

Ultrasound evaluation of effect of different degree of wrist extension on radial artery dimension at the wrist joint

Venkatesh Selvaraj, Faiza Sulaiman Buhari

Department of Anesthesiology, Critical Care and Pain Medicine, Sri Ramachandra Medical College and Research Institute, Porur, Chennai, Tamil Nadu, India

ABSTRACT

Context: Successful arterial cannulation requires wide and patent arterial lumen. A recent study has shown that success rate of radial arterial cannulation at first attempt is more at 45° angle of wrist extension in both young and elderly patients. No study has reasoned whether these high success rates at 45° is because of less compression of the radial artery at this particular angle of wrist extension. Hence, we attempted to study whether the radial artery dimensions changes with increasing angles of wrist extension in young, healthy female volunteers using ultrasound examination. **Aim:** To investigate the effect of increasing angle of wrist extension of 0, 15, 30, 45, 60, and 75° on radial artery dimensions at the level of the wrist joint using ultrasound examination. **Settings and Design:** A prospective single blinded study in volunteers. **Subjects and Methods:** Sonographic measurements of radial artery dimension at the wrist level were performed in 48 young, healthy female subjects. Height (anteroposterior in mm), width (mediolateral in mm) and depth (skin to artery) were measured at wrist extension of 0, 15, 30, 45, 60, and 75°. The dimensions at each angle are compared with 0° as the control and statistical analysis done. **Statistical Analysis:** One-way analysis of variance test. **Results:** No statistically significant change in dimension of the radial artery is observed with increasing angle of wrist extension. **Conclusion:** Ultrasound evaluation showed that increasing angle of wrist extension does not significantly change the dimensions of radial artery at the wrist joint level in young healthy female volunteers.

Received: 20-05-15
Accepted: 06-10-15

Key words: Atherosclerosis; Female; Radial artery

INTRODUCTION

Many medical textbooks recommend mild extension at the wrist joint for successful radial artery cannulation.^[1] They never advise a particular wrist angle of extension for successful cannulation. Recent study has shown that success rate of radial arterial cannulation at first attempt is more with the wrist at 45° extension in both young and elderly patients.^[2] The authors have reasoned this finding to compression of radial artery with wrist extension. Hence, we studied the effect of the increasing angle of wrist extension of 0, 15, 30, 45, 60, and 75° on radial artery dimensions using ultrasound examination in young healthy female volunteers.

SUBJECTS AND METHODS

After Institutional Ethical Committee approval, 48 young healthy female volunteers in the

Address for correspondence: Dr. Venkatesh Selvaraj, Department of Anesthesiology, Critical Care and Pain Medicine, Sri Ramachandra Medical College and Research Institute, A6 OR Complex, No. 1, Ramachandra Nagar, Porur, Chennai - 600 116, Tamil Nadu, India.
E-mail: docvenky778@gmail.com

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

Cite this article as: Selvaraj V, Buhari FS. Ultrasound evaluation of effect of different degree of wrist extension on radial artery dimension at the wrist joint. Ann Card Anaesth 2016;19:63-7.

Access this article online
Website: www.annals.in
PMID: 26750676
DOI: 10.4103/0971-9784.173022
Quick Response Code: 

age group of 18–25 years were recruited after getting written informed consent in this prospective study. The procedures followed were in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 2000. We hypothesized that the dimensions of the radial artery at the wrist joint level changed with increasing angles of wrist extension in young healthy females. The sample size of 48 in each group based on statistical power analysis was arrived (explained in the statistical analysis). We included 48 American Society of Anesthesiologists I healthy female volunteers in this study. Participants with a history of the peripheral vascular disease, any pathology restricting wrist movements, body mass index (BMI) >30 and those with any scar or deformity at the wrist joint were excluded.

Six wrist metal splint boards [Figure 1], each at a different angle from 0° to 75° in 15° increments of the extension were made with a goniometer and used in this study. The splint angles are constantly checked with goniometer before examining each participant because the angle may change with constant usage. Subjects were evaluated in sitting position. The nondominant hand radial pulse was chosen for examination. Radial artery visualization was performed with a 15–8 MHz broadband linear transducer of a high-resolution B-mode SonixTablet ultrasonograph™ Ultrasonix Medical Corporation, Canada [Figure 2]. The ultrasound examination was done by a senior anesthesiologist for all the subjects. The point of prominent arterial pulsations at the level of the proximal crease of the wrist was palpated after positioning the hand fixed to the appropriate angled splint. The ultrasound probe was placed in a transverse plane at that point, and the same probe position was maintained throughout the study. Arterial visualization was confirmed by the

pulsatile flow. Transverse images of the radial artery were obtained. Care was taken by the examiner to avoid the effect of probe weight on the dimension of the artery. The gain and the depth of ultrasound imaging is fixed and kept same in all the participants. The same procedure was repeated with the other angled splints and images are recorded. The sonographic measurement was done by a separate anesthesiologist who is blinded for the splint angle used as shown in Figure 3. This blinding is done by covering the splint with a drape so that the Anesthesiologist is not aware about the splint angle being used for that particular image.

Measurement technique

The study parameters measured are height (anteroposterior dimension), width (mediolateral dimension) and depth (skin to artery distance) of the vessel lumen measured from the frozen two-dimensional ultrasonic image on the monitor. The ultrasound probe is placed transverse to the radial artery. The measurement was done at the lumen wall interface as shown in Figure 3. Height is the maximum diameter measured from the upper edge or lumen wall interface to the lower edge along the sagittal axis of the recorded image. Width is the maximum diameter measured from the right edge or lumen interface and the left edge along the horizontal axis of the arterial image. Depth is the maximum distance from skin to upper edge or wall lumen interface in the transverse plane image.

Sample size was calculated according to the results of the previous study,^[3] we calculated the sample size with an effect size of 0.72 mm in radial artery height between 45° angle and 0° angle in young healthy individuals with a standard deviation of 0.78. From these differences and assuming α error value of 0.05

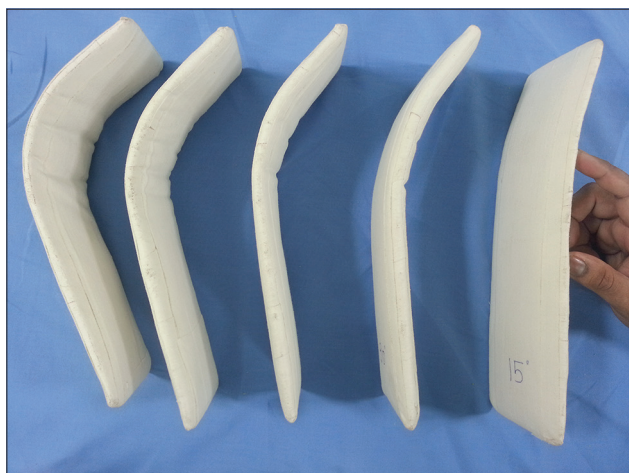


Figure 1: Rigid splint boards of varying angles



Figure 2: Ultrasound examination of radial artery

and a β value 0.20 (study power: 80%), we needed a sample size of at least 36 participants. We included 48 healthy female volunteers in our study with an expected drop rate of 25%.

The dimensions at each angle of wrist extension were compared to the corresponding dimension at 0° wrist extension taken as a control, and statistical analysis was done and tabulated.

Statistical analysis was performed using SPSS Inc. Released 2008. SPSS Statistics for Windows, Version 17.0. Chicago: SPSS Inc. Analysis of variance (ANOVA) test was used to analyze the dimensions at varying angles of wrist extension. $P < 0.05$ was interpreted as statistically significant.

RESULTS

The age distribution in the study population is 21 ± 0.98 , and the BMI distribution is 22 ± 0.16 in the study population.

Table 1 shows the radial artery dimensions at varying angles of wrist extension 0, 15, 30, 45, 60, and 75°

which includes the height (mm), width (mm), and the depth (mm).

Table 2 shows the statistical analysis comparing each parameter at varying angles of 15°, 30°, 45°, 60°, and 75°

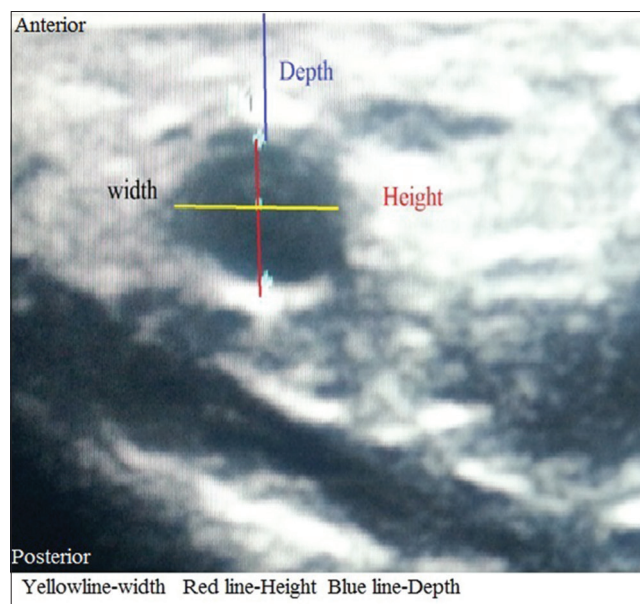


Figure 3: Measurement of dimension from the ultrasound image

Table 1: Measurements of radial artery dimension

Angulation (degrees)	n	Mean (mm)	SD	95% CI		Minimum	Maximum
				Lower bound	Upper bound		
Width							
0	48	2.2113	0.34559	2.0867	2.3358	1.55	2.83
15	48	2.1575	0.36993	2.0241	2.2909	1.33	3.00
30	48	2.2066	0.37277	2.0722	2.3410	1.54	3.00
45	48	2.2284	0.35448	2.1006	2.3562	1.68	3.10
60	48	2.2378	0.33101	2.1185	2.3572	1.68	3.10
75	48	2.2872	0.33917	2.1649	2.4095	1.68	3.00
Height							
0	48	1.8106	0.23960	1.7242	1.8970	1.35	2.26
15	48	1.7919	0.23180	1.7083	1.8754	1.39	2.26
30	48	1.8438	0.25625	1.7514	1.9361	1.37	2.60
45	48	1.8272	0.22693	1.7454	1.9090	1.37	2.41
60	48	1.8328	0.27705	1.7329	1.9327	1.40	2.83
75	48	1.7963	0.30635	1.6858	1.9067	1.30	3.10
Depth							
0	48	2.2306	0.55459	2.0307	2.4306	1.02	3.27
15	48	2.2531	0.56070	2.0510	2.4553	1.30	3.20
30	48	2.2041	0.51176	2.0196	2.3886	1.00	3.42
45	48	2.2544	0.57228	2.0480	2.4607	1.34	3.37
60	48	2.0856	0.50051	1.9052	2.2661	1.34	3.24
75	48	2.2781	0.59368	2.0641	2.4922	1.20	3.50

n: Number of participants, SD: Standard deviation, CI: Confidence interval

to the corresponding value at 0°. Statistical analysis of this data showed that there was no statistically significant change in the sonographically measured radial artery dimension at varying angles of 15°, 30°, 45°, 60°, and 75° wrist extension compared to dimensions at 0°.

On analyzing the data, we can appreciate that the width of the radial artery tends to increase gradually from 0° to 75° but the change is not statistically significant. While the mean height changes with increasing angles of wrist extension, but not statistically significant at any angle when compared to 0° wrist angle. Hence, no statistically significant compression reflecting as a change in width or height occurred with increasing angles of wrist extension on the radial artery dimension.

No dropouts during the period of study. ANOVA test was used to analyze the dimensions at varying angles of wrist extension. $P < 0.05$ was interpreted as statistically significant.

DISCUSSION

We studied the effect of varying angles of wrist extension 0, 15, 30, 45, 60, and 75° on the radial artery dimension evaluated using ultrasound examination in

Table 2: Statistical analysis of the measured data

Angulation (degrees)	n	Mean (mm)	SD	F	P
Width					
0	48	2.2113	0.34559	0.46	0.8
15	48	2.1575	0.36993		
30	48	2.2066	0.37277		
45	48	2.2284	0.35448		
60	48	2.2378	0.33101		
75	48	2.2872	0.33917		
Height					
0	48	1.8106	0.23960	0.21	0.96
15	48	1.7919	0.23180		
30	48	1.8438	0.25625		
45	48	1.8272	0.22693		
60	48	1.8328	0.27705		
75	48	1.7963	0.30635		
Depth					
0	48	2.2306	0.55459	0.51	0.77
15	48	2.2531	0.56070		
30	48	2.2041	0.51176		
45	48	2.2544	0.57228		
60	48	2.0856	0.50051		
75	48	2.2781	0.59368		

n: Number of participants, SD: Standard deviation

healthy female volunteers. We hypothesized that the dimensions of the radial artery at the wrist joint level changed with increasing angles of wrist extension in young healthy females. We found that the radial artery dimension did not show a statistically significant change with increasing angles of wrist extension from 0° to 15, 30, 45, 60, and 75°.

We used high-resolution B-mode ultrasonography for arterial diameter measurement. Echo tracking may be the ideal mode for continuous measurement of arterial diameter throughout the cardiac cycle. High-resolution B-mode is as reproducible^[4] as echo-tracking for a single point of time measurement or discontinuous measurement. Figure 4 shows the changing flow pattern in the radial artery with increasing wrist extension using color Doppler imaging.

We used healthy female volunteers of age 18–25 years in our study. The radial artery dimension is significantly larger in male than in the female.^[5] So gender may be a confounding variable, so we selected only female subjects. Radial arteries showed age-related acceleration of atherosclerosis.^[6] Total atheroma volume was strongly associated with the square of age. Atherosclerotic plaques markedly reduce the distensibility.^[7] Hence to include such elderly individuals with a different degree of atheromatous changes in our study would confound the outcome by having different distensibility and the compression effect on the radial artery. To avoid this confounding influence of age on the degree of atheroma formation of radial artery and hence its distensibility and the vessel diameter, we included only young participants of age group 18–25 years in this study.

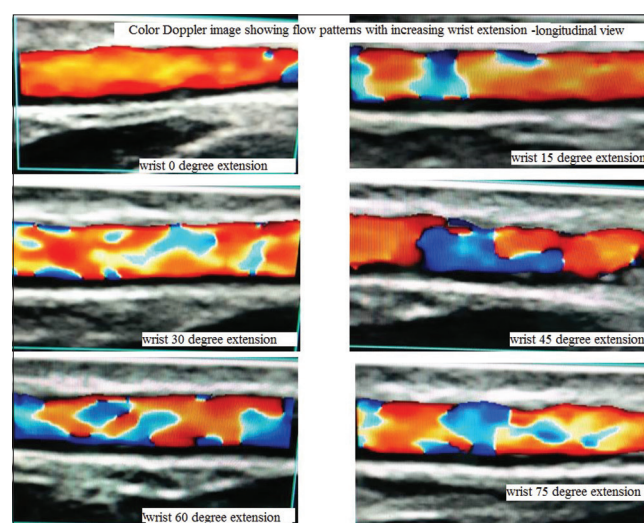


Figure 4: Color Doppler imaging showing flow pattern-longitudinal plane view of radial artery

Mizukoshi *et al.*^[5] conducted a similar study where they found that the radial artery dimension is unaltered until 45° of wrist extension. The conflicting results are due to: They have included volunteers from 22 to 38 years of age in their study. They also included both males and females in their study. The changes of atherosclerosis happen as early as the fourth decade.^[8] The uniqueness of our study is that we negated the influence of the confounding variables such as gender and age as explained above by including only the young healthy female subjects.

There are however some limitations in our study: First, this study is not intended to detect the success rate of radial arterial cannulation. Second, the study was limited to young adult females, hence might not be applicable to old adult, geriatric and children. We sincerely felt that our study has clinical applicability since more and more young adults with congenital heart disease (grown up congenital heart disease) are coming for perioperative care for noncardiac surgery. Third, the ultrasound probe pressure could have affected the dimension. We tried to negate its influence by having the same clinician doing the ultrasound measurement in all the subjects. The arterial dimension also would have been affected by the phase of the cardiac cycle.

To our knowledge, no previous study has identified or investigated the factors affecting the success rate of radial artery cannulation except for the factors such as degree of wrist extension and ultrasound guidance for cannulation. Our study has shown that there are no statistically significant changes in dimension and hence the compression of the radial artery with increasing angles of wrist extension. Hence, the decreased success rate at first attempt of radial artery cannulation at 30° and 60° compared to 45° wrist extension^[2] may not be due to compression effect on the radial artery due to wrist extension. Hence, the clinical importance of our study is that it has probed the researchers to identify

and investigate other factors that may influence the success of radial artery cannulation and hence the scope for further research.

To conclude, ultrasound evaluation showed that increasing angle of wrist extension does not significantly change the dimensions of radial artery at the wrist joint level in young healthy female volunteers.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Mark JB, Slaughter TF. Cardiovascular monitoring. In: Miller RD, editor. Miller's Anesthesia. 6th ed. Philadelphia, PA: Churchill Livingstone; 2004. p. 1272-3.
2. Pandey R, Ashraf H, Bhalla AP, Garg R. Optimal wrist angulation shortens time needed for radial artery catheterization: A prospective, randomized, and blinded study. *Acta Anaesthesiol Belg* 2012;63:187-90.
3. Kucuk A, Yalcin F, Yuce HH, Boyaci FN, Aydın MS, Kaya Z, *et al.* Forty-five degree wrist elevation is optimal for ultrasonography guided long axis radial artery cannulation both for young and elderly subjects. *Acta Med Mediterr* 2013;29:291.
4. Stadler RW, Taylor JA, Lees RS. Comparison of B-mode, M-mode and echo-tracking methods for measurement of the arterial distension waveform. *Ultrasound Med Biol* 1997;23:879-87.
5. Mizukoshi K, Shibasaki M, Amaya F, Hirayama T, Shimizu F, Hosokawa K, *et al.* Ultrasound evidence of the optimal wrist position for radial artery cannulation. *Can J Anaesth* 2009;56:427-31.
6. Moon KW, Kim JH, Yoo KD, Oh SS, Kim DB, Kim CM. Evaluation of radial artery atherosclerosis by intravascular ultrasound. *Angiology* 2013;64:73-9.
7. Giannattasio C, Failla M, Emanuelli G, Grappiolo A, Boffi L, Corsi D, *et al.* Local effects of atherosclerotic plaque on arterial distensibility. *Hypertension* 2001;38:1177-80.
8. Deopujari R, Dixit A. The study of age related changes in coronary arteries and its relevance to the atherosclerosis. *J Anat Soc India* 2010;59:192-6.