-3 points. For each parameter, data are presented as number of patients with 0/1/2/3 points.

	Before new protocol: 2018 (N = 73[c])	After new protocol: 2019 (N = 43[c])	p-value
Sedation, n	58/14/1/0	35/8/0/0	0.78
Respiration, n	67/2/3/1	40/1/0/2	0.84
Oxygen saturation, n	43/30/0/0	20/23/0/0	0.20
Systolic blood pressure, n	64/8/1/0	38/4/1/0	0.93
Heart rate, n	65/4/3/1	42/0/1/0	0.10
Pain at rest, n	19/26/20/8	19/7/14/3	0.26
Nausea, n	71/2/0/0	42/1/0/0	0.89
Motor function, n	72/1/0/0	43/0/0/0	0.44
Urine output, n	70/1/0/0	43/0/0/0	0.44
Temperature, n	65/7/1/0	40/3/0/0	0.47
Points, total, mean ± SD	2.51 ± 1.57	2.19 ± 1.52	0.32

PACU = postanaesthesia care unit; SD = standard deviation.
a) The parameters and grading system for the discharge criteria in PACU score are shown in the supplementary material.
b) Analysis with Mann-Whitney U test.
c) Evaluation is missing from 1 patient in each group, and regarding urine output from 2 patients in the before-new-protocol group.

After introduction of the new protocol, the quantities of propofol and remifentanil were significantly reduced (**Table 4**), whereas the administration of intraoperative analgesics did not differ between the two groups.

TABLE 4 Durations in the operating theatre and doses of intraoperative anaesthetics and analgesics[a].

	Mean ± SD			
	Before new protocol: 2018 (N = 74)	After new protocol: 2019 (N = 44)	Difference, mean (95% CI)	p-value
Durations in the OT, min.				
T1: time spent in the OT before commencement of surgery = time from patient arrival in the OT until surgical incision	49 ± 10	44 ± 7	6 (2-9)	0.001
T2: duration of surgery = time from surgical incision until last suture	93 ± 27	99 ± 24	-6 (-16-3)	0.33
T3: duration of anaesthesia before commencement of surgery = time from induction of anaesthesia until surgical incision	35 ± 11	9 ± 5	27 (24-30)	< 0.001
T4: emergence = time from waking up the patient until extubation or removal of laryngeal mask	8 ± 5	6 ± 5	1 (0-3)	0.61
T5: time spent in the OT in total = time from patient arrival to the OT until leaving the OT	158 ± 31	155 ± 26	3 (-8-14)	0.51
Intraoperative analgesics				
Propofol, mg	986 ± 277	813 ± 208	173 (77-269)	0.001
Remifentanil, µg	4,088 ± 1,354	3,565 ± 1,112	523 (45-1,002)	0.03
Morphine equivalents[b], mg	21 ± 7	21 ± 9	0 (-3-3)	0.84

CI = confidence intervals; OT = operating theatre; SD = standard deviation.
a) Analysis with unpaired t-test.
b) Include oxycodone and sufentanil in morphine equivalent doses. Equianalgesic doses vary in literature, and therefore the suggested dose in Danish guidelines at medicin.dk was used [14].

Furthermore, significant reductions were observed in time spent in the OT prior to surgery as well as the duration of anaesthesia before commencement of surgery (Table 4). Lastly, no significant changes were observed in the duration of surgery, emergence or the total time spent in the OT.

DISCUSSION

A simple protocol was introduced in patients undergoing elective ACL surgery with the intention of preventing patients from being unnecessarily anaesthetised prior to surgery. Implementation of the new protocol proved feasible (in 75% of patients) and produced a 22-minute reduction of the duration of anaesthesia owing to a reduction before commencement of surgery. Also, the protocol produced a 23-minute reduction of the PACU stay.

No differences in clinical outcomes were observed; neither in the frequency of PONV nor in other clinical parameters included in the PACU score, though previous studies have shown that duration of anaesthesia is associated with PONV [7-11]. However, scores on PONV and other clinical parameters were already low in both groups; thus, an inherited risk of type 2 errors exists.

It was expected that induction of total intravenous anaesthesia at a later stage in the work process would lead to a shorter duration of anaesthesia. However, the feasibility of the protocol, the magnitude of the reduction, and the effect on the PACU stay were unknown. The rationale for the protocol is obvious and may apply to other elective surgical procedures as well. The effect may be even larger when introduced in procedures with a longer duration of surgical preparations. Also, an opportunity may exist for economic benefits regarding quantities of anaesthetics, and, more importantly, reduction in the duration of the PACU stay, provided this constitutes a reduction of staff hours which constitutes the greatest cost in the PACU [15].

Implementing a change of workflow in the OT is an educational task that requires adjustment on the part of the staff. The new protocol affected the entire OT staff as it focused especially on teamwork for the protocol to be successful. Firstly, the staff had lessons introducing the new protocol, its workflow and possible significance. Secondly, reminders were visible within the OT. Thirdly, a focus on teamwork was stressed, as the protocol

required all staff being present in the OT from the start. This enabled the staff to remind each other of the new protocol and support each other. As the protocol did not affect the PACU care principles, the PACU nurses were not involved.

Previous studies have found that an increased duration of anaesthesia increases the duration of the PACU stay [4-6]. To our knowledge, however, only one previous study has investigated the effect of a similar approach (scrubbing and sterile covering before or after induction of anaesthesia). This study included patients undergoing open hernia repair [16]. In accordance with our findings, they reported shortened duration of anaesthesia, decreased use of anaesthetics, and a shorter PACU stay. However, the primary outcome was the need for vasoactive medication during anaesthesia (no difference was found), and the study was relatively small sized, like ours.

The present study has limitations that should be addressed. First, the study is a retrospective, single-centre study. Thus, it should be considered an explorative pilot only. Second, due to the retrospective nature of the study, anaesthesia was not strictly standardised. Even so, most patients were anaesthetised following an unchanged usual standardised practice. Third, the introduction of a new protocol is always associated with the risk of introducing bias. Staff might be more attentive of making the new protocol a success, thereby producing more positive results. However, the PACU nurses were not involved in the study; nor were they informed about the new workflow in the OT, and they used the usual PACU discharge criteria. Finally, the study had only short follow-up on clinical outcomes and did not include qualitative data on the patients' experiences.

Even so, we believe that the study may serve as an important reminder to clinicians of reducing the duration of anaesthesia whenever possible, and hopefully the study may stimulate further research on the topic.

CONCLUSIONS

A simple protocol by which total intravenous anaesthesia was induced immediately prior to surgical incision was feasible, reduced the duration of anaesthesia and yielded a significant reduction in the duration of the PACU stay in patients undergoing ACL surgery. Further studies with a randomised design are needed to confirm these preliminary findings.

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