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ORIGINAL ARTICLE

Neuraxial anesthesia for abdominal surgery, beyond the pandemic: a feasibility pilot study of 70 patients in a suburban hospital

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Abstract

The aim of this study is to establish the feasibility of awake laparotomy under neuraxial anesthesia (NA) in a suburban hospital. A retrospective analysis of the results of a consecutive series of 70 patients undergoing awake abdominal surgery under NA at the Department of Surgery of our Hospital from February 11th, 2020 to October 20th, 2021 was conducted. The series includes 43 cases of urgent surgical care (2020) and 27 cases of elective abdominal surgery on frail patients (2021). Seventeen procedures (24.3%) required sedation to better control patient discomfort. Only in 4/70 (5.7%) cases, conversion to general anesthesia (GA) was necessary. Conversion to GA was not related to American Society of Anesthesiology (ASA) score or operative time. Only one of the four cases requiring conversion to GA was admitted to the Intensive Care Unit (ICU) postoperatively. Fifteen patients (21.4%) required postoperative ICU support. A statistically non-significant association was observed between conversion to GA and postoperative ICU admission. The mortality rate was 8.5% (6 patients). Five out of six deaths occurred while in the ICU. All six were frail patients. None of these deaths was related to a complication of NA. Awake laparotomy under NA has confirmed its feasibility and safety in times of scarcity of resources and therapeutic restrictions, even in the most frail patients. We believe that this approach should be considered as an useful asset, especially for suburban hospitals.

Keywords Neuraxial anesthesia · Colorectal surgery · Complex surgery · Awake surgery · COVID-19

Introduction

With the outbreak of the coronavirus disease (COVID-19), on February 2020, there was a sharp reduction in the number of surgeries performed and the allocation of intensive care beds to patients needing acute care surgery became an increasingly difficult task [1]. On March 8 2020, the "Hub and Spoke" model was established in the hospitals of the Lombardy Region, the most affected region of Italy.

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Based on Lake Como (Lombardy), Valduce Hospital is a non-profit community hospital, serving a suburban district. Valduce Hospital (835 employees, 360 licensed beds, over 10,000 admissions per year) is a secondary health facility consisting of general surgical-medical Units (surgery, obstetrics and gynecology, cardiology, neurology, oncology, interventional radiology), and a center of rehabilitation.

Outlying hospitals serve suburbs and rural areas where access to resources can take longer and/or require heavy organizational effort, including the risks of travel. Furthermore, the constraints and scarcity of resources resulting from the pandemic have limited our therapeutic strategies and reshaped surgical indications [2].

Major abdominal procedures, generally carried out with minimally invasive surgery (MIS) under general anesthesia (GA), immediately suffered the potential MIS-related risks of contagion [3]. In addition, in frail elderly patients (characterized by impaired cardiovascular and respiratory reserves), pneumoperitoneum and GA would presumably have been associated with an increased risk of adverse outcomes and higher levels of use of resources [4].

Before the pandemic, at hour hospital, a small sample of frail patients requiring acute abdominal surgery had been treated with neuraxial anesthesia (NA), considering their decreased physiological reserve and their vulnerability to stressors. In our hands, NA appeared feasible, safe, and painless [5]. Therefore, in the early stages of the pandemic, even a small consecutive series of urgent and undeferrable surgeries was performed under NA in order to limit the risk of contagion in the operating room and, moreover, the number of postoperative admissions to the Intensive Care Unit (ICU) [6].

On the basis of these previous clinical experiences, even after the gradual reopening to elective surgery, we have continued to rely on this option, in case of frail patients requiring abdominal surgery, or temporary unavailability of ICU beds. The aim of this paper is to establish, through a series of 70 patients, the feasibility of NA for abdominal surgery in a suburban hospital.

Methods

Patients' recruitment

We carried out a retrospective study on all patients who had undergone awake surgery under NA at the Department of Surgery of our Hospital from February 11th 2020 to October 20th 2021.

Seventy patients (30 men, 40 women) were identified:

- Forty-three cases of acute care surgery were performed in 2020, during the early stages of the COVID-19 pandemic;
- Twenty-seven frail patients were operated in 2021 (6 of which were acute care surgeries) after the gradual reopening to elective surgery.

Inclusion/exclusion criteria for NA

Inclusion criteria: age ≥ 18 years, any Body Mass Index (BMI), any ASA score, any COVID-19 status, benign or oncological disease, elective or urgent surgery, any abdominal surgical procedure, written informed consent.

Exclusion criteria: pregnant women, emergency surgery, history of scoliosis or spinal deformity correction, degenerative spinal conditions, metastatic spinal disease, coagulopathy, concurrent use of anticoagulants, refusal of NA.

Anesthesiological and surgical procedures

In 2020, during the early stages of the pandemic, all patients requiring undelayable surgery due to abdominal urgencies underwent NA. In 2021, after the gradual easing of restrictions on surgery, and based on our experience of the previous year, NA was reserved for frail patients (considered unlikely to tolerate GA) whether urgent or elective.

The procedure was preoperatively explained to each patient. All patients and healthcare professionals involved wore personal protective equipment during all phases of each surgery.

NA was performed by two different anesthesiologists, both having considerable expertise in combined spinal-epidural (CSE), spinal anesthesia (SA) and epidural anesthesia (EA) [6]. The preferred technique for CSE at our Institution is the needle-through-needle technique (NTN) [7].

During all SA and CSE, the solution injected into the subarachnoid space had the following composition: Hyperbaric Bupivacaine 5 mg/ml (minimum dose: 2 ml, maximum dose: 2.3 ml) and Morphine Sulfate 10 mg/ml (minimum dose: 100 mcg, maximum dose: 150 mcg). During EA the solution injected into the epidural space had the following composition: Naropin 7.5 mg/ml (16 ml) and Morphine Sulfate 10 mg/ml (100 mcg).

Anesthesia was always assessed and judged adequate by pinprick prior to the start of surgery. Procedures were performed by two different surgeons with large experience in open surgery. In order to avoid aerosolization, cautery utilization was strongly limited, energy devices were used at their absolute lowest settings. When possible, Kelly clamps and heavy ties were preferred. Intraoperative and postoperative pain intensity has been monitored and regularly assessed through the use of the numeric rating scale (NRS).

Postoperative analgesia was managed with the placement of an Epidural Delivery System (EDS) in CSE and EA cases, and with the aid of an elastomeric pump (EP) in SA cases. EDSs were filled with a solution of sterile water (192 ml), Naropin 7.5 mg/ml (minimum dose: 100 mg, maximum dose: 150 mg) and Morphine Sulfate 10 mg/ml (minimum dose: 2 mg, maximum dose: 5 mg). EPs were filled with a solution of sterile water (60 ml), Morphine Sulfate (10 mg) and Ondansetron (8 mg) at an infusion speed of 2 ml/h. All EDSs and EPs were removed on postoperative day (POD) 3.

In order to prevent bleeding complications, anticoagulants were suspended (at different times on the basis of the specific anticoagulant) when possible. If needed, bridging heparin therapy was introduced. Low-molecular-weight heparin (LMWH) was introduced at least 12 h after surgery (if allowed by the patient comorbidities or clinical conditions) and taking surgical postoperative bleeding risk into account.

A separate postoperative recovery area was set up to keep patients with a certain or suspect diagnosis of COVID-19 separate from all other patients. Distinct "clean" and "COVID-19" wards were established.

Clinical chemistry tests and clinical parameters

Preoperative blood tests included complete blood count (for platelets count) and basic coagulation tests (prothrombin time, INR, activated partial thromboplastin time). In absence of complications, blood test controls were scheduled on POD 1, 4, 7.

In our clinical practice, frailty is determined as follows: patients over the age of 80, ASA score ≥ 3, affected by more than one major comorbidity (impaired cardio-respiratory function/end-stage renal or liver disease/diabetes/chronic progressive neurological disease).

As clinical parameters, we considered patients' medical history and perioperative results: surgical time, sedations, conversions to GA, NA-related complications, perioperative blood transfusions, postoperative admissions to the ICU, mean time for urinary catheter removal, mean time for first bowel movement (gas and feces) after operation, mean time for the first liquid intake and for the first solid food intake after the operation, early postoperative complications, mean postoperative length of stay (LOS), readmissions due to postoperative complications occurred after discharge.

The Clavien–Dindo (CD) classification was used to assess postoperative complications [8]. In case of multiple complications occurred in a single patient, the complication of higher grade was considered.

Statistical analysis

The statistical association between categorical variables was assessed by the Chi-square and the Cochran–Armitage tests. To compare groups for their possible differences in the average of quantitative parameters, the analysis of variance (ANOVA) was used.

Results

From February 11th 2020 to October 20th 2021, 70 patients (30 men, 40 women) with a mean age of 81.7 years (median 84, range 57–96), underwent awake surgery under NA at the Department of Surgery of our hospital (Table 1). Mean ASA score was 2.67 (standard deviation ± 0.58).

Surgery was performed in an acute care surgery regimen in 49 cases (70%). The included procedures are summarized in Table 2.

Mean operative time was 98.3 min (median 90, range 20–310). Surgery was performed under CSE in 25 cases,

Table 1 Summary of the results

Patients	
M:F	30:40 (43%:57%)
Mean age (range)	81.7 (57–96) y
Frail patients	27 (38.5%)
Surgery	
Surgery regimen	
Acute care surgery	49 (70%)
Elective surgery	21 (30%)
Mean operative time (range)	98.3 (20–310) min
Anesthesia	
ASA score, mean ± SD	2.67 ± 0.58
Type of neuraxial anesthesia	
CSE	25 (35.7%)
SA	21 (30.0%)
EA	24 (34.3%)
Sedations	17 (24.3%)
Conversions to GA	4 (5.7%)
Postoperative course	
Postoperative ICU admissions	15 (21.4%)
Overall postoperative complications	27 (38.5%)
Postoperative blood transfusions	16 (22.9%)
Demises	6 (8.5%)
Mean postoperative length of stay (range)	7.5 (2–18) d

CSE combined spinal-epidural anesthesia, d days, EA epidural anesthesia, GA general anesthesia, ICU intensive care unit, min minutes, SA spinal anesthesia, y years

Table 2 Summary of procedures performed

Surgery	Number of procedures performed
Hernioplasty (HP)	1
Cholecistectomies (C)	3
Ileal resections (IR)	2
Enterostomies (ES)	6
Subtotal gastrectomy (SG)	1
Cecum resections (CR)	3
Right colectomies (RC)	14
Transverse colon resection (TR)	1
Left colectomies (LC)	6
Sigmoid resections (SR)	5
Low anterior resections (LAR)	15
Lysis of adhesions (LOA)	4
Nephrectomies (N)	2
Hysterectomies with bilateral salpingo-oophorectomy (HBSO)	6
Unilateral oophorectomy (UO)	1

under SA in 21 cases, under EA in 24 cases. NA-related complications never occurred.

Seventeen procedures (24.3%) required sedation to better control the discomfort of the patient. Sedation was obtained through intravenous administration of Midazolam 15 mg/3 ml (minimum dose: 1 mg, maximum dose: 2 mg) and Propofol 10 mg/ml (minimum dose: 40 mg, maximum dose: 60 mg). The correlation between type of NA and sedation was not significant after the Cochran–Armitage test ($p = 0.85$).

In only 4/70 (5.7%) cases, conversion to GA was necessary due to patient inability to tolerate NA, procedural complications, hemodynamic instability and hypoxia. Among these cases, 4/49 cases (8.2%) occurred in an acute care regimen, compared to 0/21 (0%) cases in the elective regimen ($p = 0.178$, Chi-square test). The association between ASA score and conversion to GA was not significant after the ANOVA test ($p = 0.58$). Likewise, a significant relationship between operative time and conversion to GA was not detected after the ANOVA test ($p = 0.17$).

Postoperative pain, regularly assessed through NRS, always resulted well controlled. Ten patients (14.3%) required postoperative intravenous administration of Paracetamol 10 mg/ml (1 g every 8 h, for 24 h) because of NRS value higher than 3.

Fifteen patients (21.4%) required postoperative intensive care support. Thirteen of these procedures were being performed in an acute care regimen (13 of 49, 26.5%), while 2 procedures were being performed in an elective regimen (2 of 21, 9.5%) ($p = 0.112$, Chi-square test). The association between ASA score and postoperative ICU admission was not significant after the ANOVA test ($p = 0.051$). A significant relationship between operative time and postoperative ICU admission was not detected after the ANOVA test ($p = 0.6$). Likewise, the association between type of NA and postoperative ICU admission was not significant after the Cochran–Armitage test ($p = 0.78$).

A statistically not significant association between conversion to GA and postoperative ICU admission was observed ($p = 0.858$).

Sixteen patients (22.9%) required perioperative blood transfusion due to intraoperative major bleeding or postoperative severe anemia. The relationship between the variables daily antiplatelet/anticoagulant therapy and perioperative blood transfusion did not result significant ($p = 0.368$, Chi-square test).

Twenty-seven patients (38.5%) developed perioperative complications (Table 3). Mortality rate was 8.5% (6 patients).

The summary of the results, highlighting the distinction between urgent and elective cases, is described in Table 4.

Average first postoperative mobilization time was 1.4 days. Mean time for first liquid intake was POD 1.8 whereas the mean time for first solid diet intake was POD 3.1. Mean time for urinary catheter removal was POD 3.2. Mean time for the passage of first flatus was POD 2.9, mean time for first defecation was POD 4.8. Mean postoperative LOS was 7.5 days.

Table 4 Summary of the results: urgent vs elective cases

	No. of total cases	Urgent regimen	Elective regimen
Surgical procedures	70	49	21
Frail patients	27	6	21
Sedations	17	13	4
Conversions to GA	4	4	0
ICU admissions	15	13	2
Demises	6	4	2

Table 3 Summary of postoperative complications

Clavien–Dindo (CD) classification	Number of cases	Description
CD1	2	1 surgical site infection 1 surgical site dehiscence
CD2	18	1 urinary tract infection (treated conservatively) 1 abdominal collection (treated conservatively) 16 cases of perioperative blood transfusion
CD3	–	
CD4	1	Acute respiratory distress syndrome
CD5	6	3 cases of sepsis 1 pulmonary dysfunction 1 multiple organ failure syndrome 1 cardiac arrest (this patient underwent revisional surgery due to postoperative evisceration; the following course was further complicated by massive abdominal wall hematoma; shortly thereafter, the patient died due to sudden cardiac arrest)

Patients were always discharged in the absence of postoperative symptoms (e.g., dyspeptic symptoms, abdominal pain, urinary disorders, fever, laboratory abnormalities) and after first passage of stool. We did not register any cases of early readmission after surgery (within 72 h of discharge).

Discussion

During the early stages of the COVID-19 era, surgical procedures underwent an obligatory stop, due to the high contagiousness and rapid spread of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), but also due to the inadequacy of hospital facilities, unprepared to face to the need for "clean" and "dirty" paths, capable of allowing the continuation of activities [9, 10].

In this context, big debates about all aerosol-generating procedures (AGPs), like MIS and GA, fueled skepticism and fear [10, 11]. Compared to GA, NA has therefore been re-evaluated by many authors due to three of its peculiarities: the absence of aerosol production by the patient, the reduced need for prolonged ventilation or reintubation, the complete absence of postoperative delirium [12–14].

Given the perceived benefits of NA over GA, approximately half of the members of three American regional anesthesia societies have expanded their use of NA techniques during the COVID-19 pandemic [15]. In 2020, in the phase of major restrictions for surgery, we also took great advantage of NA which became part of an ICU-preserving strategy that also allowed for non-deferrable operations to be performed safely [6].

Precise management paths for surgical patients have contributed to the progressive reopening to elective surgery, accompanied by the reintroduction in the operating room of the AGPs [16–18]. In this regard, we must mention that in some referral centers, even laparoscopic operations under NA can be performed [19–22]. This requires continuous thoracic NA, which is not yet part of our usual clinical practice.

In 2021, however, the continuous succession of new coronavirus variants could still fuel surges with unpredictable consequences [23]. This kept the attention of healthcare administrators high, called to preserve hospital resources, limit the risk of contamination, and preserve the availability of ICU beds. With this in mind, we have continued to consider performing major abdominal surgery under NA in case of frail patients.

The statistical analysis of our results from February 2020 to October 2021 has highlighted some interesting insights.

In only 4 cases, conversion to GA was required. All these 4 cases were acute care surgeries. Accordingly, 13 out of 15 patients who required postoperative intensive care support underwent surgery in the acute care regimen. Furthermore, in our experience, neither the ASA score, nor the duration of the intervention itself, has been shown to be correlated with the conversion to GA or with the admission to the ICU. These results suggest a causal relationship between the criticality of the surgical regimen (understood as the urgency of decision-making and the subsequent continuous redefinition of priorities) and the intensity of both intraoperative and postoperative anesthesiological assistance. This analysis appears to identify elective patients as the best candidates for NA.

Furthermore, the results of the conversion rate to GA, deserve further thought: in all 4 cases of conversion to GA, the patients were affected by locally advanced colorectal cancer. Those operations (3 LAR, 1 LC), therefore, required a more meticulous and extensive demolition phase, together with a more extended mobilization of the residual colon. Prolonged traction and manipulation of the abdominal viscera (and thereby the mesentery), initially caused higher discomfort to the patient and, subsequently, may have elicited the mesenteric traction syndrome (MTS). MTS is characterized by a triad of hypotension, tachycardia, and facial flushing, and the trigger mechanism may be splanchnic hypoperfusion as a result of mesenteric traction or exploration of the abdominal contents during surgery [24, 25]. Further studies could investigate the role of specific surgical technical difficulties (e.g., higher BMI, smaller pelvis height in men, prolonged surgical demolition phase) on anesthesiological care.

A statistically not significant association between conversion to GA and postoperative ICU admission was observed: conversion to GA was usually associated with non-admission to the ICU while, conversely, patients who did not require conversion to GA were more often admitted to the ICU. In our opinion, these data can be partly justified by the criticality of the clinical cases and, in part, may be linked to the subjective experience of the anesthesiologist [26]. Two different anesthesiologists took part in this study; this must be counted among the limitations of this study. However, due to the small number of patients requiring conversion to GA, the association between ICU admission and conversion to GA is unclear. A larger study is needed to deepen our preliminary findings.

We furthermore investigated a possible conditioning of the results by the specific NA technique. In this regard, it is first of all necessary to specify that no case of complication related to NA has occurred. In the second instance, the association between type of NA and sedation was not significant, as was the association between type of NA and postoperative ICU admission.

Twenty-seven patients (38.5%) developed perioperative complications. We then performed a watchful analysis of the complications. In fact, if this percentage is certainly considerable, it is equally true that a more detailed analysis downsize these data. Two patients (2.8%) had surgical wound complications, 16 patients (22.9%) required perioperative blood transfusion, 2 patients (2.8%) required intravenous targeted antibiotic therapy (1 case of urinary tract infection, 1 case of abdominal collection), 1 patient (1.4%) developed a major respiratory complication, and 6 patients (8.5%) died. Five out of six deaths occurred while in the ICU. All six were frail patients. None of these deaths was related to a complication of NA.

In the present experience, although the surgeries took place under NA, the average times of mobilization, removal of the urinary catheter, intake of water/solid diet, passage of first flatus, first defecation, do not seem to deviate from our standards following similar surgical procedures, for similar diseases, performed under GA. However, since the present study did not include a control group of patients undergoing awake surgery under GA, this preliminary observation should only be considered as a starting point for future studies.

Moreover, although the surgical interventions took place in laparotomy, the average times of mobilization, removal of the urinary catheter, intake of water/solid diet, passage of the first flatus, first defecation, have not shown to deviate from our standards following similar surgical procedures performed via MIS, for similar diseases. Compared to MIS, however, the average LOS has appeared to be longer. A deep analysis of the differences between MIS, awake laparotomic surgery and awake MIS does not fall within the scope of this work and requires dedicated studies.

Some further limitations must be stated. Our evaluation of frail patients did not include a measure of comorbidity as a predictor of mortality. Baseline frailty is known to increase risk for postoperative complications, morbidity, hospital length of stay, and mortality after abdominal surgery [27]. However, a recent study comparing diverse indices of comorbidity revealed that none of the indices was sufficient to be used alone [28]. Given the complexity of geriatric cases, a new operative risk index should be developed jointly with the main surgical and geriatric scientific societies. We believe that a multidimensional geriatric assessment should be part of this indicator, as it would undoubtedly help risk stratification of elderly patients [29].

Compared with GA, NA may reduce mortality for patients with an intermediate-to-high cardiac risk [30]. Benefits of using NA rather than GA also include fewer life-threatening perioperative respiratory complications, especially in patients with pre-existing lung disease [31]. In this peculiar historical moment, it would be interesting to investigate and quantify the possible benefits deriving from awake surgery with regard to the limitation of airborne transmission of SARS-CoV-2, and subsequent contagions, in the operating room. Concerning postoperative neurocognitive decline in the elderly, the role of NA is yet to be ascertained. Randomized controlled trials on the difference in major outcomes between NA and GA are required.

Conclusions

Beyond the intrinsic limitations of awake laparotomic surgery, we want to document how, in our experience, NA has supported the continuation of acute care surgery in the first phase of the pandemic, reducing the need for postoperative management in the ICU.

Subsequently, NA has strengthened its potential role, confirming to be feasible and safe even in elderly and frail patients.

Faced with the possibility of further peaks in contagions, scarcity of resources or new therapeutic restrictions, this option could be adopted also in suburban hospitals to avoid new freezes in surgical activity.

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Dataset availability statement The dataset generated and analyzed during the present study is available from the corresponding author upon reasonable request.

Declarations

Conflict of interest The authors have no related conflicts of interest to declare.

Ethical approval All the procedures performed in this study were in accordance with ethical standards of the institutional and/or national health research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Research involving human participants and informed consent Informed consent was obtained from all individuals included in this study.

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