

Efficacy of Normal Saline as Flushing Solution to Maintain Indwelling Arterial Catheter Patency after Cardiac Single Valve Surgery

Md. Anwar Hossain^{1*}, Md. Mobarak Hossain², Md. Shamim Reza³, Md. Akram Hossain⁴, Rampada Sarker⁵

¹Assistant Professor, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases, Dhaka, Bangladesh

²Assistant Professor, Department of Thoracic Surgery, National Institute of Diseases of the Chest and Hospital, Dhaka, Bangladesh

³Assistant professor, Department of Vascular Surgery, National Institute of Cardiovascular Diseases, Dhaka, Bangladesh

⁴Specialist Cardiac Surgeon, Department of Cardiac Surgery, United Hospital Limited, Dhaka, Bangladesh

⁵Professor Department of Cardiac Surgery, National Institute of Cardiovascular Diseases, Dhaka, Bangladesh

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*Corresponding author: Dr. Md Anwar Hossain

Assistant Professor, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases, Dhaka, Bangladesh

Abstract

Original Research Article

Introduction: Arterial catheters include radial, brachial, femoral, dorsalis pedis and axillary artery are used in the intensive care unit for continuous blood pressure monitoring, repeated blood sampling. Normal saline solution can maintain patency of arterial and central venous pressure monitoring catheters. Heparinized solutions had no effect on prolonging patency and improving function of catheters while the normal saline solution increases accuracy of coagulatory tests. **Aim of the Study:** The aim of this study was to examine the efficacy of Normal saline as flushing solution to maintain indwelling arterial catheter patency among patients after cardiac single valve surgery. **Methods:** This was a prospective cross-sectional study conducted in the Department of Cardiac surgery of National Institute of Cardiovascular Disease (NICVD), Sher-E-Bangla Nagar, Dhaka, Bangladesh during the period from July 2016 to June 2017. This study included sixty patients who underwent single valve replacement surgery and shifted to the ICU with arterial line catheter. The patients who fulfilled the inclusion criteria were divided into two groups- Group 1 (with heparin solution) and Group 2 (with normal saline). **Result:** In our study we found the mean \pm SD of age among Group 1 & 2 was (36.3 \pm 6.7) & (35.7 \pm 10.3) respectively. We found 100% patients had arterial line patent in 1st POD in both groups. In 2nd POD 86.8% & 76.7% and at 3rd POD 50.0% & 43.3% patients had patency in Group 1 & Group 2 respectively. We found the mean \pm SD of platelet count at 1st POD was (206530 \pm 64441) & (212543 \pm 48768); at 3rd POD was (226517 \pm 60185) & (245957 \pm 52826); at 7th POD was (240517 \pm 57379) & (257713 \pm 53655); at 14th POD was (245850 \pm 52680) & (244337 \pm 56796) in Group 1 & 2 respectively which was significantly higher in Group 2. **Conclusion:** The use of heparin in normal saline for arterial line flushing does not significantly reduce platelet counts in cardiac valve surgery patients in comparison to use of normal saline. There was no difference in the use of heparinized and normal saline solutions to maintain patency of arterial line.

Keywords: Arterial catheters, anticoagulant, coagulatory.

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INTRODUCTION

Arterial lines are widely used in intensive care unit for continuous haemodynamic monitoring and frequent assessment of arterial blood gas analysis. Arterial catheters include radial, brachial, femoral, dorsalis pedis and axillary artery are used in the intensive care unit for continuous blood pressure monitoring, repeated blood sampling, and when there is inability to measure indirect blood pressure [1]; invasive arterial blood pressure measurements are more accurate [2]. Flush system is used to maintain patency of arterial catheter. For this purpose, heparinized solution or normal saline should be used. Heparinized

saline solution is used to prevent occlusion in the arterial catheters and central venous pressure monitoring catheters. Even at low dose, heparin administration can be associated with serious complications [3]. Heparin is an anticoagulant drug used to prevent and treat thrombosis [4]. Unfractionated heparin is a standard anticoagulant that affects multiple sites of internal and external coagulatory system and inhibits blood clotting [5]. Heparin administration can be associated with serious complications. It has a number of drug interactions, as well as potentially serious side effects. Heparin, even with low dose, can cause thrombocytopenia and bleeding [6]. The absolute

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risk of heparin-induced thrombocytopenia (HIT) with unfractionated heparin is 1%-5% [7]. Normal or isotonic saline has sodium and chloride concentrations of 154 mEq/L [8]. Normal saline solution can maintain patency of arterial and central venous pressure monitoring catheters. Heparinized solutions had no effect on prolonging patency and improving function of catheters and even caused changes in activated partial thromboplastin time (APTT) while the normal saline solution increases accuracy of coagulatory tests. Use of normal saline solution prevents patient exposure to the risks associated with heparinized solution and thus increases patient safety [3, 9]. Normal saline should be used as an alternative to heparin in arterial line and central-venous catheters. Low-dose heparin (1U/ml) should be added to the infusion set to maintain patency of arterial catheters. Extra precautionary measures must be taken when heparin therapy is instituted. Nurses and other healthcare professionals need to be reeducated on the side effects and complications of heparin therapy in order to prevent unnecessary complications and to provide safe and effective [10]. Thrombocytopenia defines as a drop in platelet count by 30% to 50% from the patient's baseline platelet count [11]. Heparin induce thrombocytopenia is defined as a decrease in platelet count during or shortly following exposure to heparin [12]. HIT is the most important and most frequent drug-induced type of thrombocytopenia. It is associated with significant morbidity and mortality if unrecognized. Despite thrombocytopenia, bleeding is rare; rather HIT is strongly associated with thromboembolic complications involving both the arterial and venous system. The risk of HIT is high with prolonged use of heparin for post-operative thromboprophylaxis [13]. Arterial catheters are widely used in intensive care units for continuous blood pressure monitoring and blood sampling. The patency of these lines is maintained by continuous flushing, usually with the addition of the anticoagulant heparin to the flushing solution. Although various studies have compared the effects of heparinized and normal saline solutions on patency of arterial catheters, few studies have considered the effect of these heparinized solutions on platelet count [4, 14, 15]. We undertook a prospective randomized comparative clinical trial to find out any effect of heparin on platelet count and to see the efficacy of normal solution as flushing solution. [16] In this study we aimed to establish the effectiveness of normal saline (sodium chloride 0.9%) flush solution in the maintenance of arterial lines in comparison to heparin flush solution.

OBJECTIVE OF THE STUDY

The aim of the study was to examine the efficacy of Normal saline as flushing solution to maintain indwelling arterial catheter patency among patients after cardiac single valve surgery.

METHODOLOGY & MATERIALS

This was a prospective cross-sectional study and was conducted in the Department of Cardiac surgery of National Institute of Cardiovascular Disease (NICVD), Sher-E-Bangla Nagar, Dhaka, Bangladesh during the period from July 2016 to June 2017. This study included sixty patients who underwent single valve replacement surgery, either MVR or AVR and shifted to the intensive care unit (ICU) with arterial line catheter. These are the following criteria to be eligible for the enrollment as our study participants: a) Patients who got shifted in ICU with arterial line after single valve replacement surgery with normal platelet count; b) Patients who were aged between 18-60 years old; c) Patients time passed from the insertion of catheter less than 6 hours; d) Usage of arterial line extension catheters, 20 cm, 20 gauze ; e) PT (Prothrombin Time) of 11-12.5 seconds ; f) PTT (Partial Thromboplastin time) in the range of 35-45 seconds And a) Patients with risk of bleeding; b) Patients with previous surgical history; c) Patients with known hypersensitivity to heparin; d) Patients who needed anticoagulants, thrombolytic therapy, platelet or whole blood transfusion; d) Patients require therapeutic heparin and TPN (Total Parenteral Nutrition); e) Patients with any history of chronic inflammatory pain (e.g., rheumatoid arthritis, ankylosing spondylitis, etc.) were excluded from our study. The patients who fulfilled the inclusion criteria were divided into two groups- Group 1 (with normal saline) and Group 2 (with heparin solution) using random numbers generated by MS Excel software's RANDBETWEEN Function. Subjects were included after signing consent by themselves or their family .Insertion of radial arterial line catheters were performed in OT by an anesthetist in aseptic condition in radial artery prior to operation. In the heparinized group, heparin (ROTEXMEDICA, TRITTAU, GERMANY) with the product number of 40124 was be used. The solution was prepared by a 1000 IU of heparin added to a half liter of normal saline; hence each milliliter of the prepared solution contained 2 IU of heparin. 3 mL of the heparin solution was used for each flush. In normal saline group patients, 3 mL 0.9% sodium chloride will be used for each flush. Arterial catheter was remained up to 72 hours. During the examination of catheters, all patients were lying on their backs. If flushing or taking blood sample from the catheter was not possible, it was considered non-functional and removed. Platelet count was measured manually preoperative, post pump and continuous for 4 days then on 7th and 14th days. The maximum time of study was 14th days and the collected data during the first 4 days were recorded every four hours in the previously prepared checklist. At the end of 1st week and 2nd week platelet count were recorded and whole data were analyzed by using IBM Statistical Package for Social Sciences version 23 (SPSS version 23.0) for windows 10.

In this study for describing the features of research units, descriptive statistics (mean, standard deviation and distribution frequency) was used. For analyzing the data, Kaplan Meier survival analysis, log rank test and Cox regression was performed and for

comparing the ratios, the Chi-square test was used. ($p < 0.05$ was considered significant).

RESULTS

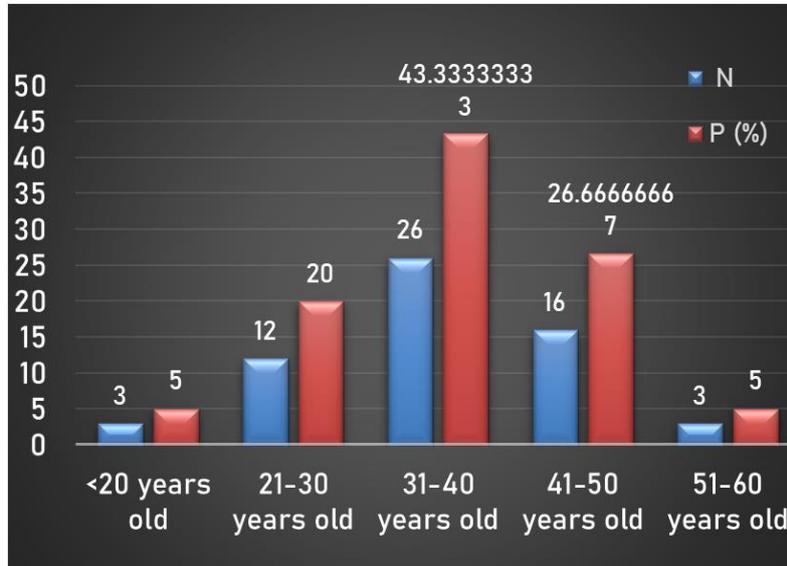


Figure 1: Age distribution among our study subjects

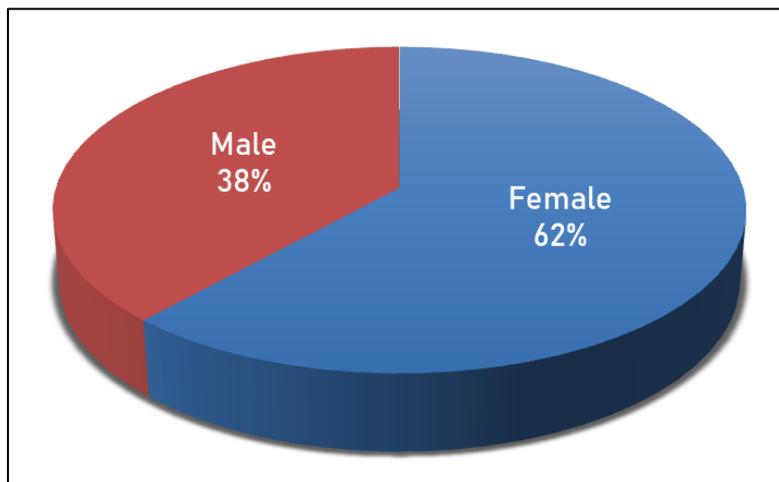


Figure 2: Gender description of the study people

Table-1: Demographic characteristics of study participants (n=60)

Demographic Characteristics	Group-1 (n=30)		Group-2 (n=30)		p value
	N	(%)	N	(%)	
Age (years)					
< 20	0	0	3	10%	
21-30	7	23.3%	5	16.7%	0.79
31-40	13	43.3%	13	43.3%	
41-50	10	33.3%	6	20%	
51-60	0	0	3	10%	
Mean±SD	36.3±6.7		35.7±10.3		0.79
Gender					
Male	12	40.0%	11	36.7%	0.79
Female	18	60.0%	19	63.3%	

Table -2: Types of Operation among study subjects

Name of operation	Group-1 (n=30)		Group-2 (n=30)		P-Value
	N	(%)	N	(%)	
MVR	22	73.3	17	56.7	0.175
AVR	8	26.7	13	43.3	
Total	30	100.0	30	100.0	

Table-3: Distribution of patients by arterial line among Group 1 & 2

Arterial Line	Group-1 (n=30)		Group-2 (n=30)		p value
	N	(%)	N	(%)	
1 st POD	30	100%	30	100%	1.000
2 nd POD	26	86.7%	23	76.7%	0.316
3 rd POD	15	50%	13	43.3%	0.607

Table-4: Comparison of platelet count in two groups in different POD

Platelet Count	Group-1 (n=30)		Group-2 (n=30)		P value
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Platelet count pre-operative	247583±55675	235813±54708	247583±55675	235813±54708	0.412
Platelet count post pump	215883±58210	222580±52422	215883±58210	222580±52422	0.633
Platelet count 1 st POD	206530±64441	212543±48768	206530±64441	212543±48768	0.685
Platelet count 2 nd POD	208363±58003	222177±55580	208363±58003	222177±55580	0.350
Platelet count 3 rd POD	226517±60185	245957±52826	226517±60185	245957±52826	0.188
Platelet count 4 th POD	241217±57558	258190±55012	241217±57558	258190±55012	0.247
Platelet count 7 th POD	240517±57379	257713±53655	240517±57379	257713±53655	0.236
Platelet count 14 th POD	245850±52680	244337±56796	245850±52680	244337±56796	0.915

In this study figure 1 showed the age distribution among study subjects where we found that majority (43%) of the patients were aged between 31-40 years old; 27% & 20% were aged 41-50 & 21-30 years old respectively. The least prevalence 5% was found among less than 20 years old and 51-60 years old. Here, figure 2 shows the gender description of our study people. Majority of our patients were female (62%) & male (38%). In table 1 we showed the demographic characteristics of study people. The highest prevalence (43.3%) was present in aged between 31-40 years old in both Group 1 & 2. Followed by (33.3% & 20%) was present in aged between 41-50 years old among Group 1 & 2 respectively. (23.3% & 16.7%) was found aged between 21-30 years old among Group 1 & 2 respectively. The lowest prevalence (10%) was found in Group 2. The mean ± SD of age among Group 1 & 2 was (36.3±6.7) & (35.7±10.3) respectively. Majority of our patients was female in both Group 1 (60%) and Group 2 (63.3%). The prevalence of male was 40% & 36.7% in Group 1 & 2 respectively. In table 2 shows that two types of operations were found among our study people. MVR was found 73.3% in Group 1 and 56.7% in Group 2 respectively. AVR was found (26.7% & 43.3%) among Group 1 & 2 respectively. Table 3 shows arterial line patency in study patients. 100% patients had arterial line patent in 1st POD in both groups. In 2nd POD 86.8% patients had patency in Group 1 and 76.7% in Group 2. At 3rd POD 50.0% patients had patency in Group 1 and 43.3% patients in Group 2 respectively. In table 4 we showed the comparison of platelet count between two groups. Platelet count preoperative was significantly higher in

Group 1 than Group 2. At post pump platelet count was significantly higher in Group 2 than Group 1 and it continued till 14th POD.

DISCUSSION

In our study we found the majority (43%) of our patients were aged between 31-40 years old; 27% & 20% were aged 41-50 & 21-30 years old respectively. The least prevalence 5% was found among less than 20 years old and 51-60 years old [Figure 1]. While in other study (Hall *et al.*) found the majority of their patients aged between 51-60 years old [17]. In this present study majority of our patients were female (62%) & male (38%) [Figure 2]. Similarly other study (Hall *et al.*) found the majority of their patients were female (n=33) and male was (n=32) [17]. In our study we found the highest prevalence (43.3%) in aged between 31-40 years old in both group 1 & 2. Followed by (33.3% & 20%) was present in aged between 41-50 years old among group 1 & 2 respectively. (23.3% & 16.7%) was found aged between 21-30 years old among group 1 & 2 respectively. The lowest prevalence (10%) was found in group 2. The mean ± SD of age among group 1 & 2 was (36.3±6.7) & (35.7±10.3) respectively. Majority of our patients was female in both group 1 (60%) and group 2 (63.3%). The prevalence of male was 40% & 36.7% in group 1 & 2 respectively [Table 1]. In this study we did MVR and AVR operations on our study people. MVR was found 73.3% in group 1 and 56.7% in group 2 respectively. AVR was found (26.7% & 43.3%) among group 1 & 2 respectively [Table 2]. In other study (Ziyaeifard M *et al.*) did CABG Surgery on

33 (66%) & 27 (54) and Valve Surgery on 22 (44%) & 28 (56%) in normal and heparin saline group respectively [3]. In our study we found arterial line patency 100% among patients in 1st POD in both groups. In 2nd POD 86.8% patients had patency in Group 1 and 76.7% in Group 2. At 3rd POD 50.0% patients had patency in Group 1 and 43.3% patients in Group 2 respectively. [Table 3] While other study (Ling Jia Goh *et al.*) found arterial line in 72 hours (97% & 100 %) among normal saline & heparin saline group; Arterial line in 120 hours was (83%) in normal Saline group & (86%) in heparin Saline group respectively [18]. In here we showed the comparison of platelet count between two groups. Platelet count at preoperative period was significantly higher in Group 1 than Group 2. At post pump, 1st POD, 2nd POD, 3rd POD, 4th POD, 7th POD and 14th POD, there was no statistically significant difference between Group 1 and Group 2. Though at post pump period platelet count was significantly higher in Group 2 than Group 1 and it continued till 14th POD [Table 4]. The parallel study done by (Hall *et al.*) comparing arterial catheter line in the two groups showed no difference at the 95% confidence interval using the central limit theorem. Sixty-five patients were recruited over 8 months: 35 in the normal saline group and 30 in the heparinized saline group. The mean platelet count was $256.6 \times 10^9 /L$ for the heparinized saline group, compared with $234.6 \times 10^9 /L$ for the normal saline group. Comparison of means with the central limit theorem showed there was no significant difference at the 95% confidence interval [17]. In 1991, (Clifton *et al.*) conducted a double-blind, randomized study comparing the effects of heparin solutions (4 IU/mL) and normal saline solutions on patency of arterial catheters. They concluded that heparinized solutions were preferable for reducing the rate of catheter occlusions and other malfunctions and that they did not significantly alter platelet count [19]. Another study of 35 ICU patients compared use of either heparin (4 IU/mL) or 1.4% sodium citrate, both in 0.9% sodium chloride solution, as a continuous flush solution. Again, platelet counts were similar in the two groups [20].

Limitations of the Study

Our study was a single center study that conducted in the department of Cardiac surgery of National Institute of Cardiovascular Disease (NICVD). Arterial line patency were assessed only for three postoperative days; therefore no data were provided on prolonged maintenance of indwelling catheters by heparinized or normal saline solutions flush. We only observed the efficacy of normal saline after evaluating those patients for a 14th POD follow-up and have not known other possible interference that may happen in the long term with these patients.

CONCLUSION AND RECOMMENDATIONS

In our study, we found that heparin in arterial line flushing solution had no effect on platelet count.

The use of heparin in normal saline for arterial line flushing does not significantly reduce platelet counts in cardiac valve surgery patients in comparison to use of normal saline. It seems that there is no difference in the use of heparinized and normal saline solutions to maintain patency of arterial line. We only evaluated the effects of normal saline in arterial line flushing on platelet count with 14th POD follow up. So, a further study with a prospective and longitudinal study design needs to be done to assess the difference of heparinized and normal saline solutions flush better in arterial lines.

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