The Lumbar and Sacral Plexus and their Role in Anesthesia

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Problem

An understanding of peripheral nerve blocks (PNB), including those of the lower extremity, is extremely important to the anesthesia professional. Over the past several years, a rise in peripheral nerve blocks for both anesthesia and post-operative pain control following lower extremity surgeries has been noted. PNBs when compared to general and regional (spinal and epidural) anesthesia have become the anesthetic of choice for both anesthesia providers and orthopedic surgeons alike. A decrease in patient complications, a decrease in cost, and a decline in the time spent in the hospital have all played a role in this preferred method of anesthesia (Hogan, Grant, & Lee, 2009).

The positive outcomes seen with peripheral nerve blocks are certainly not the only aspects that have contributed to the increasing numbers. Patients themselves, after education regarding both general and regional anesthesia techniques, often prefer PNBs for not only the increased pain control but also due to their own fear of general anesthesia (Webster, Bremner, & McCartney, 2011). Therefore, the increased demands for lower extremity nerve blocks, and the anesthesia professionals desire to meet the preferences of their patients, makes the knowledge and skills on lower extremity nerve blocks invaluable to these providers.

In the Fall Semester of 2012, the Adventist University of Health Sciences (ADU) Nurse Anesthesia Program (NAP) Class of 2014 was introduced for the first time to the peripheral nerve blocks. Although lots of time was dedicated to the procedural aspects and ultrasound techniques of these nerve blocks, the class spent several hours self-studying the anatomy and physiology of the lumbar and sacral plexus. This included reviewing approximately six to seven chapters in the Hadzic Regional Anesthesia Textbook.

Peripheral nerve blocks are becoming a highlight in anesthesia practice. Research has suggested that patients have improved satisfaction, a decrease in complications, and shorter hospital stays when they are incorporated in their care. The increased demand for this regional anesthesia technique makes it important for student nurse anesthetists to have a strong foundation in the lumbar and sacral plexus blocks including the anatomy, complications, and clinical importance.

Review of Literature

In 2010, a group of Certified Registered Nurse Anesthetists (CRNAs) completed a retrospective review of medical records to determine the benefits of regional blocks (RB) when compared to general anesthesia (GA) for patients undergoing surgeries at a same-day surgical center. The study reviewed a total of 656 charts covering the span of 2 years on patients whom were at least 18 years of age, with an American Society of Anesthesiologists (ASA) score of I or II, and undergoing shoulder or knee arthroscopy. Patients were excluded if a combination of both GA and RA was utilized. Therefore, a total of 342 charts met all inclusion criteria to be included in the study (Yauger et al., 2010).

When comparing the GA group to the RB group, the RB group reported less pain than those of the GA group. The study concluded that these reduced pain levels in the post-operative period were statistically significant with a p-value of less than 0.001. The increase in pain level for the GA group was also evident in the amount of narcotic use they required in both the operating room and in the post-anesthesia care unit (PACU) (Yauger et al., 2010).

The decrease in pain and narcotic usage was not the only significant finding reported in this study. The researchers also concluded that patients spent a statistically significant less amount of time in the PACU when undergoing RB anesthesia. It was found that the GA group

remained in PACU 20.3 minutes longer compared to the RB group. Members of the RB group were also eligible to bypass PACU which was not seen in the GA group (Yauger et al., 2010).

The study also reviewed the incidence of post-operative nausea and vomiting (PONV) amongst the two groups. Although the RB group reported a reduced incidence of PONV, these results were not statistically significant. The authors did note a limitation in this statistic as the GA group received 60% more anti-emetic treatment during their OR time than their RB counterparts (Yauger et al., 2010).

Foster et al. (2013) contributed to additional research on the importance of a sound understanding of regional anesthesia amongst anesthesia providers. This cross-sectional study reviewed 53,968 arthroscopic ACL procedures in an effort to compare hospital costs and clinical outcomes for patients receiving GA, RA, or a combination of the two. The most common anesthesia technique identified was GA, accounting for 63% of patients. Nonetheless, the study showed that a statistically significant increase was demonstrated between the years of 2004-2008 in the use of GA in combination with RA, especially a single femoral nerve injection (Foster et al., 2013).

Foster et al. (2013) reported "patient hospital charges for anesthetic types were $1065, $1614, $1849, $630, and $612 for GA alone, GA in combination with single femoral injection, GA in combination with other RA, single femoral injection alone, and RA alone respectively." While the additional costs of combining GA with a femoral nerve block is noted, the authors felt that the improved pain control was invaluable. In addition, a well performed femoral nerve block without the use of GA could reduce patients' costs remarkably.

ACL surgery is predominately performed on healthy, young adults. The most common complication seen with GA is PONV. Several studies have reported that a reduction in PONV is

seen with the use of RA when compared to GA. While RA has less systemic effects, researchers are not unanimous in their support for PNBs. Accidental injection into blood vessels, nerve damage, and central nervous system toxicity are all concerns. Additionally, surgeons have found that the time to perform PNBs and that the reliability of the block varies dramatically amongst anesthesia providers (Foster et al., 2013). The severity of these complications makes it pertinent that providers have a sound understanding of anatomy, technique, and complications prior to the participation in this form of anesthesia.

Jeng, Torrillo, and Rosenblatt (2010) contributed an article regarding PNBs and their rare, but possible complications. The complications' signs and symptoms and treatment approaches were discussed in detail. This information demonstrated the importance of safe PNB administration.

Peripheral nerve injury (PNI) is one of the more discussed complications of PNBs. PNI can be permanent or transient; transient parasthesia accounts for 8-10% of reported PNIs. While some injuries may be unavoidable, ultrasound may help to decrease these numbers. A large clinical trial would be necessary to prove this statement. Providers must be aware that their approach can contribute to PNIs. Selecting a short, beveled needle, performing a thorough pre-operative assessment, and being aware of nerve stimulator settings can all help to decrease the likelihood of this complication (Jeng et al., 2010).

Inadvertent vascular injection, which could result in hematoma formation, is also a risk of PNBs. Again, ultrasound guidance has helped to decrease this danger by allowing visualization of anatomy throughout the procedure. Anesthesia providers should remain vigilant and in the event of a vascular puncture must know how to proceed whether this is needle redirection or needle removal in the event of a hematoma formation (Jeng et al., 2010).

A sound knowledge of local anesthetic (LA) mechanism of action, dosage, and pharmacokinetics is essential in PNB administration. An overdose of LA can lead to a life threatening emergency. Recognition of signs and symptoms, acquaintance with treatment options, and knowledge of patient resuscitation protocols can all contribute to improved patient outcomes (Jeng et al., 2010).

While they may be rare, the danger of these complications must not be minimized. Patients may experience both negative short- and long-term effects on their quality of life. Consequently, providers must take an active approach in their practice to prevent these events from occurring.

Hogan, Grant, and Lee (2009) presented a research article in which they used a literature review approach to compare the success of PNBs when compared to epidural and spinal analgesia following total hip and knee arthroplasty. Patients undergoing these procedures report their pain as severe 50% of the time. This can contribute to patient dissatisfaction, as well as, a delay in physical therapy. Therefore, proper treatment of pain is paramount.

Drawbacks to spinal and epidural analgesia that are not encountered by PNBs include urinary retention, hypotension, and respiratory depression. This makes PNBs a more advantageous approach for the elderly, patients with comorbidities such as congestive heart failure and obesity, and those receiving anticoagulation therapy. In addition, PNBs reduce post-operative nausea and vomiting (PONV), narcotic use, and surgical blood loss (Hogan et al., 2009).

A lack of experience is quoted as one of the main barriers to the use of PNBs. Strategies to overcome these barriers must be mandated. PNBs are rapidly being incorporated as part of orthopedic procedures due to positive patient outcomes, a decrease in hospital length of stay, and

medical costs. Therefore it is vital that surgeons and anesthesia providers grasp the anatomy, technique, and complications of PNBs (Hogan et al., 2009).

Research has, without a doubt, proven that the increased performance of PNBs and their potential complications make it imperative that anesthesia providers are well rehearsed in this anesthesia technique. Unfortunately, research shows that the opposite may be occurring. Chelly et al. (2003) sent questionnaires to 132 Anesthesia Residency Directors to evaluate the types, number of PNBs, and techniques to which their residents were exposed. The questionnaire also sought information on how residents were taught about PNBs.

The study revealed that at least 41% of anesthesiology residency programs are without a standard approach to teaching PNB technique. The authors felt this may have actually been underreported by program directors. While a standard teaching approach was rarely available, hands on experience was also limited to most residents. This was most commonly due to a lack of training and to the surgeons' beliefs that surgical delays would result (Chelly et al., 2003).

PNB technique training is valued by the Accreditation Council for Graduate Medical Education (ACGME) whom require that residents complete at least 40 PNBs. While this criterion was being met, researchers still determined that residents were not proficient or confident in performing these blocks. This lack of confidence has its merit as it has been shown that a "direct relationship between the lack of training and the frequency of complications following the performance of PNB" exists (Fanelli et al., 1999).

According to Chelly et al. (2003), anatomy is an important concept in order to be successful at PNBs. Nonetheless, institutions were found to omit "videotapes, written instruction, and cadaver dissection." Instead residents were left to a "trial-and-error" method that placed patients at risk for adverse events. Authors suggest that a combination of didactics, videos,

simulation, hands on training, and a specific nerve block rotation be incorporated in the training of all anesthesia providers.

ADU NAP currently offers students a variety of experiences with PNBs. Students partake in an ultrasound simulation lab directed by a clinical expert, a thorough knowledge on LA pharmacology, and clinical observation of PNB performance. Horlocker (1998) emphasizes the importance of providers returning to the classroom to build a stronger foundation in anatomy, as this is the building blocks to successful PNBs. The authors of this capstone hope to contribute to this educational process by presenting a didactic portion focusing on lower extremity peripheral nerve blocks.

Project Description

In an effort to manage the presented problem, as stated above, the authors of this paper plan to implement a learning module that will help to assist students of ADU's NAP to better learn and understand the lower extremity regional blocks. This module, which will be highlighted by a PowerPoint presentation, will be made available to all of the students through the ADU Angel website. The PowerPoint presentation will be presented by the authors of this paper for the first time to the Class of 2015 on November 11, 2013. It will consist of a large overview of the anatomy, technique, complications, and clinical importance of peripheral nerve blocks of lower extremities as discussed in the above literature review. In addition to the presentation, links to helpful regional anesthesia websites and technique videos will be made available to the students.

A difficulty in recalling this material is acknowledged and therefore, the continuous availability of this module to the students of ADU will help to overcome this challenge. When students are preparing for rotations which will incorporate these nerve blocks, like orthopedic

anesthesia, access to this module will be instrumental to them. The combination of this academic knowledge and participation in the performance of these blocks during simulation lab, as well as in the clinical setting, will help to prepare SRNAs for future practice.

Several aspects must be considered in order to carry out this capstone project successfully. First and foremost, completing this task requires dedication to learning and understanding the lower extremity nerve blocks prior to the presentation of the material. In addition to an extensive literature review, having the input and direction from anesthesia professionals, whom are experts in peripheral nerve blocks, is essential. All information presented will undergo extensive review and analysis by these professionals to ensure its accuracy and completeness.

Evaluation Plan

The measurable outcome of this project is an increase in knowledge of lower extremity peripheral nerve blocks. Although this project is unable to assess students' clinical capabilities of performing lower extremity nerve blocks, their knowledge on the anatomy, complications, technique, and clinical indications can be assessed. This assessment will be performed in three separate steps.

First, an evaluation of each student's knowledge on these blocks will be assessed prior to the PowerPoint presentation. This evaluation will be administered through Angel Lockdown Browser as a 19 question test. The test results will be made available to the presenters but will be unlinked to any identifiable student information. Test results will not be immediately available for review by the students. Additionally, no grade book link will be created for these test results.

Secondly, the same evaluation administered prior to the presentation will be retaken by the students immediately following the completion of the lecture. This test will once again be

taken in Angel Lockdown Browser and will not be linked to the grade book. As before, no student identifiers will be made available to the presenters. After all tests have been completed, a short review of the questions and correct answers will be distributed.

Finally, a third evaluation will be administered approximately 3 months following the lecture given November 11, 2013. Like before, it will be administered on Angel Lockdown Browser and will not be linked to the grade book or student identifiers. The results of these evaluations will be used to assess retained knowledge regarding lower extremity blocks. It is hypothesized by the creators of this project that recall will diminish over time requiring a learning module that is easily accessible by students throughout the entire program.

Students will also be asked to complete a survey. This survey will evaluate the presenters, the lecture, and the contribution of this capstone project to their education. The success of the project will be determined by not only the students' results on the above mentioned evaluations but also through this survey.

Results and Conclusion

Three tests, containing the same 19 questions were administered to 22 students of the SRNA Class of 2015 immediately prior to the PowerPoint Lecture, immediately following the lecture, and then once again 12 weeks later. One student was unavailable for test participation. Test scores increased with each subsequent administration from an approximate mean score of 56.1% to 77.5%. Following the completion of the pre-test, post-test 1, and post-test 2, a statistical analysis was completed in an effort to determine significant outcomes. A One-Way Analysis of Variance (ANOVA) was completed first, using the mean scores between the three tests. The results of this analysis are presented below (Table 1).

Table 1 *ANOVA*

Scores

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4378.528	2	2189.264	5.091	.009*
Within Groups	23221.907	54	430.035		
Total	27600.435	56			

Note: Findings that approach statistical signficance are represented as a $p < 0.05$ level. These findings are indicated by an asterisk.

Due to the fact that statistical significance was achieved using ANOVA, a post hoc group comparison was conducted (Table 2).

Table 2 *Post Hoc Multiple Comparisons*

Dependent Variable: Scores

	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	Pre-Test	Post-Test 1	-11.1474	6.7281	.103	-24.636	2.342
		Post-Test 2	-21.4632*	6.7281	.002	-34.952	-7.974
	Post-Test 1	Pre-Test	11.1474	6.7281	.103	-2.342	24.636
		Post-Test 2	-10.3158	6.7281	.131	-23.805	3.173
	Post-Test 2	Pre-Test	21.4632*	6.7281	.002	7.974	34.952
		Post-Test 1	10.3158	6.7281	.131	-3.173	23.805

Note: The mean difference is significant at the 0.05 level and indicated with an asterisk.

Even though the mean scores increased with each subsequent test, post hoc comparisons indicated that the significant difference can be found only between mean scores of Pre-test and Post-Test 2 ($p = .002$). This result proved to be an interesting finding to the authors of this capstone project because it had been hypothesized that recall of this material would be difficult and would in fact diminish with time. There could be several factors responsible for the

improved mean test scores. Students had 12 weeks between the presentation and post-test 2. During this time, students received additional exposure to the material through an ultrasound-simulation lab, completion of assigned reading, and examination preparation. Furthermore, some students may have received exposure to lower extremity PNBs during their clinical rotations. These could all contribute to the limitations of the statistical analysis.

To evaluate the student's opinion regarding the lecture presented on lower extremity PNBs, a Likert Scale survey was made available for anonymous completion. Of 22 students, 18 electively completed this survey. The students were asked if the presentation added to their knowledge on lower extremity peripheral nerve blocks, if the information would be valuable to their clinical experience, and if they would recommend that future classes at ADU include this lecture. 78% strongly agreed while the remaining 22% agreed. When asked if the presenters were adequately prepared for the lecture, 83% strongly agreed while 17% agreed. In the final question, students were able to freely type comments and stated the following:

- "great resources,"
- "excellent breakdown of a lot of very detailed information,"
- "information provided was quite pertinent and to the point,"
- "pop quiz questions were interactive, which were great," and
- "excellent presentation."

One student noted that in the future a handout regarding anatomy and physiology would aid in examination preparation.

The literature review above demonstrated the importance of lower extremity PNBs to anesthesia providers and the importance of classroom exposure to the anatomy and physiology of these nerve blocks. The goal of this capstone project was to aid in the classroom portion of

SRNA's education on lower extremity PNBs. As the completed survey indicated, students at ADU believe that the information presented is essential in their mastery of this material and that this material should continue to be presented in subsequent years.

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