Original Article

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Evaluation of Efficacy of Bolus Ringer's Acetate in Preventing Hypotension Following Lower Limb Tourniquet Release

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Abstract

Background: Haemodynamic instability is a common entity following tourniquet release exacerbated by old age and comorbidities.

Aim: To evaluate efficacy of bolus Ringer's acetate in preventing hypotension following tourniquet release.

Methods: After ethical committee's approval, a comparative study was conducted in tertiary care hospital. Study was conducted on 80 consenting patients, control (n=40) and study (n=40) group between 20-80 years of age belonging to American Society of Anaesthesiologist (ASA)Grade I-II undergoing lower limb surgeries. Patients were divided into two equal groups, Group C patients did not receive bolus of Ringer's acetate and Group S were given additional bolus of 200 ml of Ringer's acetate prior to tourniquet release. Haemodynamic variables (heart rate (HR), Systolic, Diastolic and Mean arterial pressures, Electrocardiogram (ECG)) were monitored before and after release of tourniquet at frequent intervals. Hypotensive episodes (Fall in systolic blood pressure (SBP) >20% from baseline) and vasopressor requirement (If SBP <80mmHg then Inj. Ephedrine IV 5 mg) were noted.

Results: Statistical analysis was done using Chi-Square test and independent sample t test. Intergroup comparison of haemodynamic variables before and after release of tourniquet is comparable and is not statistically significant. Intragroup comparison of haemodynamic variables in Group C was lower when compared to Group S after release of tourniquet and this finding is statistically significant. The incidence of hypotension and vasopressor requirement was significantly higher in Group C compared to Group S (Pvalue<0.029).

Conclusion: Preloading with Ringer's acetate prior to tourniquet release in Group S may possibly be responsible for reduction in incidence of hypotension and vasopressor requirement.

Keywords: Ringer's acetate; Hypotension; Tourniquet.

Introduction

Tourniquet is used in surgical settings to occlude arterial blood flow to produce a relatively bloodless operative field, to improve visualisation of anatomical structures and to minimize blood loss. Tourniquet release can lead to significant haemodynamic changes which are exaggerated in elderly and patients with poor cardiac reserve1. Bolus of Ringer's acetate was used to reduce the haemodynamic changes after tourniquet release as it is a better buffering solution when compared to lactate. Accumulated lactate is released into the circulation following tourniquet release which further burdens the liver making Ringer's acetate fluid of choice for the study.[2,3]

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Aims and Objectives

Aim

To Evaluate efficacy of bolus Ringer's acetate in preventing hypotension, following lower limb tourniquet release.

Objectives

1. To monitor, assess and compare changes in the following parameters before and after release of tourniquet in two groups (study and control) i.e, Heart Rate(HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Blood Pressure (MAP) and Electrocardiogram (ECG) .
2. To find out number of hypotensive episodes and vasopressor requirement in both the groups.

Materials and Methods

After approval from institutional ethical committee a randomized comparative study was conducted on 80 patients between years 2018 to 2020. Patients belonging to ASA grade I & II, aged 20-80 years undergoing lower limb surgeries requiring tourniquet application under spinal anaesthesia with a minimum tourniquet application time of 60 mins were included in the study. Patients having contraindication to tourniquet use like peripheralvascular disease were excluded from the study.

Methodology of Study

Pre anaesthesia check up was performed prior to surgery and appropriate investigations were advised. All patients were kept nil orally for a minimum period of 6 hours. The procedure of spinal anaesthesia was explained to the patients and written informed consent was obtained. The participants were randomly allocated to one of the two groups, Group C (control)and Group-S (study). Patients in both the groups were given the NBM deficit fluid & maintenance fluid. The Group-C (control) did not receive any bolus Ringer's acetate prior to tourniquet release. The Group-S (study) received 250 ml bolus of Ringer's acetate over a period of 10 mins prior to tourniquet release. Standard monitoring was done throughout the procedure but readings were recorded at following times for study: Baseline, Prior to tourniquet release and after tourniquet release at intervals of 1min, 5min and subsequently every 5 minutes up to 30 min. Hypotensive episode was defined as fall in systolic blood pressure (SBP) >20% from baseline and the number was noted. Vasopressor requirement was defined as SBP <80mmHg then Inj. ephedrine IV 5mg was given & number of doses required were noted.

Statistical Analysis

The inter-group statistical comparison of distribution of categorical variables is tested using Chi-Square test. The inter-group statistical comparison of means of continuous variables is done using independent sample t test

In the study, the p-values less than 0.05 are considered to be statistically significant. The entire data is statistically analysed using Statistical Package for Social Sciences (SPSS ver 21.0, IBM Corporation, USA) for MS Windows.

Results

The mean ± SD of age of the patients studied in Group C and Group S was 39.72 ± 10.35 years and 34.42 ± 11.22 years respectively. Gender distribution was comparable in both the groups. Inter group (between 2 groups) distribution of haemodynamic variables in Group C and Group S before and after release of tourniquet was not statistically significant. Intra group(within a group) distribution of haemodynamic variablesin Group C and Group S immediately after tourniquet release(ART) and 5 minutes ART showed lower readings when compared to baseline and this finding was statistically significant. The incidence of hypotensive episodes and vasopressor requirement was higher in Group C with 8 in 40 patients compared to 1 in Group S with a P value(0.029). ECG showed transient changes in 3 patients. One patient in Group C had unifocal Ventricular Premature Complexes (VPCs) immediately after deflation of tourniquet, but was haemodynamically stable. VPCs subsided spontaneously without any pharmacological intervention. One patient developed bradycardia and hypotension after release of tourniquet which resolved after administration of inj. Glycopyrrolate 0.2 mg and inj. Ephedrine 5 mg. One patient in group S had T inversions after deflation of tourniquet associated with hypotension, patient was administered inj. Ephedrine 5 mg for hypotension. T inversions resolved after normalization of blood pressure.

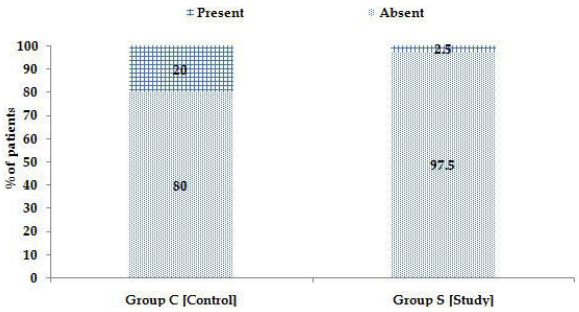
Table 1: Comparison of haemodynamic parameters in both the groups.

Groups		Group C[Control] (n=40)								Group S[Study] (n=40)								P-value			
Parameters		Heart rate		SBP		DBP		MAP		Heart rate		SBP		DBP		MAP		Heart rate	SBP	DBP	MAP
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD				
0	Baseline	86.82	12.20	133.00	14.27	81.50	9.94	97.68	11.11	84.73	9.25	131.15	10.96	79.60	8.43	97.18	9.99	0.388^{NS}	0.518^{NS}	0.359^{NS}	0.833^{NS}
1	Prior to release of tourniquet	85.47	13.34	129.05	13.44	78.30	10.12	94.80	10.02	82.70	8.45	126.63	12.17	76.22	8.53	92.83	9.31	0.270^{NS}	0.400^{NS}	0.325^{NS}	0.364^{NS}
2	Immediately ART	82.68	12.39	117.63	14.37	70.95	9.64	85.48	10.47	80.62	9.10	117.55	12.17	71.65	8.34	87.48	9.64	0.402^{NS}	0.980^{NS}	0.729^{NS}	0.377^{NS}
3	5-min ART	79.97	14.10	112.55	13.44	68.55	10.14	82.12	10.53	80.10	8.88	115.80	13.40	70.05	10.08	86.00	11.09	0.962^{NS}	0.282^{NS}	0.509^{NS}	0.113^{NS}
4	10-min ART	80.30	12.29	113.10	15.86	69.68	10.79	82.00	12.21	78.02	10.40	114.93	12.77	69.75	9.65	85.30	10.20	0.374^{NS}	0.572^{NS}	0.974^{NS}	0.193^{NS}
5	15-min ART	80.73	13.32	113.25	17.92	70.33	10.68	83.28	12.74	77.52	10.59	114.80	13.45	69.43	9.44	84.68	10.26	0.238^{NS}	0.663^{NS}	0.691^{NS}	0.590^{NS}
6	20-min ART	79.97	13.78	112.65	16.51	70.00	10.89	82.32	12.34	76.05	10.26	115.80	14.56	70.08	9.47	85.30	10.69	0.153^{NS}	0.368^{NS}	0.974^{NS}	0.253^{NS}
7	25-min ART	80.23	13.53	113.37	15.59	71.02	10.29	83.58	11.92	75.40	9.19	116.53	14.30	70.58	9.69	85.82	12.05	0.066^{NS}	0.349^{NS}	0.841^{NS}	0.404^{NS}
8	30-min ART	80.38	12.87	113.82	14.38	71.78	10.04	83.45	11.23	76.13	9.41	117.90	13.84	72.37	10.33	87.05	12.43	0.096^{NS}	0.200^{NS}	0.793^{NS}	0.178^{NS}

Table 2: Intragroup comparison of haemodynamic parameters in both the groups.

P-value (Intra-group)	Group C				Group S			
	Heart rate	SBP	DBP	MAP	Heart rate	SBP	DBP	MAP
Baseline vs Immediately ART	0.011*	0.001***	0.001***	0.001***	0.002**	0.001***	0.001***	0.001***
Baseline vs Immediately 5-min ART	0.001***	0.001***	0.001***	0.001***	0.007**	0.001***	0.001***	0.001***

Values are mean and SD, P-value (Inter-Group) by independent sample t test. P-value<0.05 is considered to be statistically significant.
*P-value<0.05, **P-value<0.01, ***P-value<0.001, NS-Statistically Non-significant.



Graph 1: Incidence of hypotensive episodes in two groups.

Table 3: Requirement of vasopressor in two groups.

Vasopressor requirement	Group C [Control] (n=40)		Group S [study] (n=40)		P-value
	n	%	n	%	
No	32	80.0	39	97.5	0.029*
Yes	8	20.0	1	2.5	
Total	40	100.0	40	100.0	

Values are n (% of cases), P-value by Chi-Square test (Fisher's exact probability test). P-value<0.05 is considered to be statistically significant. *P-value<0.05.

Discussion

Tourniquets are preferred by surgeons in peripheral limb surgeries because of their ability to limit blood flow to the limb and thereby improving the visibility of structures in the operative field and also preventing blood loss. Tourniquet use has been associated with complications varying from localized skin injuries to life threatening events such as pulmonary embolism and cardiac arrest. Most common immediate complication is hypotension/ haemodynamic instability. The incidence of hypotension after the release of tourniquet depends on various factors such as old age and comorbidities of the patient. Different methods have been used to prevent this complication like use of intravenous fluids, vasopressors, and limb elevation.

Our study included 80 ASA I&II patients who were randomly allocated to two groups, Group C(control) and Group S(study)(n=40). All patients received deficit and maintenance fluid and Group S patients additionally received 200ml of Ringer's acetate 10 minutes before release of tourniquet. Blood pressure was monitored, and hypotensive episodes were watched for in both the groups. Significant hypotensive episodes (SBP<80mmHg) were treated with intravenous Ephedrine.

Gender distribution was comparable in both the groups while mean age was 34.42 +/- 11.22 in study group and 39.72 +/- 10.35 in control group.

Inter group comparison of haemodynamic parameters were not significant as shown in table-1. A similar study done by Ali S. Ziaee et al did not find any significant relation between tourniquet duration, pressure, and age of the patient with the heart rate after deflation of the tourniquet.

Intra group comparison of haemodynamic parameters immediately and 5 minutes after tourniquet release were lower than baseline values and these findings were statistically significant as shown in table-2. Similar studies done by Ali S. Zaiee et al found that increase in tourniquet application time was associated with decrease in systolic blood pressure and Kyung Song et al found a significant decrease in MAP, CO and SV after deflation of tourniquet.

The fall in SBP, DBP and MAP can be attributed to vasodilatation and reactive hyperaemia of the tourniquet limb after the release of tourniquet. In few patients the fall in blood pressure is >20% of baseline requiring intravenous ephedrine.

Graph-1 and table-3 shows that Incidence of hypotension was more in Group C patients (8) who did not receive additional bolus of Ringer's acetate compared to Group S(1) patient. The decrease in incidence of hypotension in Group S can be attributed to preload of Ringer's acetate. Hypotension was associated with bradycardia in one patient similar to J. Jacobson et al findings where there was increased incidence of bradycardia in patients who developed hypotension. They concluded that the findings could be explained by central hypovolemia developing in conjunction with reactive hyperaemia in the leg following the release of tourniquet.

Adverse effects in our study were seen in 3 patients. Two in control group and one in study group. They were transient and did not require any major pharmacological intervention.

Many studies comparing acetate with normal saline/ Ringer's lactate with respect to changes in acid base homeostasis, electrolytes and haemodynamics in surgical and critical care setting have been done. There is clear evidence regarding beneficial effects of acetate-based crystalloids over lactate based crystalloids. Katsunori. et al showed benefits of using Ringer's acetate over Ringer's lactate as resuscitation fluid in patients with burns.

Strength of this study is Ringer's acetate was given as preloading specifically prior to tourniquet release and such studies are limited in number. To reduce haemodynamic consequences after tourniquet release, we have used Ringer's acetate to commonly used Ringer's lactate solution

considering its better profile. The limitations of this study were relatively small sample size and non-inclusion of high risk patients.

Conclusion

Preloading with Ringer's acetate prior to tourniquet release is effective as it reduces incidence of hypotensive episodes and vasopressor requirement in Group S when compared to Group C.

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