ORIGINAL ARTICLE

The Effectiveness of Applied Muscle Tension in reducing Vasovagal Reaction among Young Blood Donors in Kota Bharu

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ABSTRACT

Introduction: The vasovagal reaction (VVR) incidence is the most common adverse donor reaction poses a major risk to the donor's safety and a disincentive for repeat donation. The main objective of this study is to determine the efficacy of applied muscle tension (AMT) in reducing the VVR incidence among young blood donors aged 18-23 years old in Kelantan. **Methods:** A prospective comparative interventional study was conducted among 306 young blood donors that were equally assigned to AMT and non-AMT groups. Donors were assessed with Blood Donation Reaction Inventory at 30 minutes and 48 hours post blood donation. The subjects were followed-up on whether they make at least one donation attempt in the next six months. **Results:** Out of 306 young blood donors, the incidence of VVR was 24.8%. The AMT group showed a significant reduction in the VVR incidence rate compared to the non – AMT group ($p<0.001$). There was no significant increment of donor return among AMT group than non – AMT group upon follow-up in six months. In addition, female ($p=0.002$), low body weight ($p=0.002$), low estimated blood volume ($p=0.033$) and low systolic blood pressure ($p=0.005$), are important predictors of VVR. **Conclusion:** This study showed that AMT was an effective strategy to reduce the VVR incidence among young blood donors in Kelantan. Implementation of AMT is recommended to donors with high risk of developing VVR.

Keywords: Applied muscle tension, Vasovagal reaction, Risk factors for VVR, Donor return, Blood Donor Reaction Inventory

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INTRODUCTION

Empowering donor safety to improve donor retention is the utmost intention of blood transfusion services (BTS) as regular donors are known to be less risky due to transfusion-transmitted infection (1). The most common adverse donor reaction (ADR), known as vasovagal reaction (VVR), have become the dominant obstacle to both recruitment and retention, notably among the younger and novice donors (2).

VVR is best described as a general feeling of discomfort and weakness with nervousness, dizziness and nausea, leading to loss of consciousness (3). The reported incidence rate is between 1.5% to 8.2% worldwide (4 – 7). Various factors have been identified as the predictors for VVR, such as young age, female, inexperienced donor and low estimated blood volume (EBV). Other factors related to VVR include the emotion of fear and mobile drive donation (8).

A considerable amount of research has been published on the impact of VVR on BTS. Donors who experience VVR are less likely not to donate four times more than those who do not experience any reaction (5). While in Malaysia, a study showed that the main cause for the disposal of the whole blood unit was underweight that occurred because of VVR incidence (9). VVR can also cause minor injuries or even severe injuries if the donor happens to develop delayed VVR, such as loss of consciousness (LOC) while performing critical work or driving. Bravo et al. (10) and Newman et al. (11) found that almost 60% of the syncope reaction occurs when the donor falls from the bed when leaving. Between 10% to 12% of the reactions develop after the donor exits the donation vicinity.

Various measures are recommended to minimise VVR among blood donors, such as applied muscle tension (12,13), pre-donation water hydration (14,15), fear reduction of needles among blood donors (8,16), pre-donation salt ingestion (17), social support (18) and distraction technique (19).

Applied muscle tension (AMT) is a method generally used as behavioural therapy that involves the repeated tensing of the major muscles of the upper limbs (UL) and lower limbs (LL) with normal breathing pattern. This repeated tension will prevent the abrupt drop in the donor's blood pressure (BP) that usually occurs during VVR (20). France et al. (21) demonstrated that AMT evokes physiological adaptations that can reduce the risk of VVR. Electromyography (EMG) will verify that the AMT group participants perform the AMT technique throughout the entire donation procedure. Upon further search and literature review, there were limited studies on AMT during blood donation in Malaysia and Asia.

This study aims to determine the effectiveness of AMT in reducing VVR incidence among young blood donors in Kelantan, Malaysia and to establish the association between donor's genders, the number of donations, weight, EBV and blood volume collected with the incidence of VVR. This study also aimed to examine the probability of a donor's return in six months for future blood donations.

MATERIALS AND METHODS

Participants

This was a prospective comparative interventional study. The participants were recruited from mobile blood donations organised by Hospital Universiti Sains Malaysia (HUSM) in Kota Bharu area from June 2019 to May 2020. Following registration and screening, 306 individuals were recruited after all the inclusion criteria requirements had been met.

For the AMT group (intervention), the inclusion criteria included Malaysian citizen aged 18 to 23 years, eligible for blood donation, and donors who donated blood less than four times in their lifetime. The exclusion criteria included donors who could not practice AMT during blood donation and donors with underlying health issues (e.g. cardiovascular disease, bronchial asthma, vision and hearing problems).

For the non – AMT group (control), the inclusion criteria included Malaysian citizen aged 18 to 23 years old, eligible for blood donation, and donors who donated blood less than four times in their lifetime. The exclusion criteria included donors with underlying health issues (e.g. cardiovascular disease, bronchial asthma, vision and hearing problems).

This study received approval from the Universiti Sains Malaysia (USM) Human Research Ethics Committee (USM/JEPeM/18110743) and was conducted in accordance with the guidelines of the International Declaration of Helsinki.

Data collection and Sampling

The sample size was calculated based on 0.05 effect size, alpha of 0.05, and 95% confidence interval with an infinite population using a two proportions calculation, where 71% of donors applying AMT technique and 55% of the donor not applying AMT technique (22), the minimum sample size was 306. This study was done at fifteen mobile donation sites in the Kelantan state. Simple random sampling was employed in which every second eligible registered blood donor was recruited.

All potential blood donors completed the blood donor enrolment form, which consists of demographic information. Upon completion and submission of the form, the donors were interviewed by the medical officer. Pulse rate and BP was then measured. Once the participant was eligible for recruitment, they were randomly assigned either to the control group (non – AMT group) or the intervention group (AMT group) by picking a piece of paper from a box on which was written either group. There were 153 participants in each group. Both AMT and non – AMT groups were randomly assigned with screen partition to minimise contamination bias. Due to the intervention's nature, it was not possible to blind participants to their allocated study group. The non – AMT group did not watch the AMT video and followed the usual blood donation procedure. As for the AMT group, all participants watched an instructional video of the AMT method and then applied it during the blood donation procedure. It is a two-minute video similar to the video used in previous research (12) broadcasted on a notebook computer. The video began by explaining that only a small number of donors were affected by VVR, and most reactions were minor, to avoid negative perceptions that may discourage prospective donors. AMT was presented as a potential way of improving the donation experience. Donors were guided to tense the major muscles in their UL and LL at five-seconds intervals while maintaining normal breathing pattern. The priority was focus on repeated tensing, as opposed to tensing and relaxing the muscles. The principal investigator or other research team members will then assess the donor's technique. Once the intended technique was correct, the donors proceeded through the blood donation process while executing the AMT technique until the bleeding completed. During the blood donation process, EMG electrodes were attached to both forearms (ventral side) and calves (posterior side).

After the donation process was completed, another reading of pulse rate and BP was taken. Then, all participants from both control and intervention groups responded to the post-donation questionnaire, the blood donation reaction inventory (BDRI) (23), which is available in the Malay and English versions. BDRI consisted of eleven questions on a 0 to 5 scale, with total scores ranging from 0 to 55. The total scores have a high internal consistency level and have significantly corresponded to phlebotomist classification of donor reactions. High scores on this measure are associated

with a decreased likelihood of future donation (21). The participants were then provided with a light meal and a token of appreciation in the refreshment area.

After 48 hours post-donation, the researchers followed up with the participants by a phone call to assess the delayed VVR using the same BDRI form. After participating in this study, the subjects will be followed-up on whether they make at least one donation attempt in the next six months and data was obtained by phone call.

Data analysis

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 26.0 for window software (SPSS, Chicago Illinois, USA), and checked for missing data and outliers (none was found). Assumptions of the statistical procedures used were confirmed. Descriptive statistics were calculated for all study variables. Descriptive data were expressed in numbers, percentages and means with standard deviations. Then, the chi-square test was used to study the association between categorical variables. A $p<0.05$ value is considered statistically significant. For numerical data analysis, Independent t-test was used. Multiple logistic regressions were used to identify the association of multiple factors influencing the incidence of VVR.

RESULTS

A total of 306 blood donors aged 18 to 23 years from mobile blood donations were eligible and consented to participate in the study. Characteristics of the donors are shown in Table I. Most of the donors were predominantly female (60.10%) with a mean age of 19.11. Malay donor (89.20%) was the highest, with more first-time donors (56.50%) being recruited compared to repeat donors (43.50%). The total donation volume was 450 ml and predominantly was blood group O (36.90%). A total of 76 VVR incidences were recorded in this study, with an incidence rate of 24.8%.

A total of 153 donors were randomly assigned to the AMT group (intervention) and 153 other donors to the non – AMT group (control). Consistent with the random assignment, there was no significant difference between both groups for each donor and the donor's characteristics (Table II).

The incidence rate of VVR for the AMT group was 15.0%, compared to 34.6% for the non – AMT group (Table III). This result showed that AMT was effective in reducing VVR incidence ($p<0.001$) and its severity ($p=0.01$) among young blood donors.

Table IV presents the donor and donation characteristics association with VVR incidence. Univariable analysis using simple logistic regression showed that the

Table I: Demographic, characteristics and VVR outcome among 306 young blood donors

	Frequency (%) (n: 306)	Mean (SD)
Gender		
Male	122 (39.90)	
Female	184 (60.10)	
Age		19.11 (1.18)
Weight		63.80 (10.23)
Male		65.44 (11.03)
Female		62.72 (9.54)
Estimated blood volume		4.04 (0.55)
Sleep duration (hours)		6.88 (0.90)
Ethnic group		
Malay	273 (89.20)	
Chinese	21 (6.90)	
Indian	9 (2.90)	
Others	3 (1.00)	
Donation status		
First time	173 (56.50)	
Repeated	133 (43.50)	
Donation volume		
450 ml	306 (100.00)	
350 ml	0 (0.00)	
ABO grouping		
A	79 (25.80)	
B	88 (28.80)	
AB	26 (8.50)	
O	113 (36.90)	
VVR incidence		
Yes	76 (24.80)	
No	230 (75.20)	

Table II: Donor and donation characteristics distribution in both AMT and Non-AMT groups

Donor and donation characteristic	AMT (N: 153)	Non-AMT (N: 153)	Total	*p* value
Gender[a]				
Male	59 (38.60)	63 (41.20)	122 (39.90)	0.640[c]
female	94 (61.40)	90 (58.80)	184 (60.10)	
Age[b]	19.05 (1.19)	19.17 (1.17)		0.383[d]
Weight[b]	63.58 (10.25)	64.03 (10.24)		0.705[d]
Estimated blood volume[b]	3.98 (0.57)	4.10 (0.54)		0.187[d]
Sleep duration (hours)[b]	6.93 (0.88)	6.82 (0.92)		0.280[d]
Ethnic group[a]				
Malay	136 (88.90)	137 (89.50)	273 (89.20)	0.622[c]
Chinese	12 (7.80)	9 (5.90)	21 (6.90)	
Indian	3 (2.00)	6 (3.90)	9 (2.90)	
Others	2 (1.30)	1 (0.70)	3 (1.00)	
Donation status[a]				
First time	88 (57.50)	85 (55.60)	173 (56.50)	0.729[c]
Repeated	65 (42.50)	68 (44.40)	133 (43.50)	
ABO grouping[a]				
A	34 (22.20)	45 (29.40)	79 (25.80)	0.492[c]
B	46 (30.10)	42 (27.50)	88 (28.80)	
ab	15 (9.80)	11 (7.20)	26 (8.50)	
o	58 (37.90)	55 (35.90)	113 (36.90)	
Systolic blood pressure[b]	116.46 (9.18)	115.88 (8.34)		0.567[d]
Pulse rate[b]	80.22 (8.09)	78.53 (8.08)		0.070[d]

[a] value expressed as N (%) [b] value expressed as mean (SD)
[c] Pearson chi-square test with the level significance of 0.05
[d] Independent t-test with the level of significance of 0.05

Table III: Comparison of VVR incidence, severity and type between both AMT and Non – AMT groups

	AMT (%)	Non – AMT (%)	Total (%)	*p* value
VVR				
Yes	23 (15.00)	53 (34.60)	76 (24.80)	0.000[a]
No	130 (85.00)	100 (65.40)	230 (75.20)	
Severity				
Mild	22 (95.70)	45 (84.90)	67 (88.20)	0.010[a]
Moderate	1 (4.30)	6 (11.30)	7 (9.20)	
Severe	0 (0.00)	2 (3.80)	2 (2.60)	
Type				
Acute	19 (82.60)	33 (62.30)	52 (68.40)	0.033[a]
Delayed	2 (8.70)	9 (9.40)	7 (9.20)	0.032[a]
Both	2 (8.70)	11 (28.30)	17 (22.40)	0.021[a]

[a] Pearson chi-square test with the level significance of 0.05

intervention group, weight, EBV, gender, donation status and systolic BP were associated with VVR incidence ($p<0.05$). Meanwhile, sleep duration and ethnicity were not significantly associated with the VVR incidence ($p>0.05$). Further multivariate analysis showed that the intervention group, weight, EBV and systolic BP remained as the significant risk factors for VVR incidence among these young blood donors.

Table V describes the donor return rate for the post-donation six months follow-up period. No significant difference was found between the AMT group and the non – AMT group ($p=0.33$).

DISCUSSION

One of the issues highlighted in blood donation is the challenges in retaining eligible donors. At the same time, we are faced with a growing number of deferral criteria for donating blood (24). Among the strongest reason for donor drop – out is the incidence of disagreeable signs such as VVR (25,26).

Table V: Donor return rate in both AMT and Non – AMT groups

	Return (%)	Not return (%)	total (%)	*p* value[a]
Non – Amt	29 (44.6)	124 (51.4)	153 (50.0)	0.329
AMT	36 (55.4)	117(48.6)	153 (50.0)	

[a] Pearson chi-square test with the level significance of 0.

The present study mainly examines the incidence and predictors of VVR among young blood donors and AMT's efficacy in reducing the risk. Female was mostly picked as participants were selected from educational institutions that are commonly dominated by female students (27). Malays being the largest ethnicity in Kelantan, explained the highest number of donors (28). Lesser repeated donors were being recruited compared to first-time donors. The O blood group being the most prevalent blood group in the Malaysian community explained the highest number of donors from the O blood group (29).

The observed incidence rate of VVR among young blood donors in this study was 24.8%. The rate was higher than studies worldwide that reported between 1.5% to 8.2% (4 –7). Many factors contributed to these variations other than elementary disparities between

Table IV: Association of donor and donation characteristics with VVR

	VVR	Non -VVR	Crude OR[c] (95% CI)	*p* value	Adjusted OR[d] (95% CI)	*p* value
Intervention[a]						
AMT	23 (30.30)	130 (56.50)	Reference	0.000*	Reference	0.000*
Non – AMT	53 (69.70)	100 (43.50)	2.996 (1.1721, 5.216)		3.897 (1.979, 7.673)	
Gender[a]						
Male	21 (27.60)	101 (43.90)	Reference	0.013*	Reference	0.002*
Female	55 (72.40)	129 (56.10)	2.051 (1.164, 3.612)		3.822 (1.769, 4.145)	
Age[b]	19.04 (1.06)	19.13 (1.21)	0.932 (0.743, 1.168)	0.540		
Weight[b]	59.37 (7.12)	65.27 (10.68)	0.936 (0.907, 0.965)	0.000*	1.123 (1.045, 1.207)	0.002*
Estimated blood volume[b]	3.89 (0.43)	4.09 (0.58)	0.491 (0.295, 0.815)	0.006*	0.214 (0.052, 0.880)	0.033*
Sleep duration (hours)[b]	6.89 (0.87)	6.87 (0.91)	1.026 (0.768, 1.371)	0.861		
Ethnic group[a]						
Malay	66 (86.84)	207 (90.00)	1.364 (0.617, 3.012)	0.443		
Non - malay	10 (13.16)	23 (10.00)	Reference			
Donation status[a]						
First time	52 (68.40)	121 (52.60)	Reference	0.017*	1.888 (0.970, 3.676)	0.161
Repeated	24 (31.60)	109 (47.40)	0.512 (0.296, 0.887)			
ABO grouping[a]						
A	25 (32.90)	54 (23.50)	1.405 (0.742, 2.660)	0.296		
B	17 (22.40)	71 (30.90)	0.727 (0.368, 1.435)	0.358		
AB	6 (7.90)	20 (8.70)	0.991 (0.333, 2.494)	0.856		
O	28 (36.80)	85 (36.90)	Reference	0.334		
Systolic blood pressure[b]	109.63 (6.64)	118.33 (8.30)	0.854 (0.816, 0.895)	0.000*	1.172 (1.112, 1.235)	0.005*
Pulse rate[b]	78.07 (7.30)	79.80 (8.34)	0.974 (0.943, 1.006)	0.106	0.995 (0.956, 1.035)	0.791

[a] data expressed as N (%) [b] data expressed as mean (SD)
[c] Simple conditional logistic regression was performed
[d] Multiple conditional logistic regression was performed.
- Constant = -6.552
- Backward LR method was applied
- No multicollinearity and no interaction
- Hosmer Lemeshow test, p value: 0.852
- Classification table 82.0% correctly classified
- Area under Receiver Operating Characteristics (ROC) curve was 75.5%

* significant p value < 0.05

different populations. Firstly, it may be attributed to the BDRI form used to detect VVR among blood donors, where the result conformed to a study by Meade et al. (23). Meade et al. (23) reported that 44% of VVR cases detected using the BDRI form. Second, this study primarily focused on young donors between 18 to 23 years old, who are at higher risk of developing VVR (6,30). Younger individual has lower ventricular baroreceptor sensitivity, making them prone to VVR incidence, and with increasing age, the body became more haemodynamically stable (31).

The important finding was that the AMT technique minimised immediate and delayed VVR among young blood donors. The incidence of VVR among AMT group was significantly lower, 15.0% compared to the non – AMT group, which is 34.6%. It showed that the non – AMT group had a 3.9 – fold higher risk of developing VVR than the AMT group and indicated that AMT effectively reduced VVR incidence among young blood donors. These findings matched those observed in earlier studies (26,32).

Further analysis showed that the AMT technique significantly reduced the VVR severity. In the AMT group, there were 22 cases of mild VVR with only one moderate VVR case reported. Meanwhile, in the non – AMT group, there were 45 cases of mild, six moderate and two severe VVR cases. The difference in severity between the groups was statistically significance (p value < 0.01). This finding was consistent with the results reported by Thijsen et al. (13) and Tomasulo et al. (14).

AMT involves several techniques such as LL tensing, LL crossing, UL tensing and abdominal tensing (12,13,33). Although abdominal tensing and LL tensing are important steps of AMT (33), we applied LL and UL tensing in this study. They are more comfortable and pleasant to learn and apply during mobile donation. To our knowledge, this is the first study that measured muscle contraction using EMG. However, due to the device's limitations, we could not assess the effect of different amplitudes of muscle contraction, AMT's various techniques, and their effect on VVR. Further research is recommended to look for systematic differences between these groups of muscle contraction amplitude and other muscle characteristics (frequency, duration) and their association in reducing VVR.

This study analysis revealed that gender was a significant variable in predicting VVR and females were twice likely to have VVR compared to males. This finding was consistent with the studies conducted by Goldman et al. (34) and Philip et al. (35). This is because females have lower mean body weight and lower baroreceptor sensitivity than males that can increase the risk of VVR (36).

The first-time donation was not significant in multivariate analysis. First-time donor usually had anxious feeling related to new experience and concern for phlebotomy. Anxiety can cause peripheral vasodilation and can have direct emotional consequences (37). Certainly, it has been shown that anxiety or fear of blood donation is associated with a higher reaction rate (8).

This study showed a significant association between the low donor weight and low EBV with VVR incidence. This result was consistent with Philip et al. (35) findings, which demonstrated that the donor's weight of more than 55 kg could decrease VVR risk up to 68%, whereas higher EBV (more than 4.5L) would reduce the incidence of VVR by 92%. This can be explained by a higher percentage of blood volume lost in smaller sized donors.

Systolic BP showed a significant association with VVR. This result was consistent with the finding by Takanashi et al. (38) that concluded having a systolic BP of less than 100 mmHg would have a 29% higher risk of getting VVR when adjusted to body mass index, age and pulse compared to having a systolic BP of more than 100 mmHg. On the other hand, the pulse rate did not appear to have a significant association with VVR in this study. This was consistent with findings by Nishimori et al. (39).

In terms of ethnicity, this study found no significant difference in the occurrence of VVR. However, this finding is inconsistent with findings by Newman et al. (11), which showed that ethnic groups factor contributed to the VVR incidences. The result could be due to smaller sample size that might not capture the true outcome. In this study, no significant association was found between the amount of sleep and VVR incidence. This might be due to all donors complied with the period of needing to have at least five hours of sleep by the Ministry of Health (40) and the average sleeping hours was more than six hours in both groups. In summary of VVR predictors, this study found that a young female donor with low body weight with low systolic BP was at the highest risk of developing VVR. However, the recruitment of this type of donor shall be continued with more attention and mitigation measures.

In this study, there was no significant difference in the donor return rate in both groups. These results were consistent with those observed in a study by Olatunji et al. (41) but contradicted the study by Ditto et al. (22), which revealed that AMT increased donor retention. Another study by Ditto et al. (12) also found that AMT improved female donor return. A relevant explanation for this was the result is limited due to short follow – up duration, which was only six months in this study.

This study acknowledge that AMT intervention is one of the many factors to be considered whether to

donate blood or not. Other contributing factors include personal, social and work commitments, local, national and global events and realisation of the blood donation program. Most of these factors are beyond the donation organisation's control. On a positive note, it is interesting that up to 21% of participants in this study returned to donate blood within six months follow – up period without any further intervention.

A major limitation of this study was that it was conducted in a single donation centre with a small number of participants. Further studies are recommended to involve multi donation centres to obtain a higher number of participants. This will make the study sample and data more representative. Another limitation of this study was that our data on donor retention only took up to six months of follow – up due to time constraints. More data on confirming whether AMT efforts are associated with increased donor retention can be obtained if a longer duration of follow – up can be done.

CONCLUSION

Two major conclusions can be taken from the results of this study. This study confirmed previous authors' reports that female, low weight/EBV and low systolic BP were characteristics of donors experiencing VVR among young blood donors. The higher reaction rate was not associated with donation status when other covariant factors were controlled. Another conclusion was that AMT had been shown to reduce the risk of getting VVR and its severity among young blood donors. Although current findings did not prove the ability to improve donor retention, further research in this area is recommended.

It's always the priority to improve donor safety and ensuring sufficient blood supply. Mitigation measures, such as AMT, can be applied to donors with high risks of developing VVR to overcome the negative impact of VVR on BTS. AMT is only one of many potential manipulations that might reduce vasovagal symptoms and affect the donor's return. Future research is recommended to examine combinations including other interventions such as sodium loading, social support and water consumption. Furthermore, the BDRI can be proposed as the VVR assessment tool to evaluate the actual rate of VVR incidence among blood donors. With these, there are potential improvements in donor haemovigilance data for further planning of VVR mitigation strategies.

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