Novel chest wall blocks for severe chest wall injuries in older persons: A case series

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Novel Chest Wall Blocks for Severe Chest Wall Injuries in Older Persons: A Case Series.

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Abstract:	Patients over the age of 65 years admitted to hospital with more than six rib fractures have a mortality rate as high as 38%. Of the survivors, 34% are likely to be admitted to an aged care facility. High quality analgesia is paramount to the mitigation of rib fracture associated morbidity and mortality. We report a series of ten consecutive patients over the age of 65 years with more than eight fractured ribs. All patients were managed with a novel chest wall block. There were no deaths, and only one patient was discharged into an aged care facility.

Abstract:

Patients over the age of 65 years admitted to hospital with more than six rib fractures have a mortality rate as high as 38%. Of the survivors, 34% are likely to be admitted to an aged care facility. High quality analgesia is paramount to the mitigation of rib fracture-associated morbidity and mortality. We report a series of ten consecutive patients over the age of 65 years with more than eight fractured ribs. All patients were managed with a novel chest wall block. There were no deaths, and only one patient was discharged into an aged care facility.

Key words: rib fracture, chest trauma, regional anesthesia, pain.

Introduction:

Rib fractures in older persons (>65 years) are a significant cause of morbidity and mortality[1-2]. Recent studies have shown that older persons are twice as likely to die when admitted to hospital with multiple rib fractures, compared with younger patients[2,3]; the mortality rate for older persons is as high as 34-38%[1,2]. Furthermore, of the patients who survive to discharge, 34% will be admitted to an aged care facility[2]. For this reason, coordinated, multidisciplinary management, particularly analgesia, is required to optimise patient outcomes[3]. Regional anaesthetic techniques are often considered gold standard analgesia[3]. However, older trauma patients often have contraindications to more traditional regional techniques such as thoracic epidural (TE) and paravertebral blocks (PVBs)[4].

Recently, several novel chest wall blocks such as the erector spinae plane (ESP) and serratus anterior plane (SAP) blocks have gained favour[5,6]. However, these have been suggested to be inferior to the more traditional TE and PVB[7]. To date, the limitations of these newer blocks such as, the number of fractures that can be managed by a single ESP or SAP has not been explored. The aim of this case series was to assess efficacy and safety of the ESP and SAP in patients over the age of 65 years with more than eight fractured ribs.

Case Series:

The present case series received institutional approval (HREC:LNR/2018/QPCH/45155) and informed consent was waived by the institutional review board. Ten consecutive patients 65 years and over with eight or more rib fractures were identified from a larger study[5,6]. No patients meeting these criteria were excluded from this series. All patients were living independently at home before the injury. The mean patient age was 76.4±5.0 years and cumulative number of fractures were 10.5±3.0 (Table 1). Two patients received a unilateral ESP, two patients received bilateral ESPs, one patient received a unilateral SAP, four patients received bilateral SAPs and one patient received an ESP plus an SAP (Table 1). These patients injured themselves through a variety of mechanisms resulting in a variety of additional injuries (Table 1). The average chest trauma score (CTS)[9] was 8.7±1.5 (Table 1). Several patients had severe chest injuries beyond rib fractures. All patients received blocks via a standardized procedure.

Block insertion procedure

All blocks were performed in the operating theatre suite by Consultant Anaesthetists or Senior Anaesthesia Registrars, all of whom had significant experience performing these blocks. All patients had catheters sited under ultrasound guidance using a high frequency linear-array transducer (12-15 MHz, X-Porte, Sonosite, Bothell, MA) using a variety of Toohey needle sets. In the majority of cases, saline was used for the initial hydrodissection and the initial local anaesthetic loading dose was bolused via the catheter. Landmarks used for needle insertion for erector spinae blocks were generally three transverse processes caudad to the most superior fracture; fFor serratus anterior plane blocks, this was in the mid-axillary line over the 4th and 5th ribs in an oblique direction from posterior-inferior to anterior-superior. The majority of patients had 15-30 mLs of 0.375% ropivacaine loaded via the catheter. This was followed by Ropivacaine 0.2% on a programmed intermittent bolus setting with a background of 1mL per hour to prevent catheter blockage. The boluses were set at volumes of 5 - 20mL every one to three hours based on the number of fractures and maximum calculated local anaesthetic doses. Maximum daily doses were calculated based on local guidelines where total ropivacaine doses did not exceed 8mg/kg/day. There were no events of local anaesthetic toxicity. When bilateral fractures were present, the selected block was performed on both sides.

Outcomes

There were no complications such as pneumothoraces, as a result of the block catheter insertion. Regional anaesthetic blocks were performed on average at 3.1±1.5 days after the injury and the catheters remained in situ for 6.8±1.7 days. Blocks were performed in four patients already admitted to the intensive care unit (ICU). No patients were subsequently admitted to the ICU. Five patients had an elevated white cell count at the time of insertion. All patients had platelet counts >$100x10^9$/L at the time of insertion and removal of regional catheters. Prior to regional anaesthesia one patient was therapeutically anticoagulated with apixaban and one was on long term aspirin. No patients developed a bleeding related complication. One catheter was removed due to erythema at the site of insertion which did not progress to a significant infection. During their stay, five patients developed pneumonia(Table 2), two of which were diagnosed before the regional block. Seven of ten patients required ventilatory support during their hospital stay(Table 2). Ventilatory support was defined as any therapy used to treat type one or two respiratory failure with high flow nasal oxygen used in six patients. Only one patient was intubated (prior to insertion of the chest wall block catheters) and subsequently received a tracheostomy which was removed prior to discharge from the ICU. The average duration of ventilatory support was 10.6±12.2 days and ICU stay was 13.75±11.9 days. (Table 2). No patients experienced a thromboembolic event.

Following block insertion and catheter loading, the average time to rescue opioid analgesia was 22.3±22.5 hours. The overall, average daily oral morphine equivalent required during hospital stay was 27.13±14.9mg. In addition to the one patient who was previously on long term opioids, four patients were discharged on a short course of opioid analgesics. The average length of hospital stay was 27.7±33.6 days(Table 2). All patients survived beyond three months post discharge. Nine out of ten patients returned home and one was discharged to an aged care facility(Table 2). In the three months following discharge from hospital, only two patients required a non-elective readmission. One patient had another fall, the other was admitted with an unrelated cellulitis.

Discussion:

The case series identified ten consecutive older persons with more than eight fractured ribs. These patients were each at a very high risk (CTS>6) of serious morbidity and mortality[3,8], which we believe was mitigated, at least in part by the use of ESP and SAP catheters. By providing adequate analgesia these patients had low rates of respiratory complications, despite some protracted hospital stays. Overall, the rate of developing a new pneumonia in the present series was 30%. Prior studies of older persons with less severe injuries (mean number of rib fractures=3.6) have demonstrated a 31% incidence of pneumonia[9]. This suggests that novel chest wall blocks may improve respiratory function sufficient to mitigate the incidence pneumonia. All ten patients survived their admission and nine returned to living independently at home. Furthermore, the only patient to be discharged to an aged care facility had rib fractures as a result of a traumatic out of hospital cardiac arrest. Therefore, this was still viewed as a positive outcome.

Currently, the only high-quality evidence available for analgesia in the context of rib fractures is for TEs, PVBs and opioid-based patient controlled analgesia (PCA)[10,11]. Each of these strategies have limitations. Opioid-based PCA is inferior to both thoracic epidural and paravertebral block in relation to pain scores[10]. The use of opioids in older persons, particularly for rib fractures often leads to high rates of adverse respiratory events, falls, delirium, polypharmacy and constipation[12]. The results of this case series demonstrated reasonably low amounts of opioids used (27.13±14.9mg) considering the extent of injuries sustained compared to the amounts quoted in groups without blocks (60.8 ± 52.6 mg)[5].

Despite the clear evidence that TEs and PVBs provide superior analgesia to opioid-based PCA, their use is not routine in all facilities, and they are not without risk. The risk is related to the contraindications, both absolute and relative and potential complications, both of which are increasingly likely in an older trauma population[1,3]. TEs and PVBs are performed in deep structures that are high risk, with various surrounding structures that are subject to potential damage, bleeding or concealed infection[12]. To limit this risk, two contraindications to both techniques are coagulopathy and active infection[12]. One advantage of TE over PVB is its ability to provide analgesia to many rib fractures[12]. However, when a TE is loaded with sufficient local anaesthetic to cover multiple rib fractures, it often causes a significant hypotension[12]. If hypotension occurs the TE infusion is often stopped, thus compromising analgesia.

There is no evidence to support the use of ESP or SAP catheters over TE or PVB, but these superficial blocks have less contraindications and potential adverse effects[5,6,11]. The decision to place one block over the other was based on fracture location and clinician preference. Both ESP and SAP blocks are relatively superficial chest wall myofascial plane blocks[6,11,12], inserted into compressible muscle under ultrasound guidance[6,11, 12]. For this reason, both therapeutic anticoagulation and systemic sepsis are relative contraindications. Therefore, with careful consideration of the risks and benefits for each patient and with informed consent, ESP and SAP could be placed or left in situ in the presence of anticoagulation or systemic infection. There are no reported cases of epidural spread or significant hypotension with these blocks which is particularly important in older trauma patients and represents a significant benefit over TE and PVB.

This is the first series to document the successful use of an ESP and/or SAP for up to 17 fractured ribs. Previous cadaver studies have shown that when injected at the level of T5, the spread of 20mL of methylene blue extends from T1 in 85% of patients down to T12 in 10% of patients[13]. The case series achieved this spread using Ropivacaine 0.2% on a programmed intermittent bolus setting at volumes of 5 - 20mL every one to three hours based on the number of fractures and maximum calculated local anaesthetic doses. Importantly, there were no signs or symptoms of local anaesthetic toxicity, even when used for up to 8 days.

There were several limitations to this case series, most notably the absence of a control group to compare the use of novel chest wall block catheters to. Therefore, the positive outcomes described in the present series may have been related to other interventions such as early consultation by the acute pain service and physiotherapy. Additionally, this was a study of trauma patients, all of whom had significant non-chest wall fractures that alone require significant amounts of opioid analgesia. For this reason the opioid sparing benefit of novel chest wall blocks is likely to have been masked by the pain caused by the additional injuries sustained. Finally, the block catheters were on average inserted around day three and earlier insertion may have reduced the incidence of pneumonia. This should be the subject of future studies.

Conclusion

This case series demonstrates the safe efficacious use of ESP and SAP regional anaesthesia in the context of severely injured older patients. There were no catheter associated adverse events. Most importantly, there were no deaths, and only one patient was discharged into an aged care facility. Therefore, ESP or SAP blocks with catheter infusions should be considered early in all older persons presenting with multiple rib fractures.

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Table 1: Patient demographics and injuries.

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10
Age	76	79	74	85	82	80	74	74	71	69
Gender	Female	Male	Female	Male	Male	Male	Male	Female	Male	Male
Number of Rib Fractures	17	13	10	9	8	9	9	10	13	8
Block	Bilateral ESP	Bilateral SAP	Bilateral ESP	Unilateral ESP	Unilateral ESP	Bilateral SAP	Bilateral SAP	ESB and SAP	Bilateral SAP	Unilateral SAP
CTS	11	8	11	7	9	8	8	10	8	7
Mechanism	MVA	Fall from Height>1 meter	Fall from Height>1 meter	Fall from Height>1 meter	Fall from Height>1 meter	Fall from Height<1 meter	Fall from Height>1 meter	MVA	MVA	Fall from Height>1 meter
Additional Injuries	Cardiac arrest C-spine fracture, sternal fracture, distal radius fracture, clavicular fracture	Sternal fracture, thoracic vertebral fracture, clavicular fracture	Thoracic vertebral fracture	Lumbar vertebral fracture, Scalp laceration	Scalp laceration, thoracic lumbar and sacral fractures, bilateral pubic rami fractures and retroperitoneal haematoma	Scapula fracture, thoracic vertebral fracture	Scapula fracture	Thoracic vertebral body fracture	Sternal fracture, prepatellar haematoma	Distal phalanx fracture, Kidney laceration, Splenic laceration
Comorbidities										
- OSA	No	No	No	No	No	No	No	No	No	No
- COPD	No	No	No	No	Yes	No	No	No	No	No
- IHD	No	No	No	No	No	Yes	No	No	No	No
- CKD	Yes	No	No	No	No	No	No	No	No	No
- CLD	No	No	No	No	No	No	No	No	No	No
- Smoking History	No	No	No	No	No	No	Yes	No	No	No

ESP- Erector Spinae Plane; SAP- Serratus Anterior Plane; MVA- motor vehicle accident; OSA- obstructive sleep apnoea; COPD- chronic obstructive pulmonary disease; IHD- Ischaemic Heart Disease; CKD- chronic kidney disease; CLD- chronic liver disease

Table 2: Post block outcomes. HFNP High Flow Nasal Prongs; ICU Intensive Care Unit; LOS Length of Stay

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10
Pneumonia - Pre- Block - Post Block	 No Yes	 No Yes	 No No	 No No	 Yes No	 No Yes	 No No	 No No	 No No	 Yes No
Respiratory support - Type - Duration (days)	Intubation, Tracheostomy Intubation 13 Tracheostomy 23	HFNP 3	Nil -	HFNP 3	HFNP 15	HFNP 3	HFNP 3	Nil -	Nil -	HFNP 11
ICU Admission - Pre- Block - Post Block	 Yes No	 No No	 No No	 Yes No	 Yes No	 Yes No	 No No	 No No	 No No	 No No
ICU LOS	38 days	-	-	4 days	10 days	3 days	-	-	-	-
Hospital Mortality	No	No	No	No	No	No	No	No	No	No
Hospital Length of Stay	111	11	10	24	63	18	9	10	7	14
Discharge Destination	Aged care facility	Home	Home	Home	Home	Home	Home	Home	Home	Home
Non-elective hospital readmission within three months of discharge	No	No	No	No	Yes	No	No	No	Yes	No