INFRACLAVICULAR BRACHIAL PLEXUS BLOCKS - COMPARISON OF NEONATAL AND ADULT ANATOMY

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Introduction

The infraclavicular approach to the brachial plexus (BP) was designed to inject the local anaesthetic solution inside the BP sheath, effectively blocking the cords and branches of the BP above and below the formation of the musculocutaneous and axillary nerves [1].

Accurate placement of the needle in close proximity to the nerve is essential for a successful block, and correct placement requires a familiarity with regional anatomy and landmarks[2]. Difficulty arises when there is anatomical variation as seen in the growing child and when landmarks are difficult to identify. Techniques based on measurements from a fixed anatomical point clearly have limitations when applied to all age groups.

A search of the literature reveals a lack of information regarding the anatomy relevant to a neonatal age group. Even studies aiming to determine the success of the block in paediatric patients, use techniques that were originally developed for adults.

Is the positional anatomy of the BP in neonates significantly different to that of adults? Can techniques developed in adults be successfully used on children? With regards to the ilio-inguinal/ iliohypogastric nerve block, a previous study[3] determined that children are not "small adults" and it would be premature to use data obtained from an adult sample and simply downscaling it to use on a child.

Aims

The aims of this study were to determine the relationship of the BP (and its components), within the axilla, to the coracoid process (CP) for both a neonatal and adult sample.

Secondly, to use the data obtained, in the above-mentioned aim, to determine an improved needle insertion site for the infraclavicular block using the CP and the xiphisternal joint (XS) as bony landmarks.

And finally to compare the data obtained in the neonatal sample to that of an adult sample.

Materials and methods

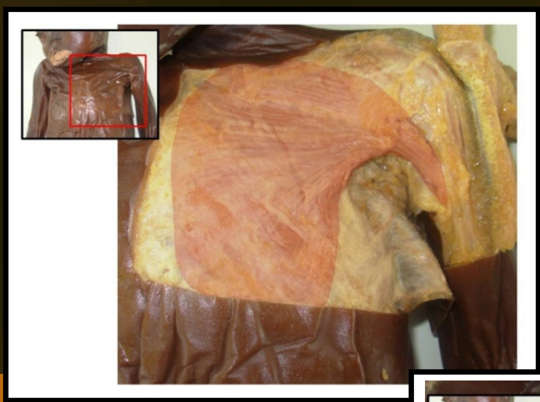

Figure 1: Skin reflected from the pectoral region of a neonatal cadaver in order to expose the pectoralis major muscle (highlighted in red).

The content of the axilla was carefully exposed in a sample of 52 neonatal cadavers (52 left and 50 right axillae; mean length: 0.43m ± 0.08m; mean weight: 1.94kg ± 1.62kg) and a sample of 81 adult cadavers (74 left and 70 right axillae; mean length: 1.70m ± 0.09m; mean weight: 57.57kg ± 14.95kg). The skin over the pectoral region was first removed in order to expose the pectoralis major muscle (see Figure 1), and subsequently reflect it in order to expose the underlying pectoralis minor muscle (see Figure 2).

Figure 2: Pectoralis major muscle (highlighted in red) reflected in order to expose the pectoralis minor muscle (highlighted in orange) extending from the coracoid process to the ribs.

Care was taken not to disturb the structures within BP sheath as the pectoralis minor was reflected (see Figure 3). The axillary vein was carefully removed in order to better visualise the structures of the axilla. The distance between (i) the CP and the XS (CP-XS line) was measured using a mechanical dial sliding calliper (accuracy of 0.01mm). All measurements were done with the cadavers' arms adducted and supinated, lying against the trunk.

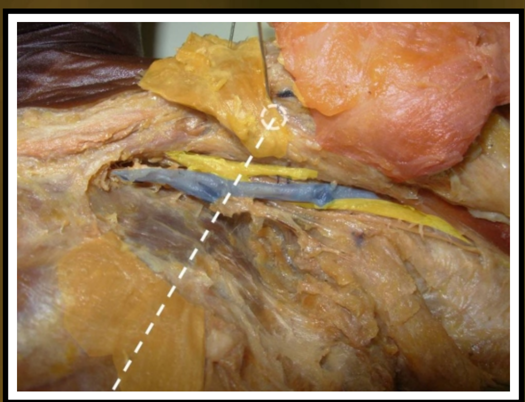

Figure 3: Both the pectoralis major muscle (highlighted in red) and the pectoralis minor muscle (highlighted in orange) has been reflected in order to expose the BP sheath. The axillary vein and BP (lateral cord and some terminal branches are visible) are highlighted in blue and yellow respectively. The position of the CP is indicated by the dashed circle, while the CP-XS line is indicated by the white dashed line.

The distances of the CP to (ii) the lateral cord of the BP (LBP) and (iii) medial cord of the BP (MBP) were then measured on the CP-XS line, as well as (iv) the distance between the LBP and MBP. These distances were then converted to a percentage of the CP-XS line distance and inserted into an MS Excel™ worksheet

The midpoint between the LBP and MBP, along the CP-XS line was also determined as this should be the ideal point of needle insertion. Therefore (v) the ideal point of needle insertion = measurement ii + ½ measurement iv (see Figure 4).

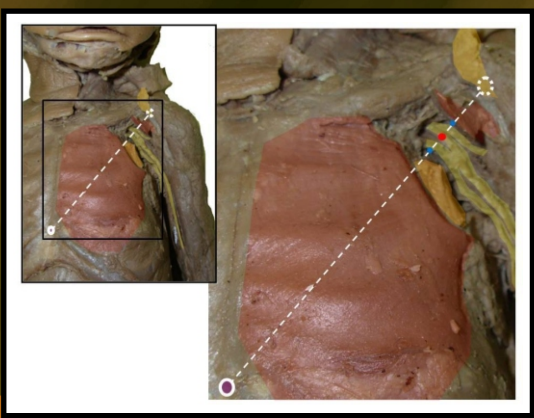

Figure 4: Both the pectoralis major and minor muscles (highlighted in red and orange respectively) have been reflected in a neonatal cadaver in order to expose the BP (highlighted in yellow). The red circle indicates the ideal site for needle insertion, or the point halfway between the LBP and MBP (blue circles) on the CP-XS line (white dashed line, between CP (dashed circle) and the XS (purple circle with white border).

In order to compare the results of the neonatal sample with the adult sample, a paired t-test was performed on measurements (ii) (v). Only the values given as a percentage of the CP-XS line distance were compared as the distances in millimetres quite clearly shows a difference between neonates and adults, due to the large size differences and not because of differences of the position of the BP within the axilla.

Results

A paired *t*-test revealed no significant difference (p > 0.05 all measurements) between the left and right sides of either the neonatal or adult samples. The left and right sides were therefore combined for the neonatal (total n = 102 axillae) and adult (total n = 144 axillae) samples. The results of both samples are summarised in Tables 1 and 2.

Table 1. Measurements for the total neonatal sample

	Total									
	CP – XS	CP – LBP		CP – MBP		LBP – MBP		MBP – Rib	CP – needle insertion	
	(mm)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(%)
n	102									
Mean	58.80	5.26	8.90	10.05	17.07	4.79	8.18	4.83	7.66	12.99
SD	11.47	1.73	2.12	2.67	3.04	1.37	1.89	2.34	2.16	2.46
Min.	36.53	2.38	5.59	5.29	11.53	2.32	4.94	1.78	3.89	8.61
Max.	91.88	12.34	14.29	18.57	29.22	8.53	15.84	19.37	15.52	20.02
CI 95%	2.23	0.34	0.41	0.52	0.59	0.27	0.37	0.45	0.42	0.48
Lower	56.57	4.93	8.49	9.53	16.48	4.53	7.82	4.38	7.24	12.51
Upper	61.02	5.60	9.31	10.56	17.67	5.06	8.55	5.28	8.08	13.47

Key:
CI 95%: Confidence interval with a 95% confidence level
Lower: Lower range of the confidence interval with a level of confidence of 95%
Upper: Upper range of the Confidence interval with a level of confidence of 95%

Table 2. Measurements for the total adult sample

	Total									
	CP – XS	CP – LBP		CP – MBP		LBP – MBP		MBP – Rib	CP – needle insertion	
	(mm)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(mm)	(%)
n	144									
Mean	232.18	23.51	9.96	36.44	15.52	13.87	5.98	16.78	30.45	12.95
SD	28.93	8.45	2.77	10.18	3.04	3.17	1.12	4.77	9.14	2.80
Min.	164.05	9.38	4.77	13.42	5.77	7.86	3.61	7.77	13.31	6.77
Max.	296.57	46.69	17.34	65.26	23.54	23.68	9.50	32.53	57.96	20.91
CI 95%	4.72	1.38	0.45	1.66	0.50	0.52	0.18	0.78	1.49	0.46
Lower	227.46	22.13	9.51	34.77	15.03	13.35	5.79	16.00	28.96	12.49
Upper	236.91	24.89	10.41	38.10	16.02	14.39	6.16	17.55	31.94	13.40

A Pearson's correlation test (this test determines the strength of the linear relationship between two variables, with a value more than 0.7 indicating a strong correlation) revealed that the only strong correlation between dependant and independent variables existed between distance of the CP to the ideal point of needle insertion (dependant variable) and the CP-XS line distance (independent variable). This strong correlation was found in both the neonatal (R = 0.7460) and adult (R = 0.7681) samples.

Comparison between adult and neonatal data

A comparison between measurements ii v showed that there is a statistically significant difference between the position of the MBP (p = 0.0000), the distance between the LBP and MBP (p = 0.000) and the distance of the ideal point of needle insertion from the CP (p = 0.0179). There is however no statistical difference between the distance from the CP to the LBP (p = 0.3264). This could indicate that the position of the lateral cord of the brachial plexus, in relation to the CP, remains in a more constant position within the axilla, throughout development.

Because there is a statistically significant difference of the point of needle insertion between the neonatal and adult data, and because of the strong correlation between the two variables, two separate linear regression formulae was developed in order to determine the distance of the point of needle insertion. The two separate linear regression formulae, determined for both the neonatal and adult sample, can be seen in Figure 5.

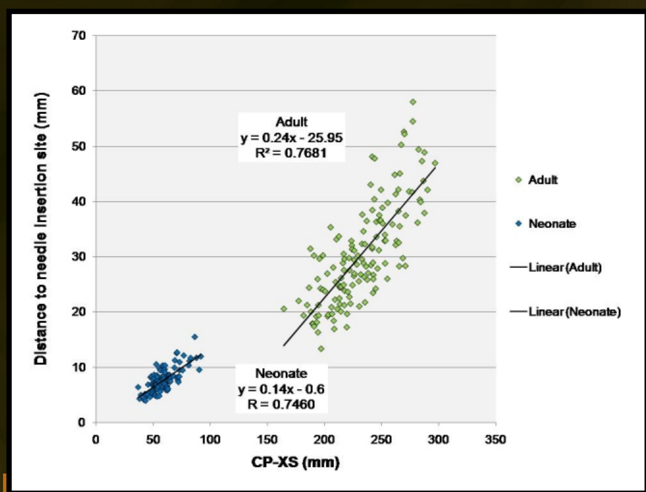

Figure 5: Linear regression formulae, for both the neonatal and adult sample, plotted on graph, with the distance to the point of needle insertion from the CP, as the dependent variable, and the CP XS distance as the independent variable.

Discussion

Sound knowledge and understanding of anatomy is vitally important for successful nerve blocks. Extrapolation of anatomical findings from adult studies and simply downscaling these findings in order to apply them to infants and children is inappropriate. This study demonstrated that the there are significant differences between the distance of the BP from the CP between neonates and adults.

This study shows that in neonates, with the arm adducted, the needle insertion site lies approximately 7.5mm from the CP on the CP-XS line. This is at a point that transects the cords of the BP, effectively increasing the chance of blocking the musculocutaneous and axillary nerves as well as the ulnar segment of the medial cord, which means the intercostobrachial nerve is also blocked. The needle should be directed parallel to the floor, effectively avoiding the possibility of piercing the pleura. The needle will pierce the skin and subcutaneous tissue, the pectoralis major muscle, the pectoralis minor muscle (covered anteriorly and posteriorly with clavipectoral fascia) and the fascia of the BP sheath, within which the brachial plexus and axillary artery lie.

Conclusion

This study suggests that caution should be taken when applying procedures originally described on adult patients on a paediatric population. A lack of knowledge regarding the differences in the distances from bony landmarks and relative depth of the BP may lead to complications or a failed block.

Therefore even with the aid of nerve stimulators or using ultrasound guidance, the anatomy should be well studied before attempting this block in paediatric

References

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