Original Research Article

Bilateral Passive Leg Raising Attenuates and Delays Tourniquet Deflation Induced Hypotension and Tachycardia in Lower Limb Surgeries Under Spinal Anaesthesia : A Randomised Controlled Trial

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BACKGROUND

Lower limb orthopaedic surgeries and ligament reconstruction surgeries are often done with touniquet applied under spinal anaesthesia. Tourniquet deflation leads to the redistribution of the circulating volume back into the limb and post ischaemic reactive hyperaemia. The passive leg raising (PLR) test has been proposed as a predictor of fluid responsiveness in critically ill patients. PLR induces a rapid increase in preload because of the auto transfusion of blood contained within the capacitance veins of the legs. Hence we thought it worthwhile to study the effect of bilateral PLR on patient’s blood pressure and heart rate after tourniquet deflation in patients undergoing lower limb surgery under spinal anaesthesia.

AIMS & OBJECTIVES

To evaluate the effect of bilateral passive leg raising in patients undergoing lower limb surgeries under spinal anaesthesia on tourniquet deflation induced.

a) Changes in blood pressure (SBP, DBP, MAP)
b) Changes in heart rate (HR)

METHODOLOGY

After approval from institutional review board, the prospective randomized control study was conducted in 50 patients of either sex, 18-60 years of age, ASA I and II, posted for elective lower limb surgery with expected surgical duration of less than 2 hours. Patients were randomly allocated into two groups. Group RL (n=25) in whom bilateral passive leg raising was conducted prior to deflation of tourniquet and Group SL (n=25) in whom patient’s legs were

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maintained in supine position prior to deflation of tourniquet. Haemodynamic parameters were recorded at time points T1-T17 prior, during and following deflation of tourniquet.

RESULTS

The study showed that, within 2 min of tourniquet deflation, there was 8.04%, 9.98% and 9.48% reduction in SBP, DBP and MAP respectively (SBP, $p<0.001$; DBP, $p<0.001$; MAP, $p<0.001$) in the control group. While, the degree of decline was insignificant or minimal in the PLR group i.e. 1.07%, 3.22% and 1.72% respectively (SBP, $p=0.202$; DBP, $p=0.042$; MAP, $p=0.458$) and within 2 min of tourniquet deflation, there was 21.06% increase in HR in control group, while the rise was much less in PLR group i.e. 8.0% and the difference in the rise between the 2 groups is statistically significant ($p<0.05$).

CONCLUSION

We conclude that the severity and duration of hypotension and tachycardia following tourniquet deflation were attenuated by bilateral PLR in patients undergoing lower limb surgery under spinal anaesthesia.

INTRODUCTION

The pneumatic tourniquet is commonly used during most of the limb surgeries so as to maintain a clean, dry surgical field and to improve the visibility of the anatomic structures.

After tourniquet deflation, the blood volume shifts back to the ischaemic limb, thereby reducing cardiac preload, which may lead to hypotension.[1] Such hypotension can be profound and has been reported to result in tachycardia and cardiac arrest.[2,3] It is therefore crucial to maintain haemodynamic stability after tourniquet deflation.

In clinical practice, cardiac preload is often increased by intravenous fluid administration prior to the deflation of the tourniquet in an attempt to reduce these cardiovascular effects caused by the shift of blood back into the limb.[2,4] However this practice may be deleterious in patients with end-stage renal disease or heart failure who have restrictions on fluid replacement.

The passive leg raising (PLR) test has been proposed as a predictor of fluid responsiveness in critically ill patients.[5-7] This test is based on the principle that PLR induces a rapid increase in preload because of the auto transfusion of blood contained within the capacitance veins of the legs. Recently, Go-Shine Huang et al concluded that bilateral passive leg raising attenuates and delays tourniquet deflation induced hypotension and tachycardia under spinal anaesthesia. Hence we also thought it worthwhile to study the effect of bilateral PLR on patient's blood pressure and heart rate after tourniquet deflation in patients undergoing lower limb surgery under spinal anaesthesia. The aim of our study was to evaluate the effect of bilateral passive leg raising in patients undergoing lower limb surgeries under spinal anaesthesia on tourniquet deflation induced.

a) Changes in blood pressure (SBP, DBP, MAP)
b) Changes in heart rate (HR)

METHODOLOGY

Place of Study

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After Institutional Review Board approval and informed written consent this study was conducted in the Department of Anaesthesiology and Intensive Care, Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi.

Study Design
Randomized controlled study.

Study Population
Patients of either sex, 18-60 years of age, admitted in Maulana Azad Medical College and associated Lok Nayak hospital, New Delhi scheduled to undergo elective lower limb surgery.
Outcome

- **Primary Outcome measure**:
  a) Blood pressure.

- **Secondary Outcome Measures**:
  a) Heart rate.
  b) Total dose of rescue ephedrine and/or atropine.

Sample Size
A power analysis was performed based on a previous study conducted by Huang et al.[17] where the decrease in MAP in PLR group was 4.3% and that of in control group were 15.1%. By applying the following formula,

$$N = 4(SD)^2[z_{crit} + z_{pwr}]^2/D^2$$

The total sample size required was 60 per group with an error of 0.05 & power of 80%. However, being a time bound study, we took 50 patients i.e. 25 patients in each group as sample of convenience.

Group Allocation
Patients were randomly allocated into two groups.
- Group PL (n=25) – Bilateral passive leg raising was conducted prior to deflation of tourniquet.
- Group NL (n=25) – Patient's legs were maintained in supine position prior to deflation of tourniquet.

Randomization was done by computer generated random number tables.

Anaesthesia Technique
- Pre-medication with oral alprazolam 0.5mg night before the surgery.
- Fasting for 8-10 hrs pre-operatively as per ASA recommendation.
- Preloading with crystalloid solution, 10ml/kg over 15 minutes prior to subarachnoid block.

Spinal anaesthesia was performed through the L3-L4 or L4-L5 interspace with appropriate dose of 0.5% heavy bupivacaine expected to achieve sensory level of T8. All the patients were monitored using ECG, Pulse oximetry and NIBP every 5 minutes throughout the anaesthesia procedure

Following spinal anaesthesia, Ringer lactate 15ml/kg was administered over initial 30 minutes followed by 8 ml/kg/hr throughout the surgical procedure. Total blood loss was recorded and was replaced by three times the volume with Ringer Lactate.

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In both groups, after induction of spinal anaesthesia, the patients were placed in supine position and a well-padded proximal tourniquet inflated to a pressure of 200-300mmHg was applied to operative limb. After the completion of surgery, the level of sensory block was noted and in PLR group, bilateral PLR was performed by raising the patient's legs to an angle of 45 degrees. Haemodynamic parameters were recorded 2 & 4 minutes after initiation of PLR. Four minutes later, while maintaining the PLR, tourniquet was deflated and haemodynamic parameters were recorded at 2, 4 & 6 minutes after tourniquet deflation i.e. PLR was maintained for total 10 minutes. Thereafter, the legs were returned to supine position.

In the control group, the legs remained in the baseline supine position but corresponding haemodynamic measurements were recorded.

Haemodynamic Monitering:

Four set of haemodynamic values were recorded at time points T1-T17.

- T1-T5: 30, 15, 10, 5 and 1 minute prior to bilateral PLR in PLR group and corresponding time points in control group (with legs remaining in supine position).
- T6-T7: 2 and 4 minutes after bilateral PLR and before deflation of tourniquet (in PLR group) and corresponding time points in control group (with legs in supine position).
- T8-T10: 2, 4 and 6 minutes after tourniquet deflation in both groups.
- T11-T17: 1, 3, 5, 10, 15, 30 and 60 minutes after completion of PLR in study group and at similar time points in control group.

Statistical Analysis

The quantitative variables are expressed as mean +/-SD and compared between groups using unpaired t-test and within group across follow-ups using paired t-test. Qualitative variables are expressed in terms of frequencies/percentages and analysed using Fishers's exact test/Chi-square test. A p-value <0.05 is considered statistically significant. The data is analysed using SPSS Version 16.0 software.

RESULTS

The study population consists of 50 patients who were divided into two groups, group-RL and group-SL of 25 patients each.

Group	N	%
RL	25	50%
SL	25	50%
Total	**50**	**100%**

Table 1: Distribution between two groups

0.5% Heavy Bupivacaine Drug Dosage and Blood Loss

The mean drug dosage in group RL was 2.69 ± 0.26 ml of 0.5% Heavy bupivacaine, while it was 2.73 ± 0.24 ml in group SL. The mean drug dosage was statistically similar in two groups (p=0.288). (Table 2)

The mean blood loss in group RL was 114.00 ± 30.69 ml, while it was 130.00 ± 45.64 ml in group SL. The mean blood loss was statistically similar in both groups. (p=0.076). (Table 2)

	RL	SL	p-value

	mean	±sd	Mean	±sd	
Drug dosage (ml)	2.69	±0.26	2.73	±0.24	0.288
Blood Loss (ml)	114.00	±30.69	130.00	±45.64	0.076

Table 2: Mean drug dosage (0.5% Heavy Bupivacaine) and mean blood loss in two groups

Level of Sensory Blockade	RL		SL	
	Preoperative	Postoperative (prior to deflation of tourniquet)	Preoperative	Postoperative (prior to deflation of tourniquet)
T8	25	0	25	0
T10	0	13	0	12
T12	0	12	0	13
Total	**25**	**25**	**25**	**25**

Table 3: Level of Sensory blockade

Level of Sensory Blockade

The level of sensory block post operatively prior to tourniquet deflation was comparable in both the groups. (Table 3),

Hemodynamic Parameters

The mean preoperative systolic blood pressure was 134 ± 11.47 mmHg in group RL, while it was 130.48 ± 11.45 mmHg in group SL. The mean preoperative systolic blood pressure was statistically similar among the groups (p=0.099). (Table 4)

The mean preoperative diastolic blood pressure was 83.60 ± 8.11 mmHg in group RL, while it was 85.40 ± 7.09 mmHg in group SL. The mean preoperative diastolic blood pressure was statistically similar among the groups (p=0.082). (Table 4)

The mean preoperative MAP was 101.92 ± 11.31 mmHg in group RL, while it was 99.16 ± 7.59 mmHg in group SL. The mean preoperative MAP was statistically similar among the groups (p=0.158). (Table 4)

The mean preoperative heart rate was 82.20 ± 9.45 per min in group RL, while it was 80.80 ± 9.81 per min in group SL. The mean preoperative heart rate was statistically similar among the groups (p=0.305). (Table 4)

Preoperative Assessment	RL		SL		p-value
	Mean	±SD	Mean	±SD	
Heart Rate	82.20	±9.45	80.80	±9.81	0.305
BP (systolic)	134.72	±11.47	130.48	±11.45	0.099
BP (Diastolic)	81.60	±8.11	85.40	±7.09	0.082
BP (MAP)	101.92	±11.31	99.16	±7.59	0.158

Table 4: Preoperative Hemodynamic parameters in two groups

The mean baseline systolic blood pressure was 127.48 ± 14.86 mmHg in group RL, while it was 125.96 ± 12.64 mmHg in group SL. The mean baseline systolic blood pressure was statistically similar among the groups (p=0.350). (Table 5)

The mean baseline diastolic blood pressure was 76.08 ± 11.19 mmHg in group RL, while it was 83.12 ± 9.77 mmHg in group SL. The difference in mean baseline diastolic blood pressure was statistically significant among the groups (p=0.011). (Table 6)

The mean baseline MAP was 92.60 ± 12.61 mmHg in group RL, while it was 97.24 ± 9.31 mmHg in group SL. The mean baseline MAP was statistically similar among the groups (p=0.073). (Table 7).

The mean baseline heart rate was 77.28 ± 10.1 per min in group RL, while it was 76.12 ± 8.67 per min in group SL. The mean baseline heart rate was statistically similar among the groups (p=0.332). (Table 8)

Comparision of Hemodynamic Parameters with Post before and after Torniquet Deflation (T5 v/s T6-T17)

i) Systolic Blood Pressure (SBP)

The mean systolic blood pressure at T5 (1minute prior to PLR) was 121.40 ± 10.49 mmHg in group-SL. The statistically significant decline in SBP occurred at T8 (2 min after tourniquet deflation) and was 111.64 ± 12.11 mmHg (p<0.001). The decline in blood pressure thereafter remained statistically significant up to T14 (corresponding to 10 minutes following PLR) (p<0.05). The mean systolic blood pressure at T5 (1 min prior to PLR) was 126.12 ± 10.62 mmHg in group-RL. There was no significant decline in mean SBP thereafter, throughout the study period (p<0.05). The difference in decline of mean SBP between the two groups was statistically significant at T8 (2 minutes after tourniquet deflation) and remained significant throughout rest of the study period. (p < 0.05). (Table 5)

BP (Systolic)	RL			SL			p-value
	Mean	±SD	p-value (vs T5)	Mean	±SD	p-value (vs T5)	
Baselline	127.48	±14.86	-	125.96	±12.82	-	0.350
T1	124.84	±13.55	-	121.44	±11.36	-	0.171
T2	123.88	±11.11	-	121.36	±9.95	-	0.201
T3	126.20	±10.81	-	120.36	±9.95	-	0.026
T4	125.80	±11.27	-	121.04	±12.07	-	0.078
T5	126.12	±10.62	-	121.40	±10.49	-	0.060
T6	128.00	±13.04	0.053	122.12	±11.49	0.181	0.069
T7	127.60	±13.41	0.122	120.32	±11.91	0.189	0.054
T8	126.00	±12.95	0.462	111.64	±12.11	<0.001	<0.001
T9	128.80	±12.37	0.201	110.76	±9.55	<0.001	<0.001
T10	128.56	±13.79	0.121	111.60	±10.61	<0.001	<0.001
T11	128.12	±14.68	0.143	113.20	±10.78	<0.001	<0.001
T12	126.44	±14.37	0.429	113.72	±10.32	<0.001	<0.001
T13	126.60	±11.98	0.368	116.08	±9.84	<0.001	<0.001
T14	124.76	±12.17	0.202	116.44	±8.45	<0.001	0.004
T15	126.76	±12.42	0.342	119.92	±9.13	0.102	0.016
T16	126.68	±11.55	0.355	120.36	±7.94	0.214	0.014
T17	126.96	±11.1	0.267	120.72	±9.09	0.318	0.017

Table 5: Mean systolic blood pressure trend between two groups

ii) Diastolic Blood Pressure (DBP)

The mean diastolic blood pressure at T5 was 78.60 ± 10.27 mmHg in group-SL. Statistically significant fall in mean diastolic blood pressure was observed at T8 i.e. 70.76 ± 11.19 mmHg (p<0.001). The decline in blood pressure thereafter remained significant up to T14 (p<0.05).

The mean diastolic pressure at T5 in group-RL was 75.84 ± 6.8 mmHg. Significant fall in mean diastolic blood pressure was observed at T14 i.e. 73.40 ± 6.08 mmHg (p=0.042). The

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decline in blood pressure thereafter remained significant up to T15 (15 minutes following PLR) ($p<0.05$). The difference in decline of mean DBP between the two groups was statistically significant T8 (2 minutes after tourniquet deflation) and remained significant till T11 (1-minute following completion of PLR). ($p < 0.05$). (Table 6)

BP (Diastolic)	RL			SL			p-value
	Mean	±SD	p-value (vs T5)	Mean	±SD	p-value (vs T5)	
Baselline	76.08	±11.19	-	83.12	±9.77	-	0.011
T1	75.68	±8.4	-	79.20	±9.39	-	0.084
T2	74.60	±7.6	-	80.44	±8.06	-	0.006
T3	74.08	±7.93	-	80.20	±9.67	-	0.009
T4	76.12	±7.33	-	79.52	±10.59	-	0.097
T5	75.84	±6.8	-	78.60	±10.27	-	0.134
T6	74.92	±8.6	0.156	80.84	±9.09	0.009	0.051
T7	77.20	±7.43	0.117	79.52	±9.67	0.292	0.173
T8	77.84	±10.53	0.094	70.76	±11.19	<0.001	0.013
T9	78.64	±9.89	0.12	71.00	±9.94	<0.001	0.004
T10	77.36	±6.59	0.049	69.44	±10.15	<0.001	<0.001
T11	78.00	±8.11	0.081	72.28	±9.91	<0.001	0.015
T12	77.80	±9.07	0.13	73.76	±10.75	0.001	0.079
T13	75.56	±6.95	0.423	75.84	±10.88	0.034	0.457
T14	73.40	±6.08	0.042	73.52	±11.04	0.003	0.481
T15	71.68	±7.01	0.005	77.32	±10.02	0.172	0.013
T16	75.32	±7.77	0.361	78.16	±9.78	0.328	0.131
T17	75.20	±7.79	0.364	79.24	±10.35	0.317	0.063

Table 6: Mean diastolic blood pressure trend between two groups

iii) Mean Arterial Pressure (MAP)

The mean of MAP at T5 in group SL was 91.56 ± 11.45 mmHg. Statistically significant fall in MAP was observed at T8 i.e. 82.88 ± 11.72 mmHg ($p<0.001$). The decline in blood pressure thereafter remained significant up to T14 (corresponding to 10minutes following PLR) ($p<0.05$).

The mean of MAP at T5 in group RL was 93.04 ± 7.29 mmHg. The blood pressure post tourniquet deflation remained statistically similar throughout rest of the study period ($p<0.05$). The difference in decline of mean MAP between the two groups was statistically significant T8 (2 minutes after tourniquet deflation) and remained significant till T14 (10 minute following completion of PLR). ($p < 0.05$). (Table 7)

MAP	RL			SL			p-value
	Mean	±SD	p-value (vs T5)	Mean	±SD	p-value (vs T5)	
Baselline	92.60	±12.61	-	97.24	±9.31	-	0.073
T1	92.32	±9.04	-	92.12	±9.47	-	0.470
T2	91.72	±7.53	-	92.68	±9.39	-	0.346
T3	91.64	±7.09	-	92.68	±9.66	-	0.333
T4	92.76	±7.7	-	93.04	±11.32	-	0.459
T5	93.04	±7.29	-	91.56	±11.45	-	0.294
T6	93.80	±7.3	0.247	93.36	±10.21	0.290	0.431
T7	95.28	±7.36	0.243	90.28	±9.64	0.211	0.221

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T8	94.84	±9.97	0.067	82.88	±11.72	<0.001	<0.001
T9	96.20	±9.31	0.05	83.00	±10.14	<0.001	<0.001
T10	94.56	±7.73	0.061	82.44	±10.05	<0.001	<0.001
T11	95.00	±9.07	0.084	84.88	±9.73	<0.001	<0.001
T12	94.56	±9.33	0.154	86.32	±9.63	0.001	0.002
T13	93.96	±6.4	0.27	87.84	±9.41	0.017	0.005
T14	92.88	±5.56	0.458	87.60	±8.87	0.013	0.008
T15	93.52	±8.37	0.381	89.44	±9.85	0.084	0.061
T16	93.96	±7.64	0.271	90.52	±9.11	0.206	0.077
T17	95.48	±6.76	0.131	92.76	±9.03	0.228	0.117

Table 7: Mean Arterial blood pressure trend between two groups

iv) Heart Rate

The mean heart rate in group-SL at T5 was 66.72 ± 11.41 beats/min. It increased to 84.52 ± 7.78 beats/min at T8 (2 minutes after tourniquet deflation) which was statistically significant compared to T5 ($p<0.001$). The heart rate thereafter remained significantly high, throughout the study period ($p<0.001$).

The mean heart rate in group-RL at T5 (1 min prior to PLR) was 70.80 ± 11.39 beats/min. It increased to 73.20 ± 10.7 beats/min ($p>0.001$) at T6 (2 minutes following initiation of PLR) and remained significantly high thereafter, throughout the study period ($p<0.001$).

The difference of mean heart rate between the two groups was statistically significant at T8 (2 minutes after tourniquet deflation) and remained significant up to T10 (8 minutes following tourniquet deflation) ($p < 0.05$). (Table 8)

Heart Rate	RL			SL			p-value
	Mean	±SD	p-value (vs T5)	Mean	±SD	p-value (vs T5)	
Baselline	77.28	±10.1	-	76.12	±8.67	-	0.332
T1	70.84	±11.97	-	67.40	±9.4	-	0.132
T2	70.40	±11.09	-	67.08	±8.37	-	0.119
T3	70.56	±11.96	-	66.48	±10.12	-	0.100
T4	69.96	±11.28	-	66.32	±10.83	-	0.125
T5	70.80	±11.39	-	66.72	±11.41	-	0.106
T6	73.20	±10.7	<0.001	69.64	±14.23	0.038	0.161
T7	73.48	±10.82	<0.001	71.88	±12.4	0.05	0.315
T8	76.96	±9.91	<0.001	84.52	±7.78	<0.001	0.002
T9	76.20	±9.98	<0.001	82.76	±8.94	<0.001	0.009
T10	75.60	±9.48	<0.001	82.20	±9.04	<0.001	0.008
T11	78.36	±8.53	<0.001	75.96	±9.05	<0.001	0.170
T12	76.88	±9.23	<0.001	74.32	±9.06	<0.001	0.164
T13	76.72	±8.39	<0.001	75.76	±9.01	<0.001	0.349
T14	77.72	±8.87	<0.001	73.08	±8.22	<0.001	0.030
T15	77.40	±8.92	<0.001	73.40	±7.78	<0.001	0.020
T16	77.84	±9.08	<0.001	73.36	±8.26	<0.001	0.015
T17	77.04	±9.45	<0.001	73.28	±7.95	<0.001	0.067

Table 8: Mean heart rate during the study period between two groups

Rescue Ephedrine and Atropine

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5 patients (20%) out of 25 patients in the study group (group-RL) and 2 patients (8%) out of 25 patients required single dose of rescue ephedrine following sub arachnoid block during the initial 30 minutes.There was no requirement of rescue atropine in any patient in both the groups. (Table 9)

	RL		SL		p-value
	n	%	n	%	
Rescue Ephidrine (6mg)	5	20%	2	8%	0.111
Rescue Atropine	0	0%	0	0%	-

Table 9: Rescue ephedrine and atropine following SAB

After Tourniquet Deflation

There was no requirement of rescue ephedrine and atropine following tourniquet deflation in any patient in both the groups. (Table 10)

	RL		SL	
	n	%	n	%
Rescue Ephidrine (6mg)	0	0%	0	0%
Rescue Atropine	0	0%	0	0%

Table 10: Rescue ephedrine and atropine after tourniquet deflation

DISCUSSION

The use of pneumatic tourniquet is very common and is almost ubiquitous in all lower limb surgeries unless contra-indicated. Particularly in orthopaedic surgeries especially arthroscopies, tension band wiring in fracture patella and other fractures like involving tarsal bones, it provides significant benefit by providing a bloodless field of surgery, thereby increasing ease of surgery and aids in limiting the surgical duration.

However, the use of tourniquet is associated with numerous disadvantages, like nerve injury being the most common, others include compartment syndrome, pressure sores, digital necrosis, deep vein thrombosis leading to pulmonary or venous embolization, tourniquet pain, rhabdomyolysis and other potential complications.

Tourniquet application often causes hemodynamic and metabolic changes whose entity depends on the tourniquet phase (Inflation-Deflation), the time duration of tourniquet inflation, extent of ischaemic area, the anaesthetic method and the cardiovascular condition of the patient.[9] Tourniquet may intensify the risk of complications like hypertension and hypotension, arterial oxygen and carbon-di-oxide partial pressure modification, lactic academia and hyperkalaemia. Thus meticulous care is important by an anaesthetist.[10]

Tourniquet deflation leads to the redistribution of the circulating volume back into the limb and post ischaemic reactive hyperaemia. Metabolites accumulated in the limb are released into systemic circulation. All these will lead to hypotension which at times may be significant leading to cardiac arrest.[2,3]

Numerous pharmacological measures like intravenous ketamine[13], intramuscular methoxamine[15] and non-pharmacological measures such as fractional deflation of pneumatic tourniquet[14] have been tried with limited success to overcome the tourniquet deflation induced haemodynamic changes. Lifting the legs in the event of circulatory collapse is a rescue manoeuvre that has been used for years by first aid rescuers. Passive Leg Raising (PLR) has recently gained interest as a test for monitoring functional hemodynamics and assessing fluid responsiveness, since it is a simple way to transiently increase the cardiac preload. Lifting the

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legs passively from the horizontal plane in a lying subject obviously induces a gravitational transfer of blood from the lower part of the body towards the cardiac cavities.

Passive leg raising (PLR) test is also used as a bedside test to evaluate the need for further fluid resuscitation in critically ill. This test involves passively raising the legs of a patient (without any active participation by the patient), which causes gravity to pull blood from the legs, thus increasing circulatory volume available to the heart (cardiac preload).

In this study, PLR was shown to attenuate and delay the hypotension and tachycardia that typically occurs after tourniquet deflation at the conclusion of lower limb surgery.

When the tourniquet was deflated, the PLR group showed less hypotension and tachycardia, showing that PLR helped to provide more haemodynamic stability in response to tourniquet deflation. As the patients' legs were returned to the baseline position, a further decrease in blood pressure was observed, suggesting that without PLR, the blood pressure reduction following tourniquet deflation would have been greater. This finding confirms that PLR is able to help maintain a more stable blood pressure in these patients, even as the blood pressure reached its nadir. Moreover, the interval between tourniquet deflation and the nadir in blood pressure was longer in PLR group than in control group. Therefore, although the hypotension still occurred after tourniquet deflation within the PLR group, the magnitude was attenuated and the time to the blood pressure nadir was delayed, compared with the control patients.

CONCLUSION

Bilateral PLR is a simple, reversible manoeuvre that mimics rapid fluid loading. According to the results of this study, the severity and duration of hypotension and tachycardia following tourniquet deflation can be attenuated by PLR. We therefore suggest that bilateral PLR prior to tourniquet deflation is indicated to maintain haemodynamic stability following lower limb tourniquet deflation.

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