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Regional abdominal wall nerve block versus epidural anesthesia after hepatectomy: analysis of the ACS NSQIP database

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Abstract

Background The aim of this study is to determine whether regional abdominal wall nerve block is a superior to epidural anesthesia (EA) after hepatectomy.

Methods Patients undergoing open hepatectomy in the NSQIP targeted file (2014–2016) were identified. Those with INR > 1.5, Platelets < 100, bleeding disorders, undergoing liver ablation without resection, and spinal anesthesia were excluded. Patients with regional abdominal wall nerve block (RAB), mostly transversus abdominis plane (TAP) block, were matched (1:1) to those undergoing EA using propensity scores to adjust for baseline differences.

Results Out of 1727 patients who met our inclusion criteria, 361 (21%) had RAB. Of whom 345 were matched (1:1) to those who underwent EA. The matched cohort was well-balanced regarding preoperative characteristics, extent of hepatectomy, concurrent ablations as well as biliary reconstruction. RAB was associated with shorter hospital stay (median: 6 days vs. 5 days, $p = 0.007$). Overall morbidity (44.1% vs. 39.4%, $p = 0.217$), serious morbidity (27% vs. 25.2%, $p = 0.603$), and mortality (2.6% vs. 2.3%, $p = 0.806$) were not different between the two groups. Individual complications, readmission rate, and blood transfusion were not different between the two groups.

Conclusion Regional abdominal nerve block is associated with shorter hospital stay than epidural anesthesia without an increase in overall postoperative morbidity or mortality. RAB is a viable alternative anesthesia adjunct to EA in patients undergoing hepatectomy. However, given the retrospective nature of this study further studies comparing the modalities should be considered to definitively define the utility of RAB.

Keywords Nerve block · Regional anesthesia · Epidural · TAP block · Hepatectomy

Liver resection is the mainstay for treatment of many hepatic lesions. Intraoperative and postoperative pain control modalities can alter the outcomes of these procedures [1–6]. Historically the use of epidural anesthesia (EA) has been a commonly used adjunct in the perioperative care of patients undergoing hepatectomy [1]. The use of EA in patients undergoing hepatectomy comes in many different variations regarding the level of placement (thoracic versus upper lumbar) and the medications utilized, specifically narcotic versus anesthetic agents [7]. The various agents, as well as the level utilized for EA have different physiologic and analgesic profiles that should be taken into consideration when assessing the effect of EA on the perioperative outcomes of hepatectomy.

Overall, EA provides excellent pain control in patients undergoing hepato-pancreato-biliary surgery [8]; however, it has many potential drawbacks that can increase the length of hospital stay and morbidity [1, 5, 9, 10]. Studies of EA use in hepatectomy patients have found it to be a risk factor for renal failure [4], as well as increase use of intravenous fluid and blood transfusions [5]. EA is known to cause redistribution of the intra-vascular volume with resultant hypotension and can an increase the use of blood transfusion or intravenous fluid requirements in response to this labile blood pressure [1]. There is also a decisional delay associated with the optimal timing of discontinuing

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epidural catheters in patients with transient post-operative coagulopathy following major hepatectomy [11]. Lastly, the utilization of EA requires a dedicated anesthesia team for effective implementation, further increasing cost and hindering its widespread use given that such staffing is often not routinely available. Given these risks and limitations of EA, the Enhanced Recovery After Surgery (ERAS) Society states routine EA cannot be recommended in hepatectomy patients [6].

Surgeons and anesthesiologists have sought alternative perioperative anesthesia adjuncts to effectively control pain while avoiding the inherent risks of EA. One modality, regional anesthetic block (RAB) of the abdominal wall has been developed in many different varieties. RAB consists of instilling a local anesthetic to block a targeted neurovascular bundle of interest [12]. Of these variations, the TAP (Transversus abdominis plane) block has recently been used with greater frequency as a post-surgical analgesic adjunct for those undergoing abdominal surgeries [13]. TAP block has shown promising results and has been found to decrease pain following various abdominal surgeries [3, 11]. The location of regional anesthesia in TAP blocks involves the neurovascular bundle located between the transversus abdominis and internal oblique muscles. In those undergoing hepatic resection, subcostal transversus abdominis plane block can achieve a greater dermatomal block, which typically is performed between the transversus abdominis and rectus abdominis muscles [14]. Another RAB that has been employed in post-abdominal surgery patients is the rectus sheath block. This RAB utilizes regional blockade at the level of posterior rectus sheath and has demonstrated efficacy in providing analgesia, specifically those undergoing upper abdominal surgeries as well [15].

Despite these benefits, the use of RAB is relatively uncommon and is marred by lack of standardization given the various anesthetics (ropivacaine versus liposomal bupivacaine) and techniques that can be employed. These variations can influence the effect RAB has on analgesia scores and perioperative outcomes. Given this potential benefit it is prudent to have standardized reporting of these specific techniques, as well as the medications used to fully understand its effect as a perioperative analgesic adjunct.

In reviewing these commonly employed post-operative anesthesia adjuncts to date, studies have mostly compared continuous wound infiltration via catheter to EA [16] but, to our knowledge only few studies have compared EA and dermatomal block plus patient-controlled IV analgesia in patients undergoing hepatectomy [17]. Given the clinical utility of both modalities and lack of consensus on optimal postoperative pain control in post-hepatectomy patients, a study comparing these interventions is of clinical benefit. The aim of this study is to compare the outcomes of RAB and conventional EA in those undergoing hepatectomy.

Methods

The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) is a national database that provides preoperative to 30-day postoperative information of surgical patients including information about the type of anesthesia (general, local with managed anesthesia care, or regional) and any adjunct anesthesia modality that was used (None, local, regional abdominal wall nerve block, epidural, and spinal). The ACS NSQIP database does not provide details about the specific medications used for those adjunct anesthesia modalities, the level of epidural catheter placement (thoracic vs. upper lumbar), the type of RAB (TAP vs. rectus sheath block vs. continuous local infiltration via catheter), the effectiveness of those adjunct anesthesia modalities, the reason for selecting one anesthesia adjunct versus the other, the timing of use of the epidural (intraoperative vs. postoperative), patient pain scores nor patient use of morphine-equivalents that reflect the effectiveness of those adjunct in terms related to anesthesia and analgesia. The targeted hepatectomy file of the NSQIP database between 2014 and 2016 was surveyed for the type of the adjunct anesthesia techniques in patients undergoing open hepatectomy. Institutional Review Board approval was awarded, and no patient consent was required for this study as it was retrospective, and all information was de-identified. Patients were excluded if they had an INR > 1.5, platelets count < 100, history of bleeding disorders, emergency surgery, undergoing liver ablation without liver resection and if adjunct anesthesia modalities other than RAB or EA were used (ex: spinal anesthesia). Of the remaining patients, those with adjunct EA and adjunct RAB were compared.

Hospital length of stay, 30-day postoperative mortality, serious morbidity, and overall morbidity rates were the primary outcome measures. Serious morbidity was defined as the development of one or more of the following: bile leak, post-hepatectomy liver failure, Organ/space infection, deep wound infection, wound dehiscence, pneumonia, unplanned intubation, failure to wean off the ventilator after 48 h, pulmonary embolism, renal failure, stroke, cardiac arrest, myocardial infarction, deep venous thrombosis, Clostridium difficile infection, sepsis, septic shock, and unplanned return to the operating room. Overall morbidity included serious morbidity (as described earlier) in addition to superficial wound infection, urinary tract infection, and superficial thrombophlebitis.

Patient demographics and baseline characteristics including age, sex, race, body mass index, functional status, ASA class, and preoperative laboratory values (including hematocrit) were analyzed. Co-morbidities were also reviewed and compared between the two study groups. These comorbidities included pulmonary disease, congestive heart failure, hypertension, stroke, diabetes, extent of cancer burden, unintentional preoperative weight loss above 10% of the body weight in the past 6 month, and steroid use. Intraoperative details such as extent of liver resection, underlying diagnosis, operative time, and blood transfusions were assessed as well.

Extent of hepatectomy could influence the choice of abdominal incision and the choice of adjunct anesthesia technique. While the type of abdominal incision is not available in the NSQIP database, the extent of resection is available and was balanced between the two groups to minimize for potential bias in selecting EA vs. RAB for hepatectomy.

Baseline characteristics of patients with EA and RAB were compared using Chi-square (χ^2) test for categorical variables and Student *t*-test for continuous variables. To account for the baseline differences between the two groups, a 1-to-1 propensity score-matched cohort was selected. A logistic regression model was used to estimate the likelihood of placing (EA vs. RAB) and a propensity score (ranging from 0 to 1) was calculated for each patient from the logistic regression model. Patients with EA and RAB were matched on propensity scores using a non-replacement 1-to-1 match with a caliper of 0.005.

Comparisons of baseline characteristics and study outcomes of the matched cohort were then performed using χ^2 test for categorical variables and Student *t*-test or Mann–Whitney test (Wilcoxon rank sum test) depending on the distribution of the continuous variables. Statistical analysis was conducted using Stata version 11.2 (StataCorp, College Station, TX).

Results

Of the 1727 patients who met the inclusion criteria, 1366 (79%) patients had an EA, and 361 (21%) had a RAB. There were significant differences between the 2 groups before matching. Patients with RAB were more likely to be white (82% vs. 62%, $p < 0.001$), undergo neoadjuvant chemotherapy (39.6% vs. 31.0%, $p = 0.002$), have concurrent ablation (19.7% vs. 14.3%, $p = 0.012$) than those with EA. Preoperative hematocrit ≥ 35 (83.7% vs. 79.1%, $p = 0.037$) and partial hepatectomy (62.7% vs. 55.4%, $p = 0.027$) were more common in the EA than the RAB group (Table 1).

After propensity score matching both groups had 345 cases and demonstrated a well-balanced preoperative and intraoperative profile (Table 2). (Table 3) summarizes the postoperative outcomes of the two patient groups in the propensity score-matched cohort. In comparing RAB vs EA there were no significant difference in overall morbidity (39.4% vs 44.1%, $p = 0.217$), serious morbidity (25.2% vs. 27%, $p = 0.603$) nor in 30-day mortality (2.3% vs 2.6%, $p = 0.806$) between the two groups. RAB was also associated with shorter hospital stay (median: 6 days vs. 5 days, $p = 0.007$). However, individual complications, readmission rate, baseline hematocrit, operative time, and blood loss were comparable between the two groups ($p > 0.05$).

Discussion

Our data demonstrates significant findings and suggest that conventional EA for hepatectomy is not superior to RAB. This goes against the previously held conception that EA is the preferred analgesic adjunct in hepatectomy patients. We found no significant difference in morbidity nor mortality between the matched cohorts for patients undergoing RAB and EA. We examined numerous outcomes between the two cohorts, and all postoperative outcomes were comparable between the two groups except for a shorter hospital stay in patients receiving RAB, despite having comparable preoperative and intraoperative characteristics as well as postoperative complications rates.

There are many factors that could contribute and explain our findings. To begin, in regard to the length of hospital stay after open hepatectomy factors including the extent of hepatectomy, postoperative complications, institutional recovery protocol, patient's functional status, surgeon's preference, and perioperative pain control are all plausible influencers. However, both groups in our study had comparable extent of hepatic resection, rates of postoperative complications, and preoperative functional status, so those factors were unlikely to be contributing to the observed difference in hospital stay. Our findings of longer hospital stay with EA in comparison to RAB are consistent with the result of a recent randomized controlled trial (RCT) by Hausken et al. [17]. In this study, patients with intravenous patient-controlled analgesia plus wound infiltration with long acting local anesthetic (liposomal bupivacaine) had shorter average hospital stay (3 days) than those undergoing thoracic epidural anesthesia (4.2 days) [17]. The authors note that shorter hospital stay might be attributed to the local wound infiltration; in contrast to another RCT by Aloia et al., where no local wound infiltration was performed and no difference in hospital stay was observed between the IV-PCA group and thoracic epidural group [8].

The result of this study also demonstrated comparable post-operative complications rates. Specifically, our findings suggest that there is no increase in blood loss, acute renal failure, or postoperative complications in patients undergoing hepatectomy with either EA or RAB. Though prior studies comparing the outcomes of patients undergoing hepatectomy with and without EA are conflicting. Some studies suggest that EA is superior to other adjunct anesthesia

Table 1 Comparison of baseline characteristics of patients with epidural anesthesia and regional abdominal block

Variable	Epidural $N=1366$	%	Regional $N=361$	%	p value
Age (years), mean ± standard deviation	59.2 ± 12.8		58.6 ± 13.8		0.453
Gender (Male)	677	49.5	183	50.7	0.702
Race (White)	851	62.3	296	81.9	< 0.001
Body Mass Index, mean ± standard deviation	28.3 ± 6.4		28.9 ± 6.8		0.104
Viral hepatitis	139	10.9	32	9.5	0.471
Cirrhosis	87	13.4	26	17.5	0.202
Diagnosis					0.726
Benign	218	16.0	54	15.0	
Secondary cancer	705	51.6	190	52.6	
Hepatocellular carcinoma	205	15	46	12.8	
Biliary malignancy	185	13.5	55	15.24	
Other	53	3.9	16	4.4	
Neoadjuvant therapy	420	31.0	142	39.6	0.002
Diabetes	204	14.9	61	16.9	0.357
Current smoker	231	16.9	65	18.0	0.623
Dyspnea	54	4.0	12	3.32	0.579
Cardiac disease	6	0.4	0	0.0	0.207
Pulmonary disease	56	4.1	14	3.88	0.850
Ascites or varices	5	0.37	1	0.28	0.798
Hypertension	618	45.2	172	47.7	0.415
Steroid use	47	3.4	10	2.8	0.526
Weight loss	49	3.6	16	4.4	0.453
Preoperative hematocrit ≥ 35	1123	83.7	283	79.1	0.037
American Society of Anesthesiologists class ≥ 3	1002	73.4	280	77.6	0.104
Dependent functional status	5	0.37	4	1.1	0.082
Type of resection					0.027
Partial lobectomy	856	62.7	200	55.4	
Left hepatectomy	146	10.7	38	10.5	
Right hepatectomy	263	19.3	83	23.0	
Extended hepatectomy	101	7.4	40	11.1	
Concurrent ablation	194	14.3	71	19.7	0.012
Pringle maneuver	295	21.6	74	20.5	0.651
Biliary reconstruction	122	9.0	22	6.1	0.082
Concomitant resections					0.186
0	648	48.1	157	45.8	
1	388	28.8	88	25.7	
2	158	11.7	51	14.9	
3 +	152	11.3	47	13.7	
Wound class (clean contaminated)	88	6.44	26	7.2	0.605
Preoperative infection	25	1.8	1	0.3	0.031
Preoperative transfusion	7	0.51	0	0.0	0.173

techniques without any observed increase in postoperative complications [8]. Perhaps that EA is associated with low central venous pressure which is desirable during hepatic parenchymal transection to decrease hepatic congestion and blood loss can further explain this [8]. However, other studies have reported increased blood transfusion, intravenous fluid administration, acute kidney injury, and cardiac arrest with EA [1, 8–10, 17]. These effects might be related to the vasodilatory effect of neuraxial anesthesia [18]. Despite these conflicts our findings found no significant difference in complication nor transfusion requirements between both cohort groups. Thus, in terms of complication rates both EA

Table 2 Comparison of baseline characteristics in matched cohort

Variable	Epidural $N=345$	%	Regional $N=345$	%	p value
Age ≥ 65	135	39.1	129	37.4	0.467
Race (White)	293	84.9	280	81.2	0.187
BMI ≥ 30	141	40.9	127	36.8	0.322
Viral hepatitis	25	7.3	32	9.3	0.554
Cirrhosis	14	4.1	26	7.5	0.139
Diagnosis					0.163
Benign	51	14.8	52	15.1	
Secondary cancer	192	55.7	181	52.5	
Hepatocellular carcinoma	49	14.2	44	12.8	
Biliary malignancy	48	13.9	52	15.1	
Other	5	1.5	16	4.6	
Neoadjuvant therapy	122	35.4	135	39.1	0.591
Diabetes	55	16.0	55	16.0	1.000
Current smoker	67	19.4	62	17.9	0.625
Dyspnea	9	2.6	12	3.5	0.506
Pulmonary disease	11	3.2	13	3.8	0.678
Ascites or varices	0	0.00	1	0.29	0.317
Hypertension	158	45.8	164	47.5	0.647
Steroid use	8	2.3	10	2.9	0.633
Weight loss	14	4.1	15	4.4	0.850
American society of anesthesiologists class ≥ 3	271	78.6	267	77.4	0.713
Dependent functional status	2	0.6	4	1.2	0.412
Preoperative hematocrit ≥ 35	276	80.0	270	78.3	0.197
Type of resection					0.929
Partial lobectomy	198	57.4	190	55.1	
Left hepatectomy	35	10.1	38	11.0	
Right hepatectomy	74	21.5	79	22.9	
Extended hepatectomy	38	11.0	38	11.0	
Concurrent ablation	65	18.8	64	18.6	0.602
Pringle maneuver	71	20.6	70	20.3	0.925
Biliary reconstruction	23	6.7	22	6.4	0.364
Concomitant resections					0.085
0	152	44.1	152	44.1	
1	93	27.0	83	24.1	
2	43	12.5	49	14.2	
3 +	57	16.5	61	17.7	
Wound class (clean contaminated)	23	6.7	26	7.5	0.657
Preoperative infection	2	0.6	1	0.3	0.563

and RAB seem to be useful comparable adjuncts in post-hepatectomy patients.

Though the effectiveness of EA to control perioperative pain is well established [1, 2], the use of epidural catheters is often associated with protocolized management approach that involve an anesthesia team that handles gradual weaning protocol until discontinuation of treatment. Occasionally this process might lead to longer hospital stay; particularly when coagulopathic status in the context of liver surgery arise. On the other hand, RAB use is often cheaper, does not require such extensive resource utilization and is overall easier to handle at the patient and nursing level. This in coinciding with our results further highlights the importance of our study's findings as RAB is less invasive and less resource intensive with similar outcomes and a shorter LOS.

Epidural anesthesia (EA) has been the historically preferred approach for post-hepatectomy patients. However, with the advent of RAB, less invasive adjuncts now exist to help these patients recover. A systematic review of TAP blocks from Abdallah et. al, showed improved analgesia

Table 3 Postoperative outcomes of the propensity matched cohort

Variable	Epidural $N=345$	%	Regional $N=345$	%	p value
Blood transfusion	74	21.5	66	19.1	0.449
Post-hepatectomy liver failure	16	4.6	25	7.3	0.147
Bile leak	44	12.9	38	11.1	0.454
Superficial incisional surgical site infection (SSI)	20	5.8	10	2.9	0.062
Deep incisional SSI	2	0.6	3	0.9	0.654
Organ Space SSI	29	8.4	37	10.7	0.300
Sepsis	17	4.9	10	2.9	0.169
Septic shock	9	2.6	7	2.0	0.613
Wound dehiscence	5	1.5	4	1.2	0.737
Pneumonia	6	1.8	11	3.2	0.219
Reintubation	9	2.6	10	2.9	0.816
Failure to wean off the vent	8	2.3	8	2.3	1.000
Pulmonary embolism	5	1.5	5	1.5	1.000
Deep vein thrombosis requiring therapy	10	2.9	5	1.5	0.192
Acute renal failure	5	1.5	11	3.2	0.129
Urinary tract infection	5	1.5	8	2.32	0.401
C. difficile infection	3	0.9	1	0.3	0.316
Stroke/Cerebrovascular accident	0	0.00	1	0.3	0.317
Cardiac arrest	3	0.9	1	0.3	0.316
Myocardial infarction	6	1.7	2	0.6	0.135
Return to the OR	14	4.1	11	3.2	0.541
Readmission	34	9.9	42	12.2	0.331
Overall morbidity	152	44.1	136	39.4	0.217
Serious morbidity	93	27.0	87	25.2	0.603
30-day mortality	9	2.6	8	2.3	0.806
Complication with invasive intervention	32	9.4	50	14.5	0.09
Length of stay, mean ± standard deviation	7.5 ± 4.9		6.9 ± 5.2		0.461
Length of stay, median (interquartile range)	6 (5–9)		5 (4–7)		0.007

in patients undergoing laparotomy for colorectal surgery, laparoscopic cholecystectomy, as well as appendectomy [19]. In patients undergoing hepatectomy, continuous local anesthetic infiltration via wound catheter [16] and local wound infiltration with liposomal bupivacaine plus intravenous patient-controlled analgesia [17] were compared to EA. Both modalities show promising non-inferior results to EA and perhaps some advantages regarding functional recovery and hospital length of stay. In relation, very few studies have compared the use of EA and dermatomal RAB in post-hepatectomy patients [16, 17]. Given the scarcity of data in this topic our study gives further insight into RAB and its utility in this patient population.

This study has several limitations that should be noted irrespective of our findings. To begin, it is retrospective in nature and lacks key data that is related to the details of EA, RAB, and the rationale to select one modality versus the other. In relation, we do not have information regarding postoperative pain scores and narcotic use, so it is not possible to compare the effectiveness of both modalities in the perioperative period. Second, there is no information pertaining to which type of RAB used, so we cannot provide specific recommendations for one type or the other. Third, the NSQIP data does not capture variables related to RAB such as timing of the block, volume, and type of administered local anesthetic, use of ultrasound and operator experience. Fourth, as mentioned previously the type, level, and functionality of the EA used is not known which could affect our results. Fifth, there is no information about the incision type which could affect the selection of EA versus RAB; however, MIS patients were controlled for in our study. Finally, propensity score matching was used to match the two groups; however, this method does not account for variables that are not captured in the dataset and could potentially affect the outcomes of interest.

Despite these limitations our study does provide insight into the potential utility of RAB in post-hepatectomy patients, demonstrating shorter LOS, and no significant difference in mortality or complications. In an era of implementing enhanced recovery protocols, a key metric of studies focusing on the effectiveness of perioperative analgesia is length of hospital stay as a surrogate for better pain control and overall perioperative care [20]. Our study suggests that RAB is associated with shorter hospital stay that cannot be attributed to differences in morbidity rate as a confounder. Additionally, given the lack of currently available data on this topic and the less invasive nature of RAB in comparison to EA, the use of RAB in this patient population may be a comparable adjunct when compared to EA.

Conclusion

In conclusion, this was a retrospective study that compared epidural anesthesia to regional abdominal wall block during hepatectomy. Patients undergoing RAB had shorter hospital stay than those undergoing EA and both groups had comparable morbidity and mortality. This study suggests that RAB may be a viable alternative to EA in patients undergoing open hepatectomy; however, the retrospective nature of the study and the constraints of the NSQIP database limits the strength of these findings. Thus further studies should be conducted to definitively assess the utility of RAB in this patient population.

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Declarations

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