Sweeney, Jonathan L., The Cephalic Vein: Anatomical Study and Evaluation of the Coracoid Process as a Topographical Bony Landmark. Master of Science (Medical Sciences-Anatomy), April 2020

INTRODUCTION. Clinicians require accurate anatomical information when gaining central venous access. Despite the cephalic vein cut down (CVCD) procedure being described as a superior choice to other methods, the cephalic vein's (CV) anatomical variations can make it challenging to locate. We asked if the coracoid process (CP) could be utilized as an accurate topographical landmark to locate the CV. The present study set out to prove the CV will be located within 1 cm of the CP with statistical significance.

METHODS. We conducted bilateral shoulder dissections on 41 cadavers to determine the location of the CV in relation to the CP. Distances were measured horizontally, vertically and directly from the CP to the CV utilizing digital calipers. We also measured diameter via extracted veins where the inner luminal circumference was measured and divided by π to obtain diameter.

SUMMARY. Resulting means were: Straight line distance: 9.48 ± 4.45 mm, horizontal distance: 13.50 ± 6.45 mm, vertical distance: 11.03 ± 5.17 mm, and diameter: 1.59 ± 0.67 mm. A one sample student t-test on the straight-line distance, with the expected population mean set to 10 mm so that the H_0 indicates the data would be $\geq$ 10 mm and the H_a indicates the data was < 10 mm. The α was set to 0.05, had a resulting p=0.333906 and the test statistics was -1.860547. From the results, the H_0 was rejected. Since clinicians will likely have more than just 10 mm of open incision space while gaining access to the CV, the *t*-test was repeated with an expected

population mean of 15 mm. The resulting *p*-value was $3.66613e^{-16}$ and the H_0 was rejected. When α was set to 0.0001. The results remained significant.

CONCLUSION. We showed that the CV can be located within 1 cm of the CP with statistical significance. The average incision for the CVCD procedure is 3-6 cm. It can safely be assumed that the incision will be spread to a width of 1.5 cm. If the clinician does not quickly locate the CV, they can assume it is likely deeper than the muscle belly, a variation or absent. This will aid clinicians in avoiding unnecessary time searching for the vein and instead rapidly transition to an alternative approach, transitioning the original CVCD incision to the reservoir incision. With this new information, we hope to persuade more clinicians to make the CVCD their first and primary attempt for central venous access over the subclavian puncture.

THE CEPHALIC VEIN: ANATOMICAL STUDY AND EVALUATION OF THE CORACOID PROCESS AS A TOPOGRAPHICAL BONY LANDMARK

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THE CEPHALIC VEIN: ANATOMICAL STUDY AND EVALUATION OF THE CORACOID PROCESS AS A TOPOGRAPHICAL BONY LANDMARK

INTERNSHIP PRACTICUM REPORT

Presented to the Graduate Council of the Graduate School of Biomedical Sciences University of North Texas Health Science Center at Fort Worth in Partial fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

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CHAPTER I

INTRODUCTION TO THE STUDY

The following practicum report was performed as a requirement for the Master of Science Anatomy Track program, from May 2019-May 2020 at the University of North Texas Health Science Center (UNTHSC). The study was conducted under direct supervision of Rustin Reeves, PhD, in the Center for Anatomical Sciences and Department of Physiology and Anatomy at UNTHSC.

When a patient requires chemotherapy, it is common for a totally implantable venous access port (TIVAP)* to be surgically placed. This allows continued central venous access without having to persistently puncture the patients vein. A TIVAP can not only aid in the administration of long-term chemotherapy, but also when a patient requires multiple phlebotomy's, contrast for scanning and in some cases parenteral nutrition (Mudan, 2015). There are two methods for placing a TIVAP: direct percutaneous puncture of a central vein and open insertion via cut-down method of a distal vein (Mudan, 2015). The most commonly chosen techniques are the percutaneous subclavian puncture (SCP) method and the cephalic vein cut down (CVCD) procedure.

The SCP is conducted by puncturing the subclavian vein (SV) via needle insertion under the clavicle and then making an incision at the level of the second intercostal space and forming a pocket for the reservoir just caudal to the incision (Mudan, 2015). SCP occasionally results in

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*Abbreviations used in this report are listed in Appendix A

pneumothorax, arterial puncture, hemothorax and brachial plexus injury. These complication rates have been documented to be around 12% (Biffi, 2009). Cardiovascular usage of the subclavian vein for pacemaker lead placement has also observed pinch off syndrome or subclavian crush syndrome where the lead placed via the subclavian vein is crushed between the first rib and the clavicle (Koketsu, 2010).

The CVCD involves surgical dissection down to the cephalic vein in the deltopectoral groove and insertion of a catheter and reservoir in the same incision. The CVCD has been shown to be a safe and feasible option for TIVAP placement as well as having a lower complication rate when compared to the SCP (Koketsu, 2010). This technique involves less trauma to the vessel and reduces damage to the surrounding structures (Perez, 2020). The SCP has a risk estimation 1.09 times greater when compared to the CVCD (Perez, 2020). Additionally, the CVCD technique did not observe the occurrence of pinch-off syndrome or subclavian crush syndrome (Koketsu, 2010).

The path of the CV starts with the dorsal venous network of the hand which gives rise to the dorsal metacarpal veins (Dogood, 2017). The CV traverses the anatomical snuffbox and runs up the lateral surface of the forearm (Dogood, 2017). In the cubital fossa it communicates with the basilic vein through the median cubital vein (Dogood, 2017). Next, the CV then rises on the lateral portion of the humeral region of the upper limb before crossing medially and running up the deltopectoral groove (Dogood, 2017). The CV will then pierce the clavipectoral fascia and terminates into the axillary vein (Dogood, 2017).

According to current research the CV is present 96% of the time and completely absent 4% of the time (Loukas, 2008, Dogood, 2017, Steckiewicz, 2015). When present, the CV is superficial to the fascia and adipose tissue of the deltopectoral groove 74% of the time and deep

to the fascia, adipose and muscles of the pectoralis major and the deltoid muscles 26% of the time (Loukas, 2008, Dogood, 2017, Steckiewicz, 2015). The CV has a documented anatomical abnormality of a supraclavicular course occurring 2% of the time (Loukas, 2008, Dogood, 2017, Steckiewicz, 2015). A common method employed for locating the CV is to locate the deltopectoral groove topographically. The deltopectoral groove is the indentation created by the joining of the deltoid and pectoralis major muscle in the shoulder region (Loukas, 2008). The groove consists of a fat pad that separates the two muscles (Loukas, 2008).

Despite the CVCD having less complications when compared to the SCP (Otsubo, 2016) and being stated that the CVCD should be the first choice for central venous access over the SCP (Cavallaro, 2014), the SCP is still the standard first choice for central venous access. It was our assumption that one factor that the CVCD is not chosen over the SCP, is due to the CV documented anatomical variations. A study by Luis Andres, published in 2009, recorded that the CV was located median to the coracoid process (CP) at an average distance of 7.9 mm ± 6.0 mm with a range of 0-20 mm (Yeri, 2009). These measurements were taken from the closest edge of the CP to the closest edge of the CV. Based on this information, we asked if the CP could be used as an accurate topographical landmark to locate the CV.

During the beginnings of the research for this study, it became apparent that the diameter of the CV was a crucial data point and that the method for gathering the diameter varied widely from study to study. When the CV is < 1 mm it will be unsuitable for pacemaker lead placement (Steckiewicz, 2015). An additional study recorded that out of an n = 548, 324 patients had CV diameters of >1.5 mm and were found to be independently associated with the primary functional maturation of 86% in the radiocephalic arteriovenous fistula maturation. It was stated that along with the radial artery diameter, CV diameter was the most significant factor associated

with autogenous radiocephalic arteriovenous fistula maturation (Kordzadeh, 2017). This journal further justifies the value of accurate diameters of the CV in anatomical studies. The current studies have been seen to use several methods for measuring diameter from taking pictures of dissections and analyzing with computer for pixel difference, ultrasound measurements as well as measuring the whole CV with calipers when it is still in the cadaver. It was noted that no standardized method for measuring the CV diameter was utilized. Despite taking extreme precaution, every method has its short falls. Ultrasound, although known to be accurate, is very user dependent, measuring a whole cephalic vein will not translate to inner luminal diameter and is very dependent on whether the vein collapses slightly while measurement is being taken. Computer programs and ultrasounds are not widely used or accessible to all labs. This calls for a standardized method of measuring vein diameter so that all studies will be on the same page and can be easily compared no matter what tools and resources are available. This is understood to be difficult as some papers are dealing with live patients and others are cadaver specimens.

This project utilized 41 cadaver donors. Bilateral dissections were conduction on the shoulder region of cadavers to locate the CV and measure its distance from the CP. Our first Specific aim is to determine if there is a consistent landmark that can be used by clinicians to locate the CV. We tested the hypothesis that the Cephalic Vein (CV) would be located within 1 cm of the Coracoid Process (CP) a statistically significant amount of the time. Our H_0 would be that the CV would be located $\leq$ 10 mm (1 cm) from the CP. Therefore, rejecting the H_0 would prove the effectiveness of the CP as a topographical landmark to locate the CV. Our second specific aim was to develop an accepted and standardized method to measure the diameter of the CV both in vivo and once removed. We will test this hypothesis that there is a constant difference seen between cadaveric vessel diameter (removed) and in vivo diameter of

measurement of the Cephalic Vein (CV). Veins will put under pressure via manometer and the diameter will be measured at three locations (proximal, middle and distal) to give approximate vein diameters of the vein in vivo. The veins will then be cut open and fixed onto slides where their circumferences were measured with Mejia scopes at 3 locations (Proximal, middle and distal). These measurements will be compared to determine if there is a constant difference. A constant difference would mean that cadaveric measurements could be adjusted to provide diameters that would relate to a live patient. The circumference measurement technique will also be conducted to attempt to provide a standardized technique for diameter measurements regardless of lab resources and equipment.

CHAPTER II

INTERNSHIP SUBJECT

BACKGROUND AND LITERATURE

The path of the CV starts with the dorsal venous network of the hand which gives rise to the dorsal metacarpal veins (Dogood, 2017). The CV traverses the anatomical snuffbox and runs up the lateral surface of the forearm (Dogood, 2017). In the cubital fossa it communicates with the basilic vein through the median cubital vein (Dogood, 2017). Next, the CV rises on the lateral portion of the humeral region of the upper limb before crossing medially and running up the deltopectoral groove (Dogood, 2017). The CV will then pierce the clavipectoral fascia and terminates into the axillary vein (Dogood, 2017).

When assessing a patient for central venous access with a TIVAP the two most common methods are the CVCD and the SCP. The SCP has been the common choice by surgeons over the CVCD method. SCP occasionally results in pneumothorax, arterial puncture, hemothorax and brachial plexus injury. These complication rates have been documented to be around 12% (Biffi, 2009). Cardiovascular usage of the subclavian vein for pacemaker lead placement has observed pinch off or subclavian crush syndrome where the lead placed via the subclavian vein is crushed between the first rib and the clavicle (Koketsu, 2010). The CVCD has been shown to be a safe and feasible option for TIVAP placement as well as having a lower complication rate when compared to the subclavian method (Koketsu, 2010). Additionally, the CVCD technique did not observe the occurrence of pinch-off/subclavian crush syndrome (Koketsu, 2010). However, the

failure rate of the CVCD was noted at 6% with the cause being anatomical abnormalities or failure to locate the cephalic vein (Koketsu, 2010).

With anatomical abnormalities including absence of the CV being noted as a challenge in utilizing the CV for TIVAP placement, it has been the focus of several studies. According to current research the CV is present 96% of the time (Loukas, 2008, Dogood, 2017, Steckiewicz, 2015). When present, the CV is superficial to the fascia and adipose tissue of the deltopectoral groove 74% of the time and deep 26% of the time (Loukas, 2008, Dogood, 2017, Steckiewicz, 2015). The CV has a documented anatomical abnormality of a supraclavicular course occurring 2% of the time (Loukas, 2008, Dogood, 2017, Steckiewicz, 2015).

Common method employed for locating the CV is to locate the deltopectoral groove topographically. A study found by Luis Andres published in 2009 recorded that the CV was located median to the CP at an average distance of 7.9 mm +/- 6.0 mm with a range of 0-20 mm (Yeri, 2009). This data point raises the possibility that the CP could serve as a topographical bony landmark to locate the position of the CV. More research is needed to make this claim.

Of note: when the CV is < 1 mm it will be unsuitable for pacemaker lead placement (Steckiewicz, 2015), making the diameter of the CV an important measurement. An additional study recorded that out of an n=548, 324 patients had CV diameters of > 1.5 mm and were found to be independently associated with the primary functional maturation of 86% in the radiocephalic arteriovenous fistula maturation. It was stated that along with the radial artery diameter, CV diameter was the most significant factor associated with autogenous radiocephalic arteriovenous fistula maturation (kordzadeh, 2017). This paper further justifies the value of accurate diameters of the CV in anatomical studies. The current studies have been seen to use several methods for measuring diameter from taking pictures of dissections and analyzing with

computer for pixel difference, ultrasound measurements as well as measuring the whole CV with calipers when it is still in the cadaver. It was noted that no standardized method for measuring the CV diameter was utilized. Despite taking extreme precaution every method has its short falls. Ultrasound, although known to be accurate, is very user dependent. Measuring a whole cephalic vein will not translate to inner luminal diameter and is very dependent on whether the vein collapses slightly. In addition, computer programs are not widely used or accessible to all labs. This calls for a standardized method of measuring vein diameter so that all papers will be on the same page and can be easily compared no matter what tools and resources are available. This is understood to be difficult as some papers are dealing with live patients and others with cadaver specimens.

SPECIFIC AIMS

When conducting a CVCD procedure, it is imperative that a clinician have confidence to find the CV. The CV has an absence rate of 4%, however, it is still recommended as the first choice over the SCP for central venous access (Loukas, 2008, Dogood, 2017, Steckiewicz, 2015). This study is an attempt to bring data to the table that will convince physicians to transition to the CVCD over the SCP. We will do this by attempting to establish a formal topographical anatomical landmark.

Aim 1: Determine if there is a consistent landmark that can be used by clinicians to locate the CV.

Hypothesis 1: The CV will be located within 1 cm of the coracoid process a statistically significant amount of the time.

Aim 2: Develop an accepted and standardized method to measure the diameter of the CV both in vivo and once removed.

Hypothesis 2: There is a constant difference seen between cadaveric vessel diameter (removed) and in vivo diameter of measurement of the CV.

SIGNIFICANCE

We found a single study that referenced a data point that related the CV to the CP. This study measured straight line distance from the medial edge of the CP and the lateral edge of the CV (Yeri, 2009). This distance was found to be 7.9 mm +/- 6.0 mm with a range of 0-20 (Yeri, 2009). However, when a clinician is preparing to conduct a CVCD on a patient, it may be difficult to palpate the medial edge of the CP. We believe that a distance from the center of the CP to the center of the CV will be a more useful measurement. Straight line distance by itself can be helpful but gives an incomplete picture of the effectiveness of the CP as a topographical landmark. That is why we included horizontal, vertical and angular offset of the CV from the straight-line segment between bilateral acromion processes.

Should this study prove the effectiveness of the CP as a topographical landmark in locating the CV it would improve efficiency of clinicians in learning, teaching and conducting the CVCD. It is our hope that this increased efficiency will lead to more clinicians choosing the CVCD over the SCP method. This choice would benefit patients in that the CVCD has been shown to have less complications when compared to the SCP (Koketsu, 2010).

Additionally, there is no currently accepted standard for measuring the diameter of the CV in cadaveric anatomical studies. The chosen method is variable depending on multiple factors including resources. The CV research study will measure diameter via inner luminal circumference and obtain the diameter mathematically. This method is simple and requires

minimal special equipment. This technique will hopefully be adopted as the standard for future anatomical studies.

The final cutting-edge part of this study will be the data gathered by relating the diameter of the vein in the cadaveric specimen to the diameter of the vein when placed under physiological pressures. These data will attempt to provide a conversion table for the CV from cadaver to live tissue giving clinicians applicable data for their practices.

MATERIALS AND METHODS

This research is a cadaveric study. A bilateral dissection of the CV will be conducted on approximately 41 cadavers. Measurements will be taken in vivo of the CV. Then the CV will be removed from the cadavers for further testing of their diameters. The mean will be obtained for all quantitative data as well as standard deviation. A one sample, student t-test will determine statistically significant, with a 95% confidence interval. The expected distance from the CP to the CV will be set at $\geq$ 10 mm. We believe this distance would give significant power to these data for use in clinical setting. The t-test will also be conducted with the expected population mean set at $\geq$ 15 mm to evaluate statistical significance if the surgeon has a greater field of view.

Section 1: Cadaver Data Recorded

Basic data will be obtained from medical history, if present. BMI will be obtained from history. Position of the body will be noted and likely will be in the supine position. The shoulder region will be evaluated for any abnormalities to include surgical scars, tattoos, implantable devices, growths or anatomical abnormalities. The entire chest region will be evaluated for similar abnormalities.

Section 2: Measuring Prior to Dissection and dissection technique

Distance from the jugular notch to the axillary will be measured. The axilla measurement will be taken from the most superior point of the axillary cleft. The distance from the axillary cleft will also be measured to the acromion process. The distance from the axillary cleft to the superior portion of the clavicle will be obtained as the length of the deltopectoral groove. After completion of these measurements a straight incision will be made from the medial one-third of the clavicle to the axillary cleft at an approximate forty-degree angle. A second incision will be made from the superior point of the first incision perpendicular to the sternum until the edges of the lateral and inferior incisions are in line vertically. The resulting triangular fold of skin will be reflected laterally and clamped down with forceps. Fat and fascia will be removed in a stepwise fashion until the muscle fibers are visible, and the fat surrounding the cephalic vein is observed.

Section 3: Recording Cephalic Vein Variability

The presence of the CV will be noted, and its location will be described as either, superficial, deep to muscle, absent or an anatomical variant. Superficial notation will be selected when the CV is in the deltopectoral groove but is not covered superficially by muscle belly. Superficial notation will be given if the vein is between the muscle belly of the deltoid and the pectoralis major muscles. A notation of deep will only be given if the CV is covered superiorly by the muscle of either the deltoid or the pectoralis major muscle. If no CV is located a further dissection will be conducted to confirm absence or anatomical variant.

Section 4: Coracoid Process Measurements

The coracoid process will be palpated, and the center will be marked with a blue stick pin. A clock position will be given to the most direct route to the CV. A direct distance will be measured in millimeters from the previously mentioned blue pin to the center of the CV. A horizontal and vertical distance will also be measured in millimeters from the previously mentioned pin to the center of the CV. Distance from the superior portion of the acromion process to the closest edge of the CV at its location closest to the coracoid process will be measured.

Depth will be measured by taking the scalpel and noting the depth of the cut from the outermost part of the dermis to the most superficial edge of the CV at the coracoid process. This portion of the scalpel will then be measured with a digital caliper. A goniometer will be positioned so the pendulum is parallel with the sternum and perpendicular with an imaginary line segment between bilateral acromion processes. The swinging pendulum of the goniometer will then be aligned with the angle of the CV at the point closest to the CP.

Section 5: Image Documentation

Pictures will be taken with a Canon EOS Rebel T6, Manufactured in Oita, Japan, Using a tripod at its highest setting and the two forward legs up against the cadaver tank. Pictures will be obtained on the Canon EOS Revel T6 on 18x magnification and 55x magnification with a R and L marker visible to establish right and left laterality. A probe will be used when necessary to clearly demarcate the vein edges and a blue stick pin will mark the CP.

Section 6: Final Measurement of CV Diameter

Once the vein is extracted from the body it will be taken to the Center for BioHealth Lab (CBH-369) where it will be placed in a monometer and put under pressure of 100 mm H20 (Ochsner). Once pressure has been reached the outer diameter of the proximal, middle and distal portions of the vein will be measured. Once this is completed a straight-line incision will be made across the entire length of the vein and it will be opened up and put between two glass slides. The circumference of the inner lumen will then be measured, and the resulting circumference will be divided by Pi to obtain the diameter. This measurement will be taken at the separate three points (proximal, middle and distal). Since the outer diameter was taken under pressure. The resulting difference will be evaluated to attempt to obtain a constant difference between the two data points.

RESULTS

A total of 41 Cadavers were dissected. There were 23 males and 18 females (Appendix Table A2). A single female cadaver was only able to have dissections completed on one side due to advanced tumor growth in the axillary region on the left (L) side. This L side was not counted as absent but rather was just disregarded from the study due to the inability to complete a thorough dissection. This made for a total of n=81 (41 x 2 -1=81) shoulder dissections conducted. The location of the CV as well as absence rates and superficial verse deep are summarized in Table 1 below.

Table 1: CV Location Breakdown

CV Present (93%)	75/81	
	Superficial Groove (97%)	73/75
	Deep Groove (3%)	2/75
	Anatomical variations (0%)	0/75
CV Absent (7%)	6/81	
Total (n)	81	

A mean and standard deviation (SD) were obtained for all data points (Table 2). Straight line distance was the only data point where a student t-test was conducted. This data point was a direct line measurement from the CP to the CV in a medial direction. The data were analyzed using a Shapiro-Wilk Test (SWT) to check for normality. The SWT showed a rightward/positive skew and a *p*-value of 0.0597345. This result was under suspicion, so the data were normalized using a square root data transformation. The SWT on the transformed data were *p*-value of 0.9876 with a normal distribution and without any skew. A Turkey Fence test was done and showed no outliers in the data set. Nest, the data were analyzed using a one sample, left tailed, student *t*-test against an expected population mean. The population mean was set to 10 mm so that the H_0 would predict the data would be $\geq$ 10 mm while the H_a would predict the data was < 10 mm. The α was set to 0.05. The resulting *p*-value was 0.333906 and the test statistics was -1.860547. The H_0 was rejected. Since clinicians will likely have more than 10 mm of open incision while gaining access to the CV, the *t*-test was repeated with an expected population mean of 15 mm. The resulting *p*-value was $3.66613e^{-16}$ and the H_0 was rejected. When α was set to 0.0001. The results remained significant. Diameter of the CV was obtained by taking the circumference of a open vein and dividing by π. The formula used was $d=C/\pi$.

Figure 1: Box plot of data

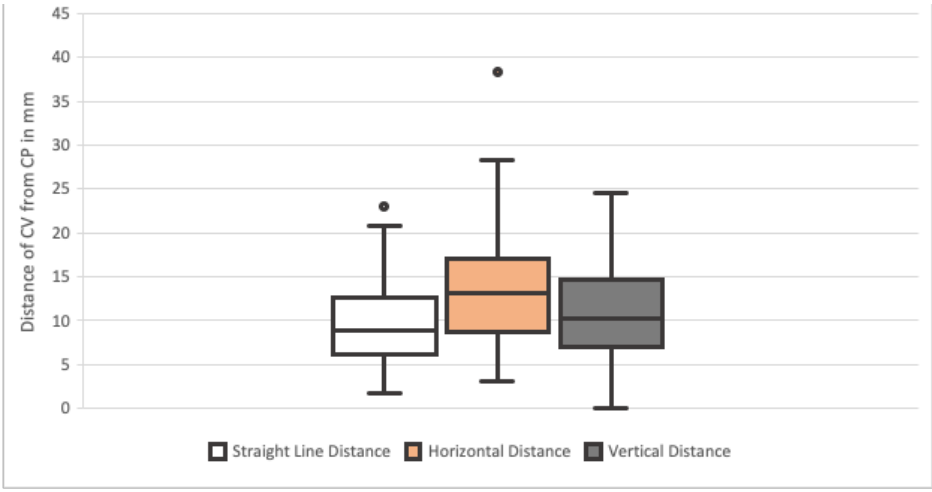

Table 2: Pertinent Data Points Means and STD

	Mean	STD
Straight distance	9.48* mm	4.45 mm
Horizontal distance	13.50 mm	6.45 mm
Vertical Distance	11.03 mm	6.45 mm
Diameter	4.99 mm	2.08 mm
CV depth	13.53 mm	7.68 mm
Angle of CV	34.28 °	8.82 °
Groove Length	104.96 mm	9.35 mm
CV diameter	1.59 mm	0.67 mm

** Indicates statistical significance at α=0.05*

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DISCUSSION

This study showed that the CP can be utilized as an efficient topographical landmark to locate the CV within 1 cm. Furthermore, this study showed that when the parameters are widened to 1.5 cm, the statistical significance is increased to $\alpha = 0.0001$. We hope that this data will encourage more clinicians to adopt the CVCD over the SCP method. Clinicians can have confidence while utilizing the CP to locate the CV that this method will show the CV to be found a statistically significant portion of the time. Furthermore, if clinicians utilizing this method do not locate the CV quickly, they now have statistical data that shows the CV is likely not present either by absence or anatomical variation. Based on this paper, these clinicians can quickly transfer to an alternative method for central venous access. The added confidence to make this quick transition is one of the main objectives this study gives to clinicians. They should not waste valuable time with a patient under anesthesia looking for the CV when it is likely not there. This will aid in lower anesthesia times and operating time, hopefully creating greater outcomes for patients.

The new method of diameter testing was successful and simple. This method can be completed with few resources which makes it ideal for labs working on a smaller budget. The measuring portion can be completed manually, with the use of a similar microscope as presented in this study, or with pixel computer imaging technology. Due to the positioning of the vein during dissection we recommend that a circumference-based diameter testing be the new standard vein measurement for in cadaver-based anatomy. This will allow for uniformity of data collection for this type of research within the clinical and anatomical communities.

LIMITATIONS

This paper had some limitations. Since we were utilizing cadavers from a health science center that were intended for dissection within the medical school's anatomy courses, we were limited to these cadavers with no choice for using fresh or additional specimens. This also meant that our dissections were very limited to the axillary region since we could not disturb other potential areas needed for dissection in the anatomy course. In a future study it would have been nice to dissect out the entire CV from hand to axillary. This added data would have helped to track the CV better and aid to our overall understanding of the entirety of the CV as a whole. It was for this limitation that the scope of the study was focused on the CV in relation to the CP in the axillary region. The pressurized data testing was unable to be completed possibly due to damage the vein sustained during dissection and extraction. It may have been successful if greater care was used during the dissection as well as more blunt dissection verse sharp instrument dissection. It is our opinion that these data would aid greatly to the study of cadaver-based anatomy and it is our sincere hope to refine the procedure and attempt it again in a future study.

Due to difficulty fixating the extracted vein onto the monometer for pressure testing, we were unable to address specific aim 2. Multiple attempts were made including changing sutures from prolene to nylon and finally vicryl with no success. The veins did not hold their pressure well enough to get a good sample measurement. Unfortunately, we were not able to complete this portion of the study due to issues with pressure testing that were varying too much from sample to sample

SUMMARY AND CONCLUSIONS

The placement of TIVAPs for central venous access is a procedure that is done routinely in hospitals and clinics across the world. The two main procedures are the cephalic vein cut-down procedure (CVCD) and the subclavian puncture (SCP). The CVCD has been shown to have less complications (Otsubo, 2016) and is recommended to be the first choice (Cavallaro, 2014). However, the SCP is still the first choice for most clinicians. We hypothesized that difficulty locating the CV could be a reason that clinicians prefer the SCP over the CVCD. This difficulty locating the CV has shown to increase average operating times of the CVCD which can play a big factor in clinician efficiency and anesthesia times can affect patient complication rate. This study set out to give clinicians statistical data to aid them in locating the CV via the CP. We hope that clinicians will make the CVCD their first choice utilizing the CP to locate the CV quickly, which we have shown statistically to be doable. If a clinician utilizes this method and is not able to quickly locate the CV, they now have statistical evidence that the CV is likely not there and can rapidly transition to the SCP procedure utilizing the original incision for the port pocket of the SCP. With this technique, even if the CVCD is unsuccessful, it will not waste significant time, but if it is successful it will help to reduce complication rates significantly through reduction in total time in surgery.

We showed that the CP can be used to locate the CV within 1 cm at a significance of $\alpha = 0.05$ and within 1.5 cm at a significance of $\alpha = 0.0001$ (Aim 1). We were unable to confirm a formula for relating cadaver vein diameters to live tissue diameters due to difficulty maintaining airtight seals on the extracted vein samples (Aim 2). However, we were able to show the simplicity of measuring vein via circumference then calculating mathematically to obtain the

diameter (Aim 2). This method was simple and cost effective and could standardize the cadaver-based vein diameter testing.

In summary, This study adds to the current data that is known about the cephalic vein including location rates and diameter. Specifically, these data give clinicians the confidence to quickly locate the CV, perform a CVCD if possible, and if unsuccessful, then move rapidly to the alternative, yet less desirable SCP method, without lengthening surgical time.

CHAPTER III

INTERSHIP EXPERIENCE

DESCRIPTION OF INTERNSHIP SITE AND EXPERIENCE

This internship practicum was performed at the University of North Texas Health Science Center in Fort Worth, TX under the direct supervision of Rustin Reeves, PhD over the course of a year as a partial requirement for the degree of Master of Science. When I began the project in May 2019, I was assigned by Drs. Reeves and Yurvati to gather information on the CV and determine how often it is found in specific locations near the deltopectoral groove. Dr Yurvati had a vested interest in the topic as a vascular surgeon who routinely places TIVAPs. I started by performing a detailed literature search into previous articles that had been published on the topic of the CV as well as learning about the procedure itself. It was during this time that I made the determination that the CP could be utilized as a good landmark for the CV. I looked over anatomy figures as well as an additional background literature search. I discovered that it had been measured before, but the measurement was only a straight-line distance and it was from the medial edge of the CP to the lateral edge of the CV. This study did measure the distance from the CP to the CV, however, they did not mention the possibility of using the CP as a topographical landmark to locate the CV. I decided more data points could be beneficial to clinicians and decided to base the research project around proving the CP could be utilized to locate the CV. I met weekly with Dr. Reeves throughout the entire year long project from May 2019-August 2020. Our weekly meetings were an opportunity for me to update Dr. Reeves as well as ask for

guidance or clarification on anything I needed. In June 2019 I presented my Work-in-progress seminar in the Center for Anatomical Sciences.

All cadavers for this study were provided by the UNTHSC. We used cadavers from the physical therapy program as well as both medical school programs (TCOM and UNT/TCU). I had to wait for the donors to be prepared for dissection for the anatomy course before I was able to have access to them. Once access was given, I had a tight time schedule to complete my dissections before the course would get to the shoulder. I was very busy for this period dissecting the TCOM's donors given the large number of them and the short amount of time before the students started their dissection on the shoulder region. During the weeks of September and October of 2019, I paused my research to focus on my Structural Neuroscience course I was taking.

Due to the dissection timeline, I was finished with all my dissections prior to completing the literature review. It was for this reason that I continued to pour over the current research well after my initial dissections were complete. After the dissections I moved to CBH-369 to work on the pressure testing of the extracted veins. Over many weeks I attempted to secure the veins with an air-tight seal. However, this was only able to be accomplished with a handful of veins and I did not feel that the data was yielding any results. It was during this time that I suspended work on the pressure testing of the veins and ruled this part of my project "unable to complete".

The results of this study have been reported in this practicum report. I was accepted to present at the 2020 UNTHSC Research Appreciation Day. However, this even was cancelled due to health concerns regarding the Coronavirus outbreak of 2019-2020. I am awaiting approval to present in June, 2020 at the American Association of Clinical Anatomist annual conference in New York, NY.

This study showed me a behind the scenes look into the world of anatomical research. It was more difficult than I ever imagined and involved many challenges and hurdles to overcome. I was given the amazing chance to learn from my PI, committee members as well as all the faculty and students in the Center for Anatomical Sciences. This collaborative effort has helped me to develop as a student and scientist.

JOURNAL SUMMARY

- May 2019
    - 6-10th
        - Met with Dr Yurvati at Medical City Hospital.
            - Discussed Project and specific aims.
            - Introductions with Dr Adam Beyer (surgical Resident).
        - Began in depth article review on CV research as well as central venous access.
        - Began formulating data tables and measurements to be taken.
    - 13-17th
        - Continued article reviews.
        - Added additional data points to table.
    - 20-24th
        - Determined the CP could make for a good anatomical landmark.
        - Decided to utilize clock position as data point.
        - Created table of topographical markers to obtain measurements.
    - 27-31st

        - Met with Dr. Reeves
            - Discussed central access procedure and how it is conducted to include patient arm position.
            - Went over data points to be collected.
            - Scheduled meeting with Dr Yurvati.
            - Received permission to take photographs of specimen (Cadavers) during the course of the study.
        - Obtained workspace CBH-369.
        - Completed Designation of Advisory Committee form
- June 2019
    - 3-7th
        - Lunch with anatomy, genetics and physiology research track students (5th)
        - Met with Dr Reeves to practice procedure on single cadaver.
            - Data obtained and recorded
            - Determined picture procedure as well as measurements will require calipers.
    - 10-14th
        - Received key to CBH-369
        - Met with Dr. Reeves
            - Scheduled dissections times for individual cadaver sets.
            - Made plans to obtain goniometer for angular measurements
        - Participated in JAMP anatomy lab (13th)
    - 17-21st

        - Participated in TABs program week (17th-20th)
    - 24-28th
        - Work in Progress presentation (24th)
- July 2019
    - 1-5th
        - Independence Day (4th)
    - 8-12th
        - Met with Dr Reeves to discuss upcoming meeting with Dr Yurvati
    - 15-19th
        - Meeting with Dr Reeves and Dr Yurvati
    - 22-26th
        - Dissected first set of PT cadavers with Dr Reeves
- August 2019
    - July 29th-August 2nd
        - Nothing to report
    - 5-9th
        - Started UNT/TCU cadaver dissections (8th)
    - 12-16th
        - Started TCOM cadaver dissections aided occasionally by Alfred Abraham OMS3
    - 19-23rd
        - Deadline to be finished TCOM cadaver dissections (22nd)
    - 26-30th

        - Began data compiling of all collected information. Developed excel spreadsheet equations

- September 2019
    - 2-6th
        - Continued data evaluation and began statistical analysis of data.
        - Ran data means through student t-tests and confirmed statistical significance.
    - 9-13th
        - Out of Town
    - 16-20th
        - Met with Dr Reeves. Discussed goals and expected deadlines including upcoming conferences.
    - 23-27th
        - Taking Structural Neuroscience Course with TCOM (September 24th – October 15th)
- October 2019
    - September 30th- October 4th
        - Taking Structural Neuroscience Course with TCOM (September 24th – October 15th)
    - 7-11th
        - Taking Nervous System Course with TCOM (September 24th – October 15th)
    - 14-18th

        - Taking Nervous System Course with TCOM (September 24th – October 15th)
    - 21-25th
        - Met with Dr Reeves to discuss research project work to be done post nervous system course.
- November 2019
    - October 28th- November 1st
        - Final Preparations for Proposal defense
    - 4-8th
        - Research Proposal Defense
    - 11-15th
        - Made adjustments based on proposal defense. Began making final data compilations and evaluations
    - 18-22nd
        - Met with Dr Reeves to discuss data evaluations and statistical evidence post proposal defense. Discussed any relevant adjustments based on proposal defense
    - 25-29th
        - Thanksgiving Break (22nd-26th)
- December 2019
    - 2-6th
        - Met with Dr Reeves to discuss work to be done in the new year after Christmas break.

- 9-13th
    - Christmas Break.
    - Met with student from Department of Biostatistics and Epidemiology to have statistics checked.
    - Completed Intent to Graduate form.
- 16-20th
    - Christmas Break.
- 23-27th
    - Christmas Break.

- January 2020
    - December 30th- January 3rd
        - Christmas Break.
    - 6-10th
        - Began work on Internship practicum
    - 13-17th
        - Work on Internship Practicum
    - 20-24th
        - Work on Internship Practicum
    - 27-31st
        - Work on Internship Practicum
- February 2020
    - 3-7th
        - Work on Internship Practicum

- 10-14th
    - Work on Internship Practicum
- 17-21st
    - Work on Internship Practicum
- 24-28th
    - Work on Internship Practicum

- March 2020
    - 2-6th
        - Abstract accepted to 2020 RAD
        - Out of town from 4th-12th
    - 9-13th
        - Out of town from 4th-12th
    - 16-20th
        - Internship Practicum submitted to committee
    - 23-27th
        - Research Appreciation Day on March 27th Cancelled
            - In light of public health concerns regarding COVID-19

- April 2020
    - March 30th- April 3rd
        - Practicum defense April 1st

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APPENDIX A

Table A1: Abbreviations used in this report.

Abbreviation	Definition
TIVAP	Totally Implantable Venous Access Port
SCP	Subclavian Puncture
CVCD	Cephalic Vein Cut-Down
CV	Cephalic Vein
SV	Subclavian Vein
CP	Coracoid Process
SD	Standard Deviation
SWT	Shapiro-Wilk Test
L	Left
R	Right

Appendix B

Table B2: Pertinent data points means list and STD

	Mean	STD
Straight distance	9.48* mm	4.45 mm
Horizontal distance	13.50 mm	6.45 mm
Vertical Distance	11.03 mm	5.17 mm
Diameter	1.59 mm	0.67 mm
CV depth	13.53 mm	7.68 mm
Angle of CV	34.28 °	8.82 °
Groove Length	104.03 mm	11.96 mm

** Indicates statistical significance at α=0.05*

Table B3: Gender Breakdown

Males	Females
23	18

Table B4: Breakdown of CV Locations.

CV Present (93%)	75/81	
	Superficial Groove (97%)	73/75
	Deep Groove (3%)	2/75
	Anatomical variations (0%)	0/75
CV Absent (7%)	6/81	
Total (n)	81	

Appendix C

Figure C1: Box plot of data

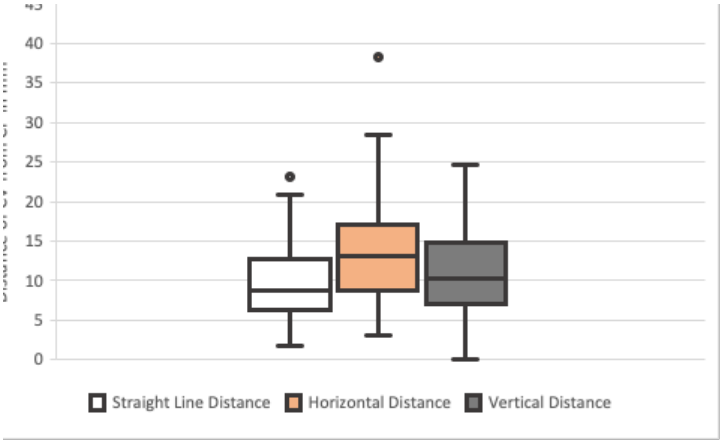

Figure C2: Graphical representation of data on human body

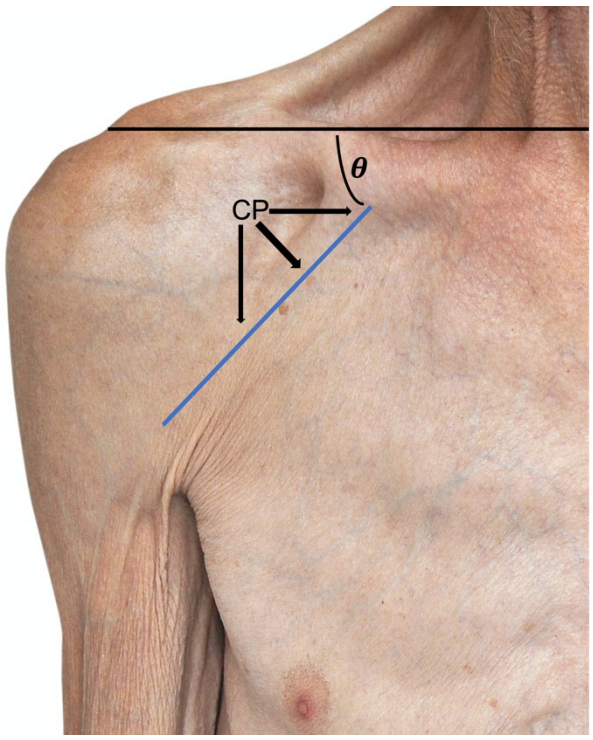

Figure C3: Picture illustration of the TIVAP

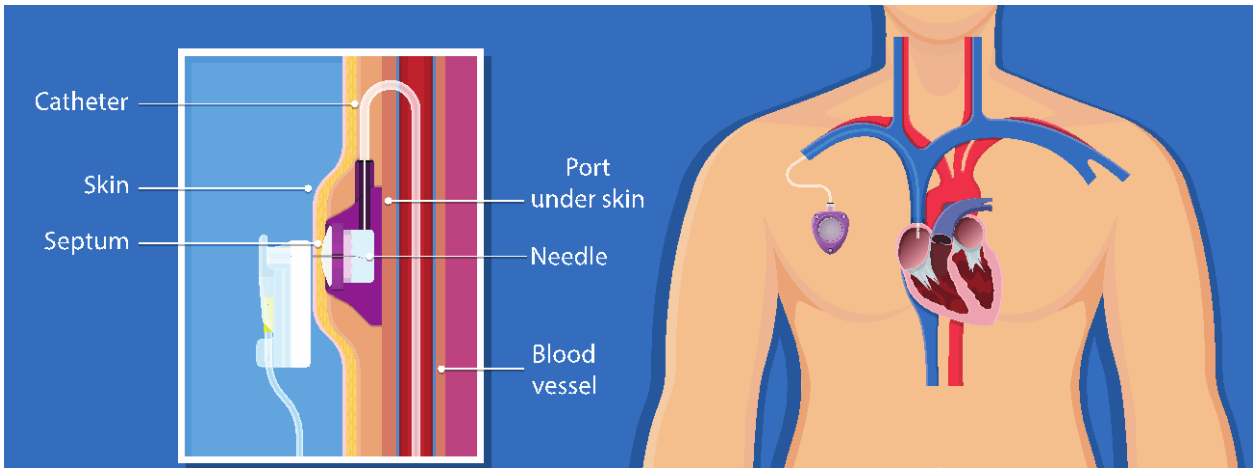

Figure C4: Anatomical representation of CV superimposed on bones

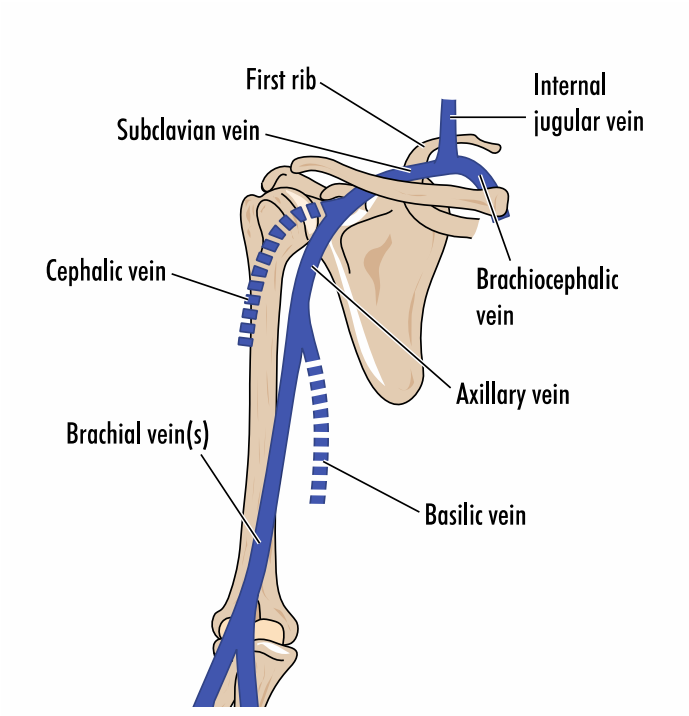

Figure C5: Anatomical representation of the CV superimposed on skin

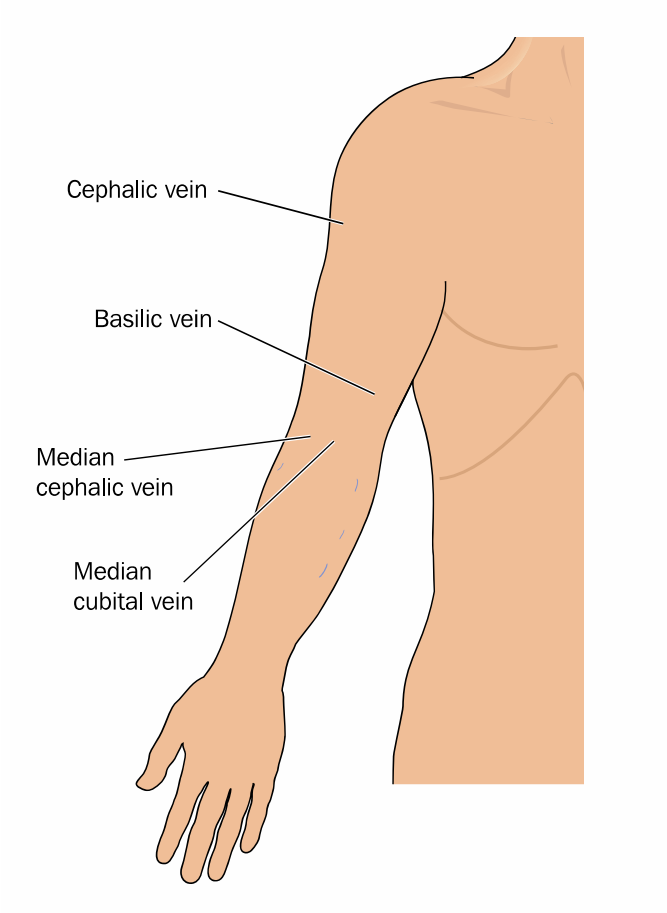

Figure C6: Graphical representation of data