

Comparison of Blood Pressure Measurement between Different Directions of Cuff tube in Tucked Arm Surgery: A Randomized Control Trial

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Background: During blood pressure (BP) measurement, the standard positioning of cuff tube is on the downside direction. However, the use of upside cuff tube direction may be more suitable in some situations to minimize an event of bend or to reduce a chance of compression by surgical team. Therefore, we investigated the difference of BP measurement between two methods.

Methods: Thirty adult patients scheduled for thyroid surgery were enrolled and got BP measurements of both arms. They were randomized to receive upside cuff tube placement in one arm and downside on the other. BP was measured during preoperative period and intra-operative period every 15 minutes till the end of operation or 2 hours.

Results: Systolic blood pressure (SBP) was significantly different in preoperative on the right arm side, the mean SBP in the upside cuff tube direction was 129.33 ± 23.78 mmHg and in the downside cuff tube direction was

132.80 ± 21.29 mmHg ($p=0.017$). Diastolic blood pressure (DBP) and mean blood pressure (MAP) were found not significantly different between upside and downside cuff tube direction. The number to repeat measurement of blood pressure during intra-operative period was not significantly different ($p=0.940$) between upside and downside cuff tube direction (upside median was 1 and 4, respectively).

Conclusions: There was only significant different in systolic blood pressure in different cuff tube direction during preoperative at the right arm. However, this difference was not clinically important.

Keywords: Blood Pressure, Cuff tube, Tucked arm surgery

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Introduction

Intraoperative hypotension is a common occurrence during procedures performed under general anesthesia. Oscillometry is the standard method of measuring BP in anesthetized patients. The direction of cuff tube should be on the downside according to worldwide standard. However, the use of upside cuff tube direction may be more suitable in some situations such as tucked arm operation. This method is convenience and minimizes an event of bend or to reduce a chance of compression by surgical team.

The accuracy of noninvasive BP measurements may be influenced by many factors¹. American Heart Association clinical practice guidelines (AHA) Recommendations for Blood Pressure Measurement stated that the position of cuff should be placed in the middle of patient's upper arm at the level of the right atrium (the midpoint of the sternum).

There are no literatures that investigate the difference of BP between upside and downside cuff tube direction method. Therefore, we investigated the different of BP between measurement of upside and

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downside direction at preoperative and during intra-operative period and to compare number to repeat measurement of BP between those two different methods during intra-operative period.

Methods

After an ethic approval from Ramathibodi Ethical Committee (ID-03-60-29), Mahidol University, Sample size was calculated by repeated measurement (2 groups) equality (same difference across time and common correlation with fixed number of time point). The researcher chose 30 patients who have been selected by criteria. Inclusion criteria were the patients who had to undergo elective thyroid surgery which was needed tucked arm surgery in Ramathibodi hospital and able to join the research project by signing up, age 18-65 years and ASA physical status was in I-III. Exclusion criteria composed of patients who had vascular disease e.g. Co-arcuation of Aorta, the difference of SBP between arms more than 15 mmHg and irregular rhythm of heart rate e.g. atrial fibrillation.

All patients were evaluated the qualifications before joining program then randomized to be measured and recorded blood pressure between the difference of cuff tube direction method in pre-operative and intra-operative period. We reported blood pressure in the term of systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial blood pressure (MAP) which was calculated using formula: $[(\text{diastolic blood pressure} \times 2 + \text{systolic blood pressure}) / 3]$.

During intra-operative, blood pressure were measured and recorded in pre-induction period and then every 15 minutes till the end of operation or 2 hours with difference cuff tube direction (depended on anesthesiologist) in each side of arm with different blood pressure monitoring machine.

Statistical analysis

All data were analyzed using commercially available SPSS program v.18. Numerical variables were examined for normality using Shapiro -Wilk normality test. Descriptive statistics were calculated for all

variables of interest. Continuous measures are summarized using means and SDs, whereas categorical measures are summarized using counts and percentages.

Pre-operation period, compare difference arterial blood pressure of individual between upside and downside cuff tube direction by paired samples t- test. The parameters between upside and downside cuff tube direction were univariate compared with Chi-squared and Fisher's exact tests for categorical variables and Student's T test for continuous variables and comparison of blood pressure changes during intra-operative analysis by repeated measure ANOVA. The p-value of less than 0.05 was indicated as statistically significant.

Results

There were 30 patients undergoing elective thyroid surgery which needed tucked arm surgery met our criteria and were included in this study. Patient's characteristics were shown in table 1. Most of patients were female gender (76.6%). Median age was 51.90 years old. ASA physical status is mostly in class I. All patient had no obesity in our study ($\text{BMI} = 23.99 \pm 3.54$). Equally between difference of upside and downside cuff tube direction in each group was 30 (50 %) per group.

Table 1 Patients' characteristics

Variable	Statistics (N = 30)
Cuff tube direction	
Upside	30 (50%)
Downside	30 (50%)
Age (years)	51.90 $\pm$ 18.22
Sex (male/female)	7 (23.4%) / 23 (76.6%)
Weight (kg)	59.9 $\pm$ 11.79
Height (cm)	157.58 $\pm$ 6.97
BMI (kg/m^2)	23.99 $\pm$ 3.54
ASA status	
I	13 (43.4%)
II	10 (33.3%)
III	7 (23.3%)
HT (Yes / No)	10 (33.3%) / 20 (66.7%)
DM (Yes / No)	4 (13.3%) / 26 (86.7%)

Table 2 Comparison of difference average blood pressure between right arm and left arm at preoperative period between upside and downside cuff tube direction

Blood Pressure	Right arm		<i>p</i> -value	Left arm		<i>p</i> -value
	upside	downside		upside	downside	
SBP (mmHg)	129.33 ± 23.78	132.80 ± 21.29	0.017	132.30 ± 23.68	128.77 ± 20.95	0.053
DBP (mmHg)	75.13 ± 11.66	75.27 ± 9.99	0.891	75.90 ± 9.89	75.67 ± 9.92	0.836
MAP (mmHg)	93.20 ± 14.92	94.44 ± 12.68	0.198	94.91 ± 13.43	93.27 ± 12.55	0.137

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial blood pressure,
 $p < 0.05$ is considered significantly difference.

For pre-operative data (Table 2), the systolic blood pressure on the right arm when measured in upside direction is average 129.33 mmHg and in downside direction is 132.80 mmHg. Only SBP in the right arm side was significantly different between upside and downside cuff tube direction, but other parameters were not different.

Table 3 Comparison of average blood pressure between upside and downside cuff tube direction during intra-operative period

Blood pressure	Cuff tube direction		<i>p</i> -value
	Upside	Downside	
Systolic blood pressure (mmHg)	120.89 ± 12.46	121.75 ± 11.70	0.785
Diastolic blood pressure (mmHg)	74.88 ± 6.12	75.02 ± 6.30	0.929
Mean arterial blood pressure (mmHg)	90.20 ± 6.65	90.58 ± 7.13	0.833

$p < 0.05$ is considered significantly difference.

During intra-operative data (Table 3), all parameters of average blood pressure were not different during intra-operative period between upside and downside cuff tube direction (p -value > 0.05).

Table 4 Difference blood pressure between upside and downside cuff tube direction during intra-operative, pre-induction period and every 15 minutes

Time	Cuff tube direction		<i>p</i> -value	Mean difference (95% CI)
	Upside (N =30)	Downside (N =30)		
Systolic blood pressure (mmHg)				
Pre-induction	133.17 ± 21.33	133.0 ± 21.24	0.976	0.167 (-10.834 to 11.167)
15 minutes	110.97 ± 28.49	115.83 ± 23.76	0.475	-4.867 (-18.426 to 8.692)
30 minutes	110.80 ± 21.07	108.33 ± 18.87	0.635	2.467 (-7.870 to 12.803)
45 minutes	123.20 ± 14.69	122.43 ± 17.83	0.856	0.767 (-7.678 to 9.211)
1 hour	122.03 ± 28.69	125.45 ± 18.74	0.594	-3.414 (-16.161 to 9.334)
Diastolic blood pressure (mmHg)				
Pre-induction	78.27 ± 12.65	78.20 ± 11.87	0.983	0.067 (-6.272 to 6.405)
15 minutes	71.93 ± 11.19	72.33 ± 14.71	0.906	-0.40 (-7.156 to 6.356)
30 minutes	70.60 ± 12.91	67.40 ± 11.33	0.312	3.20 (-3.075 to 9.475)
45 minutes	77.57 ± 9.84	75.67 ± 11.82	0.501	1.90 (-3.722 to 7.522)
1 hour	77.48 ±12.96	78.97 ± 12.38	0.658	-1.483 (-8.148 to 5.182)
Mean arterial blood pressure (mmHg)				
Pre-induction	96.57 ± 13.72	96.40 ± 13.43	0.962	0.167 (-6.851 to 7.184)
15 minutes	84.97 ± 14.23	86.77 ± 16.69	0.655	-1.80 (-9.817 to 6.217)
30 minutes	83.93 ± 14.75	81.03 ± 13.15	0.425	2.90 (-4.320 to 10.120)
45 minutes	92.73 ± 9.91	91.23 ± 12.02	0.600	1.50 (-4.192 to 7.192)
1 hour	92.34 ± 15.94	94.45 ± 12.77	0.581	-2.103 (-9.699 to 5.492)

$p < 0.05$ is considered significantly difference. CI = confidence interval.

Table 4. All blood pressure measurement (SBP, DBP and MAP) during intra- operative and pre-induction period were not significantly different and also every 15 minutes were not different in any points of time (p -value > 0.05).

During intra-operative data, the median number to repeat measurement the blood pressure of upside cuff tube direction during intra-operative period was 3 and the downside cuff tube direction was 4, concluded that was not significantly different (p -value = 0.940)

Discussion

Systolic blood pressure (SBP) was significantly different in preoperative on the right arm side, the mean SBP in the upside cuff tube direction was 129.33 ± 23.78 mmHg and in the downside cuff tube direction was 132.80 ± 21.29 mmHg ($p = 0.017$). Diastolic blood pressure (DBP) and mean blood pressure (MAP) were found not significantly different between upside and downside cuff tube direction. No difference in number to repeat measurement blood pressure between those two methods during intra-operative period.

There are many factors that can also interfere with BP measurement. Cuff size and tightness of fit can affect its accuracy. Automated or manual blood pressure machine can also be a problem of reliability for many decades and this was found out by Myers MG, et al.², this study was compared between an automated and manual sphygmomanometer. The data revealed that conventional manual blood pressure readings can be replaced automated machine.

Existing of past literatures never mentioned about upside cuff tube direction method only evidences found out how to use proper circumference of pressure cuff which is related to blood pressure like Loenneke JP, et al.³. This study observes the association between arm circumference and blood pressure among adult Americans (collecting data in 33,261 patients from the National Health and Nutrition Examination Survey. The data demonstrated that those with greater arm circumference had higher blood pressure and suggest

that arm circumference may play an important role in blood pressure values. Many recommendations were launched about suitable procedure to measure BP.

The results of this study demonstrated that only SBP on the right arm side was significantly different between the upside and downside cuff tube direction during pre-operative period. These findings were similar previous studies. Ambiguity of blood pressure between inter-arms was found out that no significantly different of blood pressure between inter-arms differences from Orme S, et al.⁴.

The accuracy of noninvasive BP measurements is important to detect intraoperative hypotension in anesthetized patients. Although SBP measurements were significantly different between two methods, the difference of BP measurement was only 3.47 mmHg. This should not affect in clinical outcome. A systematic review and meta-analysis⁵ found out the association of a difference in systolic blood pressure between arms more than 15 mmHg could be a useful indicator of risk of vascular disease and death.

Therefore, in clinical practice, anesthesiologist may consider upside cuff tube direction procedure to measure blood pressure during intraoperative in patients with tucked arm position.

Conclusion

The quality of intraoperative BP measurement dose not affected by cuff tube direction. The decision of measurement blood pressure on different cuff tube direction is depend on individual physician and health care team judgment.

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