



ORIGINAL INVESTIGATION

Assessment of main complications of regional anesthesia recorded in an acute pain unit in a tertiary care university hospital: a retrospective cohort

Marta G. Campos *, Ana R. Peixoto, Sara Fonseca, Francisca Santos, Cristiana Pinho, Diana Leite

Hospital Universitário São João, Departamento de Anestesiologia, Porto, Portugal

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Abstract

Background: Regional anesthesia has been increasingly used. Despite its low number of complications, they are associated with relevant morbidity. This study aims to evaluate the incidence of complications after neuraxial block and peripheral nerve block.

Methods: A retrospective cohort study was conducted, and data related to patients submitted to neuraxial block and peripheral nerve block at a tertiary university hospital from January 1, 2011 to December 31, 2017 were analyzed.

Results: From 10,838 patients referred to Acute Pain Unit, 1093(10.1%) had side effects or complications: 1039 (11.4%) submitted to neuraxial block and 54 (5.2%) to peripheral nerve block. The most common side effects after neuraxial block were sensory (48.5%) or motor deficits (11.8%), nausea or vomiting (17.5%) and pruritus (8.0%); The most common complications: 3 (0.03%) subcutaneous cell tissue hematoma, 3 (0.03%) epidural abscesses and 1 (0.01%) arachnoiditis. 204 of these patients presented sensory or motor deficits at hospital discharge and needed follow-up. Permanent peripheral nerve injury after neuraxial block had an incidence of 7.7:10,000 (0.08%). The most common side effects after peripheral nerve block were sensory deficits (52%) and 21 patients maintained follow-up due to symptoms persistence after hospital discharge.

Conclusion: Although we found similar incidences of side effects or even lower than those described, *major* complications after neuraxial block had a higher incidence, particularly epidural abscesses. Despite this, other serious complications, such as spinal hematoma and permanent peripheral nerve injury, are still rare.

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* Corresponding author.

E-mail: u012891@chs.j.min-saude.pt (M.G. Campos).

Introduction

Regional anesthesia (RA) has been increasingly used and plays a prominent role in anesthesiologists' clinical practice. Many advantages are associated with better postoperative pain control, lesser systemic opioids need, diminishing nausea, pruritus and constipation, earlier bowel function recovery, more efficacious breathing, and easier participation in physical therapy.¹

Despite all the technological and pharmacological advances in RA's safety, side effects and complications occur. The increasing prevalence of risk factors for nerve injury, like obesity, diabetes, potent anticoagulants, and the increasing use of continuous catheter-based peripheral nerve blocks (PNB) may alter the rate of neurological complications.² These may range from transient neurological symptoms, urinary retention, nausea or vomiting (NV) to peripheral nerve injury (PNI), central nervous system (CNS) infections, local anesthetic (LA) toxicity, or post-dural puncture headache (PDPH). Spinal cord injury, hematoma or epidural abscess (EA) are rare events, but can become devastating.^{3,4} Despite PNI after RA is rare in contemporary anesthetic practice, the real serious complications incidence after RA is still uncertain: there are few recent studies and few include PNB; there are inconsistencies in multicenter data collection and there is a variation in the complications rate between hospitals.^{2,5} Accurate data on risk factors and clinical course are also not available and, consequently, there is no evidence on management strategies recommendations.

Acute Pain Units (APU) promotes individualized care in acute pain after surgery, diagnostic procedures, trauma, or medical diseases. They play a key role in pain management and prevention or treatment of side effects and complications related to the techniques.

This study aims to evaluate the main RA complications managed by an APU of a tertiary university hospital.

Methods

Study design and settings

After Ethics Committee approval, a retrospective database analysis of all APU patients from January 1, 2011 to December 31, 2017 was conducted. Clinical data for patients submitted to neuraxial block (NB) and PNB with recorded side effect or complication was collected and analyzed. Pregnant women undergoing labor analgesia, patients under 18 years of age or undergoing other unconventional postoperative systemic analgesia were excluded.

Data collection

Demographic data such as gender, age, weight, height, comorbidities, usual medication, and physical status were collected according to the American Society of Anesthesiologists Physical Status (ASA-PS). Anesthetic technique data were collected from the intraoperative period records; Technique side effects, which are unwanted but generally predictable and expected events, or complications, defined

Table 1 Demographic data of patients with reported side effects or complications.

Age, median (IQR), years	61 (50–69)
Weight, median (IQR), kg	70 (60–80)
Height, median (IQR), cm	163 (160–170)
ASA-PS, n (%)	
Class I/II	803 (77.3%)
Class III/IV	290 (27.9%)
Major comorbidities, n (%)	
Diabetes Mellitus	167 (15.3%)
Heart disease	87 (8.0%)
Malignant disease	66 (6.0%)
Chronic kidney disease	44 (4.0%)
Atrial fibrillation with hypocoagulation	31 (2.8%)
Transplant history	7 (0.6%)
Inflammatory bowel disease	7 (0.6%)
HIV	5 (0.5%)
Surgery, n (%)	
Elective	1003 (91.7%)
Urgent	90 (8.2%)
Hospital service, n (%)	
Orthopedics	458 (41.9%)
General surgery	221 (20.2%)
Vascular surgery	170 (15.6%)
Urology	100 (9.1%)
Plastic surgery	53 (4.8%)
Gynecology	45 (4.1%)
Thoracic surgery	21 (1.9%)
Neurosurgery	16 (1.5%)
Intensive care unit	8 (0.7%)
Infectious disease	1 (0.1%)

ASA-PS, American Society of Anesthesiologists physical status; HIV, human immunodeficiency viruses; SD, standard deviation; CSE, combined spinal epidural.

as unexpected events but recognized as possible, were recorded from the postoperative period.

Statistical methods

Statistical analysis of data was performed using the Statistical Package for Social Sciences (SPSS) version 26.0. The descriptive analysis of the variables was used to summarize the data. Ordinal and continuous data did not follow a normal distribution, based on the Kolmogorov-Smirnov test for the normality of the study population. Categorical variables were described as frequency rates and percentages and continuous variables were described using median and interquartile range (IQR) values.

Results

Between January 1, 2011 and December 31, 2017, 10,838 patients were referred to APU with 32,184 consultations. Demographic data of patients with reported side effects/complications are shown in Table 1. There were 9122 NB and 1041 PNB performed. Of these, 1039 (11.4%) submitted to NB and 54 (5.2%) to PNB had side effects or complications, according to Table 2.

Table 2 Anesthetic/analgesic techniques performed in patients with reported side effects or complications.

	Total	Side effects / Complications
Neuraxial block	9122	1039 (11.4%)
CSE	4425 (48.5%)	396 (8.9%)
Epidural	4241 (46,5%)	592 (14.0%)
Spinal	456 (5.0%)	51 (11.2%)
Peripheral nerve block	1041 (11.4%)	54 (5.2%)
Femoral nerve block	101 (9.7%)	8 (7.9%)
Sciatic nerve block	48 (4.6%)	5 (10.4%)
Interscalene brachial plexus nerve block	416 (40.0%)	21(5.0%)
Axillary brachial plexus nerve block	422 (40.5%)	20 (4.7%)
Others	54 (5.2%)	-

CSE, combined spinal epidural.

Table 3 Side effects and/or complications reported in patients undergoing NB.

	Epidural (n = 4241)	CSE (n = 4425)	Spinal (n = 456)
Neurologic			
Sensory deficit	288 (6.8%); 2 days (1–3)	177 (4.0%); 2 days (1–3)	39 (8.6%); 1 day (1–3)
Motor deficit	78 (1.8%); 2 days (1–3)	39 (0.9%); 2 days (1–3)	6 (1.3%); 1 days (1–2)
Spinal pain	19 (0.4%); 12 days (3–20)	14 (0.3%); 3 days (2–8)	2 (0.4%); 2 days (1–4)
PDPH	5 (0.1%); 3 days (1.5–4)	14 (0.2%); 4 days (2–5)	4 (0.9%); 2 days (1–3)
Tinnitus	2 (0.05%); 3 days (1–4)	-	-
Subcutaneous cell tissue hematoma	1 (0.02%)	2 (0.05%)	-
Epidural abscess	1 (0.02%)	2 (0.05%)	-
Arachnoiditis	-	1 (0.02%)	-
Drug related			
Nausea or vomiting	95 (2.2%); 2 days (1–3)	87 (2.0%); 2 days (1–3)	-
Pruritus	43 (1.0%); 1 day (1–2)	40 (0.9%); 1 day (1–3)	-
Sedation	28 (0.7%); 3 days (1–4)	4 (0.09%); 2 days (1–4.5)	-
Urinary retention	9 (0.2%); 1 day (1–2)	8 (0.2%); 1 day (1–2)	-
Respiratory depression	3 (0.07%); 3 days (2–3)	-	-
Metallic flavor	5 (0.1%); 7 days (2–8)	-	-
Perioral paresthesias	2 (0.05%); 6 days (2–7)	-	-
Cardiovascular			
Hypotension	13 (0.3%); 1 day (1–2)	8 (0.2%); 1 day (1–3)	-

N (%); Median days of onset of symptoms after placement of epidural catheter (IQR).

NB, neuraxial block; CSE, combined spinal epidural; PDPH, post-dural puncture headache.

Neuraxial block

During the study period, 1039 patients submitted to NB (11.4%) reported side effects or complications (Table 3). Before performing the RA, 276 of these patients (26.6%) were anticoagulated with enoxaparin at a prophylactic dose with a median suspension time of 14 hours (IQR, 12–16 hours; range 10–36 hours); and 32 (3.1%) at a therapeutic dose with a median suspension time of 25 hours (IQR, 24–28 hours; range 23–42 hours).

In 95.1% of the patients with side effects/complications, the anesthetic/analgesic technique was NB (Table 2): 78.7% lumbar and 21.3% at thoracic level. From those 988 (95.1%) maintained the epidural catheter (EC) for postoperative analgesia. Ropivacaine (0.1%, 0.15% and 0.2%) was the predominant LA (97.8%) for epidural infusion.

Median EC length of stay for patients with side effects/complications was 5 days (IQR, 3–6 days; range, 1–67 days). Signs of infection at the EC insertion point were found in 53 (5.4%), which had a median length of EC stay of 7 days (IQR, 5–11.5 days; range, 2–23 days). The catheter tip microbiological study is presented in Table 4. A patient has died due to refractory septic shock with multiorgan failure, starting on an infected orthopedic prosthesis.

According to APU's protocol, if there are severe, persistent, or worsening neurological deficits, a CNS image study, Magnetic Resonance Imaging (MRI) when clinical situation allows, is performed: Computed Tomography (CT) was performed in 13 patients and MRI in 3. The diagnosis of subcutaneous cell tissue hematoma, EA and arachnoiditis was made in 7, as described in Table 5.

Of the 627 patients with sensory or motor deficits after NB, 204 (32.5%) maintained persistent neurological deficits

Table 4 Type of EC withdrawal from patients with reported side effects or complications and microbiological study result of EC tip.

Removed according to APU protocol	913 (92.4%)
Accidental exteriorization	20 (2.0%)
Signs of infection at the EC insertion point	53 (5.4%)
Microbiological study of EC tip:	
Negative	21 (40.4%)
<i>Staphylococcus epidermidis</i>	10 (19.2%)
<i>Staphylococcus aureus</i>	5 (9.6%)
<i>Klebsiella pneumoniae</i>	4 (7.7%)
<i>Methicillin-resistant Staphylococcus aureus</i>	3 (5.8%)
<i>Pseudomonas aeruginosa</i>	3 (5.8%)
Polymicrobial	2 (3.8%)
<i>Staphylococcus capitis</i>	1 (1.9%)
<i>Staphylococcus haemolyticus</i>	1 (1.9%)
<i>Staphylococcus hominis</i>	1 (1.9%)
<i>Proteus mirabilis</i>	1 (1.9%)
Removed at the operating room	1 (0.1%)
Removed after death	1 (0.1%)

EC, epidural catheter.

at hospital discharge. Sixteen patients with neurological deficits and pain before surgery were referenced to chronic pain unit (CPU) and 56 patients to telephone surveillance: follow-up was lost in 4; 48 had early symptoms' resolution, on average until 5 days after hospital discharge; 4 were referred for APU's ambulatory consultation. The remaining 132 patients were directly sent to APU's ambulatory consultation. Of these patients, 13 (9.6%) underwent electromyographic (EMG) study: 7 had PNI, requiring continuous follow-up in APU and physical rehabilitation medicine (PRM).

Patients with subcutaneous cell tissue hematoma had complete neurological symptoms resolution before hospital discharge. Arachnoiditis patient was sent to APU's ambulatory consultation with sensory deficits and spinal pain, with complete resolution 8 months after the diagnosis. The 3 EA patients were surgically approached for emergent decompression on average 8 hours after MRI confirmation. After hospital discharge, follow-up included PRM and APU's ambulatory consultation. Only one had complete resolution of neurologic symptoms.

Peripheral nerve block

During the study period, 54 patients submitted to PNB (5.2%) reported side effects/complications, described in Table 6. Of these, 26.0% (n = 14) had continuous regional postoperative analgesia during a median of 1 day (IQR, 1–4 days; range 1–6 days). All catheters were removed according to APU's protocol.

Sensory deficits were the main side effects and 21 patients maintained follow-up due to persistent symptoms after hospital discharge: 16 of them were evaluated by telephone with complete early symptoms resolution and 5 were directly managed at APU's ambulatory consultation. Two patients with persistent sensory deficits performed EMG study: one was submitted to femoral block without evidence of nerve damage; the other to interscalene brachial plexus block and revealed persistence of neurologic deficits with

Table 5 Description of patients with severe neuraxis complications.

	Age	ASA-PS / Relevant medical history	Surgery	Anesthetic technique/Number of attempts	EC length of stay (days)	Symptoms (days after EC placement)	EC tip – Microbiologic study	Treatment
Epidural abscess	39	II / Inflammatory Bowel Disease	Major digestive	Lumbar Epidural / 3	3	Spinal pain and fever (D4), sensory deficit (D12)	MRSA	Antibiotic and neurosurgical decompression
	65	IV / Heart Transplant; DM	Major orthopedic	Lumbar CSE / 4	13	Spinal pain (D13), sensory and motor deficits (D33)	MRSA	
	61	II / Prostate cancer; DM ^a	Peripheral vascular	Lumbar CSE / 3	6	Spinal pain and fever (D11)	Negative	
Subcutaneous cell tissue hematoma	62	III / DM; HF	Major orthopedic	Lumbar CSE / 1	16	Spinal pain and inflammatory signs (D11)	Negative	Antibiotic
	70	III / CRD; HF	Major orthopedic	Lumbar CSE / 1	5	Spinal pain and inflammatory signs (D14)	MRSA	Antibiotic
	62	III / Epilepsy; Malignant disease	Major digestive	Lumbar Epidural / 2	4	Sensory and motor deficits (D4)	Not applicable	Surveillance
Arachnoiditis	69	III / Obesity	Peripheral vascular	Lumbar CSE / 3	5	Spinal pain and sensory deficits (D13)	Negative	Antibiotic

ASA-PS, American Society of Anesthesiologists Physical Status; CRD, chronic renal disease; CSE, combined spinal epidural; DM, diabetes mellitus; EC, epidural catheter; HF, heart failure; MRSA, methicillin-resistant staphylococcus aureus.

^a Patient with Methicillin-resistant Staphylococcus aureus (MRSA) bacteremia sepsis.

Table 6 Side effects and/or complications reported in patients undergoing PNB.

	PNB (n = 1041)
Sensory deficit	51 (4.9%); 1 day (1–2)
Motor deficit	18 (1.7%); 1 day (1–3)
Nausea or vomiting	9 (0.9%); 1 day (1–1)

N (%); Median days of onset of symptoms after placement of peripheral catheter (IQR).
PNB, peripheral nerve block.

inconclusive EMG study after 12 days; A posterior MRI showed a pseudomeningocele, requiring continuous PRM and CPU follow-ups.

Discussion

RA's complications decreased in recent decades mainly due to technological and pharmacological advances, better patients' selection and greater attention in timely complications diagnosis. Permanent neurologic complications are effectively rare but also underreported probably due to lack of surveillance or symptoms recognition, so it's extremely difficult to obtain reliable and consistent incidence data.^{3,4}

Complications/ Side effects after NB

According to Cameron et al. in 2009, the risk of developing a serious complication after NB was 1:35,000.⁶ In 2018 a higher incidence of *major* adverse neuraxial events related to epidural analgesia in non-obstetric patients, 1:6000 to 1:1000, was described.^{5–7} In this study, from a single center, we found an incidence of NB *major* adverse events of 1.5:1000.

Neurologic complications

Sensory and motor deficits

As described in the literature, sensory (48,5%) and motor deficits (11.8%) were the most frequent side effects related to NB in our study. Paresthesia had an overall incidence of 5.5% and it was more frequent after spinal block (8.6%) then epidural (6.8%) or combined spinal epidural (CSE) blocks (4.0%). Paresthesia is frequently described during NB technique (6.3%) but if occurs during needle or catheter placement, there is an increased risk of permanent lesion.^{8–10} These techniques' details weren't collected in our database. New motor block after NB assessed by the modified Bromage scale¹¹ had a global incidence of 1.4% after NB (1.8%, 1.7% and 0.9% after epidural, spinal and CSE blocks, respectively).

Neurologic deficits may result from neural or vascular damages, ischemia, or drug-related neurotoxicity.^{3–5} Although most LA in clinical doses does not cause nerve damage, prolonged exposure, higher doses, or concentrations may be deleterious. LA neurotoxicity is most associated with intrathecal lidocaine, mepivacaine and prilocaine.⁴ None of these LAs were used in our patients.

The majority of sensory/motor deficits were temporary and 67.5% of our patients had complete resolution before hospital discharge. The remaining (32,5%, n = 204) and who had follow-up by APU (n = 200), 83.5% (n = 167) had early symptoms resolution until 3 months after discharge and 5% (n = 10) between 3 months to 1 year. We recorded an incidence of 7.7:10,000 (0.08%) of new permanent PNI after NB, documented by EMG study, similar to the literature: Horlocker et al. point an incidence of permanent neurological damage after NB from 0-8:10,000 cases and Naithani et al. between 0–0.16% after spinal and epidural anesthesia.^{8,9}

The 16 patients referred directly to the CPU had neurological deficits or pain previous to surgery. Pre-existing spinal condition or other neurological diseases are known to increase the incidence of postoperative neurological complications.^{4,12}

Transient neurologic symptoms (TNS) have a variable incidence, up to 37% after spinal block.¹³ It is characterized by lumbar/gluteal pain that can irradiate for legs, usually without neurologic deficits.^{10,14} Cauda equina syndrome (CES) is an unusual (1:33,000 to 1:100,000) and severe complication of NB induced by sacral roots damage.^{8,14} It presents with lumbar pain, lower extremities neurologic deficits, sexual, intestinal and vesical sphincter dysfunctions.¹⁰ According to the deficits presented in this study, without bladder, sexual or intestinal disfunction and with early recovery in the majority, CES or TNS are a rare complication not detected in our database.

PDPH

It remains a common complication after NB. Its prevalence is about 1% in non-obstetric population.^{4,7} PDPH is due to cerebrospinal fluid (CSF) loss through a leak in the meninges and headache results from intracranial support loss, with traction and pressure on pain-sensitive structures and cerebral vasodilatation.¹⁵ In our study, a 0.3% incidence of PDPH after NB was documented: 61% submitted to CSE block, 22% to epidural block and 17% to single-shot spinal block. Related symptoms, like diplopia and tinnitus, were recorded. Almeida et al. reported higher rates of PDPH by inexperienced providers and residents.^{15,16} Given the university hospital context of our hospital, a higher headache prevalence would be expected. Age or prolonged immobilization of our patients may be the cause of these results.

According to the risk factors described, young females are at increased risk of developing PDPH and our data also showed a higher incidence (74%; median of 49 years). Higher needle size and tip design are the most important procedural factors.¹⁵ In our patients, PDPH occurred mostly after CSE blocks, which were performed using the available kit at the hospital – 18G Touhy epidural needle and 27G pencil point tip spinal needle. Only in two cases were used, as a rescue, larger and beveled spinal needles (22G and 25G); In 50% and 43% of cases, respectively, the epidural and subarachnoid spaces were reached after more than one attempt. The accidental dural puncture with 18G Touhy epidural needle was only reported in two cases. In the literature, approximately 50% of cases resolve spontaneously within 5 days and in 90% of cases in 10 days.¹⁰ All cases of our study resolved with prophylactic approaches, maximum at 7th day.

Infection

The development of major CNS infections may range from 1:6000 to 1:1000 in epidural procedures.⁴ In this study, EC's insertion point infection was clinically evident in 0.6% of patients, which presented a median length of EC stay of 7 days (IQR, 5–11.5 days; range, 2–23 days). EC tip microbiological study was positive in 60% of these cases although we do not do this exam by routine.

The incidence of EC tip colonization varies from 0% to 55% in the literature. According to our and several other studies, despite colonization of the EC tip, epidural space infection is uncommon, and the presence of positive tip culture is not a reliable predictor of infection. Thus, routine culture of EC may not be indicated.¹⁶ According to APU protocol, patients with positive microbiological study and no symptoms are followed-up in ambulatory consultation during a minimum of 12 months.

Positive microbiological EC tip is mainly due to *Staphylococcus epidermidis*, human skin commensal, and *Staphylococcus aureus*, resulting from probable tip contamination. Harde et al. identified the same microorganism in skin swab and EC tip cultures performed in the same patient, showing a significant correlation between bacterial colonization of the skin around the EC's insertion site and its tip.¹⁷

Infection of CNS depends on several maneuvers, since the EC's placement until its removal: sterile dressing, skin disinfection, LA solution or catheter handling, removal and ward handling protocols.^{9,17} Although we do not have data about patient skin wash, disinfectant solution type neither disinfection times, according to our protocol, we should do skin wash with neutral solution, skin disinfection with 10% povidone iodine nonalcoholic solution with adequate drying times.

Patients with *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* on EC tip had respiratory and urinary tract infections with the same organism isolated, according to certain studies about the possibility of hematologic spread through the spinal cord from the remote side.¹⁷

Epidural abscess (EA)

EA can be neurologically devastating if unrecognized. According to data reviewed by The Second ASRA Practice Advisory on Neurologic Complications Associated with RA and Pain Medicine in 2015, EA has an incidence of 13 in 1.7 million NB. Cook et al. described an incidence of 1:40,000 to 1:100,000 NB.^{4,18}

In our study, the EA incidence was higher: 1:3040 (0,03%). This may be a consequence of a greater monitorization performed in our hospital since 2007, with APU patients' referral, but also probably due to the lack of protocols related to the entire process of regional technique: from its execution to the EC's removal in the ward.

Patients with EA were immunocompromised, namely with malignancy, history of heart transplantation, inflammatory bowel disease under chronic corticotherapy or diabetes mellitus. These are in line with previous studies that point these as risk factors. Difficulty in EC's placement often leads to an asymptomatic epidural or subcutaneous hematoma which also allows for infection proliferation.^{7,10,18,19} According to

the APU's data, two patients with EA had a record of moderate difficulty in EC's technique.

Catheterization length of stay is also an important risk factor: several studies reported EA development after an EC stay of at least 3 days.^{7,9} In this study, only one (0,7%) of the 140 patients (13,5%) who maintained the EC for more than 7 days, developed EA. The others maintained the EC for a median of 3 days. What's the infection cause: the length of EC stay? EC and drugs handling in the ward? EC's placement/removal techniques?

NB in patients with previous or coexisting infection is a controversial issue.¹⁹ During the study period, 327 patients with EC admitted in the intensive care unit (ICU) were assessed by APU: 148 with sepsis or bacteremia during hospitalization and only one developed an EA. There were no reports of other *major* neurological complications. The incidence of epidural analgesia in critically ill patients remains poorly investigated, despite its benefit on pain control, pulmonary function, ventilatory weaning, intestinal, cardiovascular and immune functions. ICU patients may present relative contraindications to NB, such as coagulation disturbances, severe hypovolemia, hemodynamic instability, neurological assessment, and technical difficulties. However, the risk-benefit balance of epidural analgesia may be favorable. More prospective studies should be carried out to evaluate NB risk factors and complications in critically ill patients.

Two of the three patients with an EA had Methicillin-resistant *Staphylococcus aureus* (MRSA) isolation at EC's tip: one was an older patient, with MRSA bacteremia, secondary to orthopedic prosthesis infection; the other was a young individual with inflammatory bowel disease submitted to abdominal surgery, without evidence of systemic infection in the postoperative period.

All patients diagnosed with EA were submitted to emergent surgical decompression on median 8 hours (IQR, 6–11 hours; range, 6–11 hours) after MRI confirmation, and started immediately intravenous empirical antibiotic therapy. Several studies found favorable neurological outcomes in patients treated within the first 12 hours from symptoms onset.⁹ After hospital discharge, our patients were observed in ambulatory APU consultation during a minimum of one year. After this period, the youngest patient had complete resolution of the symptoms and the other two were referred to CPU due to the persistence of sensory deficits and low back pain, although without significant functional disability.

Spinal hematoma (SH)

SH is particularly catastrophic as it may go unnoticed until there is permanent neurologic compromise.²⁰ The incidence of SH in patients undergoing NB is extremely variable. A study carried out in Sweden between 1990 and 1999 showed a rate of 1:3600 to 1:29,000 in patients undergoing orthopedic surgery.²¹ ASRA described in 2015 an incidence of epidural hematoma of 33 in 1.7 million NB.⁴

Female gender, increased age, spine's anatomical abnormalities, changes in hemostasis during NB, or catheters' removal and traumatic spinal puncture/ EC placement are considered risk factors.^{7,10} In this study, there were 3 cases of subcutaneous cell tissue hematoma, probably due to moderate difficulty in EC's placement, but development

of SH was not evident. A vast majority (92.4%) of EC were placed and removed according to the APU's protocol, respecting hypocoagulation suspension times and normal analytic results. Accidental displacement rate of EC was only 0.23%. Some researchers reported that one-third of all SH occurred in patients in the absence of any previously known risk factors, respecting thromboprophylaxis suspension times. Therefore, adherence to guidelines regarding hypocoagulation, anti-aggregation and NB may reduce, but not completely extinguish its occurrence.⁵⁻⁸

Arachnoiditis

Adhesive arachnoiditis can be a severe complication of NB and with incidence reports between 1:10,000 to 1:25,000.²³ This diffuse inflammatory meninx reaction to injurious stimulus results in subarachnoid scarring. It may be associated with alcohol-containing antiseptic solutions and is rarely related to EC *per se*.^{7,22} Because of the varied symptomatology, clinical diagnosis can be difficult, and the number of cases can be underestimated.⁹ In our study, we only recorded one case of arachnoiditis (0,01%). The course of arachnoiditis commonly starts slowly and include back pain, decrease in muscle strength and changes in lower extremities and perineum sensitivity. Critical cases can lead to bladder and intestinal dysfunction or complete paraplegia.²³ In our study, the patient was submitted to CSE block in the operating room for vascular surgery. In the ICU postoperative period, due to a non-functioning EC, a new one was placed on the 3rd postoperative day. After 5 days, the EC was removed and 5 days later the patient developed persistent low back pain and sensory deficits in the lower limbs. The diagnosis of arachnoiditis was performed through MRI. The patient was followed-up in APU's ambulatory consultation with complete resolution of the deficits in about eight months later.

Drug-related side effects

Nausea and/or vomiting

It was the most frequent complaint recorded and it affected 2.1% of all patients submitted to NB. Prospective studies reported postoperative retching and vomiting in 11.1% of patients after spinal anesthesia. There are several patients, anesthetics, and surgical factors that influence their incidence and severity.²⁴ Spinal anesthesia does not always reduce NV compared to general anesthesia (GA) possibly because of hypotension, intrathecal opioid additives, or sympathetic blockade, resulting in a vagally mediated over-activity of the gastrointestinal system.¹

Hypotension

Of the patients submitted to epidural analgesia in the postoperative period, 0.23% reported hypotension episodes. The injected LA leads to vasodilatation by affecting sympathetic efferences, with temporary sympathicolysis, blood pressure fluctuation and hypotension. This can also be related to the LA's concentration and method of administration, with higher concentrations and bolus regimens being more often associated with hypotension episodes than infusions.^{24,25}

Pruritus

It can be troublesome neuraxial opioids side-effect. We recorded an incidence of 0.9%, which is smaller than the reported in several studies: 83% in postpartum patients; 69% in non-pregnant patients including males and females; and 30% to 60% after intrathecal opioid for orthopedic surgery.²⁶ In fact, in the majority of epidural analgesia cases sufentanil was the opioid of choice and actually pruritus, invoked by lipid-soluble opioids, is of shorter duration, which can underestimate the cases.²⁶

Urinary retention

In this study we only report an incidence of evident urinary retention in 0.18% of patients submitted to NB. The majority of patients with EC can experience urinary retention, but in our center they usually remain with a bladder catheter in the postoperative period. Postoperative urinary retention can result from intraoperative damage of the pelvic autonomic nerve, use of sympathomimetic and anticholinergic drugs and stress-induced activation of inhibitory sympathetic reflexes. Type and length of surgery, intraoperative fluid management, early postoperative ambulation and previous history of micturition problems could play a more important role in immediate postoperative urinary retention than the type of postoperative pain control.^{1,27}

Complications/ Side effects of PNB

In the early postoperative period, mild paresthesia may be present in up to 15% of patients that undergo PNB.⁴ In this study, 4.9% (n = 51) of patients submitted to PNB complained of an early sensory deficit, on median 1day after the technique. Motor deficits were present in 1.7% (n = 18).

After hospital discharge, only 30.4% (n = 21) had prolonged sensory or motor deficits, but as in the literature, most of these symptoms disappear within days to weeks.^{4,28} Our patients were evaluated by telephone or ambulatory consultation within one month and 72.6% of cases had complete deficits' resolution within the first week; the remaining until 2 months. There was only one case of persistent sensory deficits one year after surgery, due to a pseudomeningocele, with follow-up in CPU. The patient was submitted to shoulder surgery under interscalene plexus block. These arthroscopic surgeries are associated with PNI, ranging from 0.1% to 10%, mainly caused by surgical traction to improve exposure or by arthroscopic portal placement.⁴ Pseudomeningoceles are more frequent after forceful distraction, causing neuropraxia and tears in the dura and arachnoid mater with CSF leak, usually self-limited and asymptomatic. Occasionally, CSF may accumulate in the supraclavicular tissues and cause local pain and symptoms related to liquid hypotension in orthostatism.²⁹

Similar to neuraxial injury PNI is commonly linked to needles' or catheters' trauma, ischemia or drug toxicity. It is also associated with patient factors like advanced age, extreme biotypes, history of chemotherapy, diabetes mellitus or previous neurologic disease. Surgical technique with retractor stretches, direct nerve injury, compressive dressings, use of tourniquets, improper or prolonged positioning, are also important factors.^{4,28}

In a large prospective study of Neal et al., serious PNI are reported in 2.4:10,000 PNB and Auroy et al. described permanent neurologic complications in 1.5:10,000 cases.^{4,12}

Theoretically, recent studies showed that nerve location with ultrasound increased the rate of successful PNB compared with electrical stimulation and reduced the rate of vascular puncture.³⁰ In future studies, it would be equally important to record the type of technique used for PNB.

The small number of complications associated with PNB may be due to our small sample. However, PNB are increasing in our hospital and surveillance of these patients by APU will allow us to follow-up its rare but possible complications.

In general, all candidates for RA should be rigorously evaluated and informed of any potential side effects or complications of these techniques and the decision to perform it must be made on an individual basis considering its benefits and the risk factors for complications. The APUs are fundamental in monitoring, following-up and guiding the treatment of patients with complications, and in the future will serve as a link between hospitals and primary health care to define the most appropriate therapeutic strategies. They can also provide useful information and education to health care providers, patients, and tutors. In this new era, in which APUs exist in all national hospitals, we need to carry out more frequent and rigorous audits, which allow us to better monitor the frequency and severity of each RA's complications.

Despite this, we recognize some limitations of our study, namely due to its retrospective character with recording and information bias such as the lack of data in the APU's electronic records related to the anesthetic technique, disinfection type and complications registration.

Conclusion

Although we found incidences of side effects similar or even lower than those described in the literature, *major* adverse events/complications after NB had a higher incidence, with particular emphasis on EA cases. Despite this, other serious complications, such as SH and permanent PNI, are still rare.

Conflicts of interest

The authors declare no conflicts of interest.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.bjane.2021.03.011>.

References

- Hutton M, Brull R, Macfarlane A. Regional Anaesthesia and outcomes. *BJA Education*. 2018;18:52–6.
- Brull R, McCartney C, Chan V, et al. Neurological complications after regional anesthesia: contemporary estimates of risk. *Anesth Analg*. 2007;104:965–74.
- Kent C, Bollag L. Neurological adverse events following regional anesthesia administration. *Local Reg Anesth*. 2010;3:115–23.
- Neal JM, Barrington MJ, Brull R, et al. The Second ASRA Practice Advisory on Neurologic Complications Associated with Regional Anesthesia and Pain Medicine: Executive Summary 2015. *Reg Anesth Pain Med*. 2015;40:401–30.
- Pitkanen M, Aromaa U, Cozanicis D, et al. Serious complications associated with spinal and epidural anaesthesia in Finland from 2000 to 2009. *Acta Anaesthesiol Scand*. 2013;57:553–64.
- Cameron C, Scott D, McDonald W, et al. A Review of Neuraxial Epidural Morbidity: Experience of More Than 8,000 Cases at a Single Teaching Hospital. *Anesthesiology*. 2007;106:997–1002.
- Bos E, Haumann J, Quelerij M, et al. Haematoma and abscess after neuraxial anaesthesia: a review of 647 cases. *Br J Anaesth*. 2018;120:693–704.
- Horlocker TT, Wedel DJ. Neurologic complications of spinal and epidural anesthesia. *Reg Anesth Pain Med*. 2000;25:83–98.
- Naithani U, Verma D, Rajkumar S, et al. Lower limb weakness and paresthesia after combined spinal epidural anesthesia for abdominal hysterectomy: a report of three cases. *Anaesth Pain Intensive Care*. 2015;19:187–91.
- Ganem E, Castiglia Y, Vianna P. Spinal Anesthesia-induced Neurological Complications. *Rev Bras Anesthesiol*. 2002;52:471–80.
- Breen TW, Shapiro T, Glass B, et al. Epidural anesthesia for labor in an ambulatory patient. *Anesth Analg*. 1993;77:919–24.
- Hebl JR, Horlocker TT, Kopp SL, et al. Neuraxial blockade in patients with preexisting spinal stenosis, lumbar disk disease, or prior spine surgery: efficacy and neurologic complications. *Anesth Analg*. 2010;111:1511–9.
- Auroy Y, Benhamou D, Bargues L, et al. Major Complications of Regional Anesthesia in France. *Anesthesiology*. 2002;97:1274–80.
- Markey J, Osama N, Bird D, et al. Transient Neurologic Symptoms After Epidural Analgesia. *Anesth Analg*. 2000;90:437–9.
- Almeida M, Shumaker D, LeBlanc K, et al. Incidence of postdural puncture headache in research volunteers. *Headache*. 2011;51:1503–10.
- Martinez B, Canser E, Alonso A, et al. Postdural puncture headache and epidural blood patch in a large obstetric anaesthesia population. *Asian J Anesthesiol*. 2018;56:23–32.
- Harde M, Bhadade R, Iyer H, et al. A comparative study of epidural catheter colonization and infection in Intensive Care Unit and wards in a Tertiary Care Public Hospital. *Indian J Crit Care Med*. 2016;20:109–13.
- Cook TM, Counsell D, Wildsmith JA. Major complications of central neuraxial block: report on the Third National Audit Project of the Royal College of Anaesthetists. *Br J Anaesth*. 2009;102:179–90.
- Grewal S, Hocking G, Wildsmith J. Epidural abscesses. *Br J Anaesth*. 2006;96:292–302.
- Agarwal A, Kishore K. Complications and controversies of regional anesthesia: a review. *Indian J Anaesth*. 2009;53:543–53.
- Moen V, Dahlgren N, Irestedt L. Severe neurological complications after central neuraxial blockade in Sweden 1990-1999. *Anesthesiology*. 2004;101:950–9.
- Bogod D. The sting in the tail: antiseptics and the neuroaxis revisite. *Anaesthesia*. 2012;67:1305.
- Sghirlanzoni A, Marazzi R, Pareyson D, et al. Epidural anaesthesia and spinal arachnoiditis. *Anaesthesia*. 1989;44:317.
- Borgeat A, EkatoDRAMIS G, Schenker CA. Postoperative nausea and vomiting in regional anesthesia: a review. *Anesthesiology*. 2003;98:530–47.
- Holte K, Foss NB, Svensén C, et al. Epidural Anesthesia, Hypotension, and Changes in Intravascular Volume. *Anesthesiology*. 2004;100:281–6.
- Kumar K, Singh SI. Neuraxial opioid-induced pruritus: An update. *J Anaesthesiol Clin Pharmacol*. 2013;29:303–7.

27. Ladak SS, Katznelson R, Muscat M, et al. Incidence of urinary retention in patients with thoracic patient-controlled epidural analgesia (TPCEA) undergoing thoracotomy. *Pain Manag Nurs*. 2009;10:94–8.
28. Jeng CL, Torrillo TM, Rosenblatt MA. Complications of peripheral nerve blocks. *Br J Anaesth*. 2010;105:97–107.
29. Pascual-Gallego M, Zimman H, Gil A, et al. Pseudomeningocele after traumatic nerve root avulsion. A novel technique to close the fistula. *Interv Neuroradiol*. 2013;19:496–9.
30. Munirama S, McLeod G. A systematic review and meta-analysis of ultrasound versus electrical stimulation for peripheral nerve location and blockade. *Anaesthesia*. 2015;70:1084–91.