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"OBSERVATIONAL STUDY OF NONINVASIVE BLOOD PRESSURE MONITORING IN LATERAL DECUBITUS POSITION SURGERY BETWEEN DEPENDENT & NONDEPENDENT ARM UNDER GENERAL ANESTHESIA."

Anaesthesiology

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ABSTRACT

Background and Aims: Study of correlation between the Pulse rate, Perfusion index, SPO2 in dependent/nondependent arm in LDP. To know various hemodynamic changes as well as any positional correction needed in LDP. **Materials and methods:** After getting approval from ethical committee, patients age between 18 to 70 years & ASA class I to III posted for surgery under LDP considered and arm circumference was measured for selection of appropriate NIBP cuff, Pulse rate, BP, PI, SPO2 were measured in recovery room & pre-post induction. After proper padding at pressure points in LDP, pulse rate, BP, PI, SPO2 was documented from baseline to every 5minute in both arms until 45minute and thereafter every 15 minutes. Once surgery finished after supine position all data were measured in both arms. **Result:** All demographic data were comparable. In recovery room, pre-post induction before LDP in right and left upper arm for pulse, BP, PI, p value >0.05, so comparable. After LDP, pulse rate, SBP, DBP & MBP when compared between dependent and nondependent arm shows no significant changes except at 40 minutes for DBP($P<0.05$). Out of total 6 patients having BMI>25, five needed frequent arm reposition for low PI reading. Post-surgery again after supine position there were no significant changes in clinical parameters between two arms. **Conclusion:** It is concluded intermittent NIBP is well correlated in either upper limb in LDP surgery under GA. But, as anesthesia progress PI changes can be there due to perfusion changes as well as with anesthetic medication, but PI difference between two arms can be early indication for reposition. When we compared BMI and PI it shows correlation in LDP surgery.

KEYWORDS

NIBP (noninvasive blood pressure), PI (perfusion index), LDP (lateral decubitus position)

INTRODUCTION:

The safe practice of anesthesia requires careful monitoring of vital signs. So, patients undergoing surgery under general anesthesia, monitored anesthesia care, regional anesthesia, sedation needs to be monitored intermittently and as well as when required. Intermittent blood pressure monitoring during anesthesia aid drug titration, fluid management and provides early warning sign. Blood pressure correlates directly with cardiac and vascular function. In operation theatre, post operative period, and in Intensive care unit Non-Invasive Blood Pressure (NIBP) monitoring is nowadays most commonly used by automated oscillometric device method. [1] The reference point for measurement of blood pressure is at level of right atrium. [4] There are many factors affect measurement of blood pressure like size of cuff, kinking of cuff, leaking of cuff/ connection, any motion artifacts (extrinsic/intrinsic), patient's position etc. [1]

Patients are operated in LDP surgery like hip, renal stone surgery, nephrectomy, lung surgery in which BP varies with arm due to hydrostatic forces. In LDP (kidney position) kidney rest is commonly used. Kidney rest placed under table with lower hip flexed. [3]

Perfusion index (PI) is derived from pulse oximetry and values ranges from 0.02% (very weak) to 20% (strong). [5]

Perfusion index is a numerical value that indicates the strength of the infrared (IR) signal returning from the monitoring site. It is calculated by the following PI=AC/DC ×100

AC represents pulsatile component of infrared signal, the light which is absorbed by the pulsating arterial inflow, it also represents amplitude of waveform & DC represents non-pulsatile component of infrared signal that is absorbed by the skin, other tissues and non-pulsatile amount of the blood at the vascular site[10][11].

Hence, Perfusion index can be used to assess perfusion dynamics. [6] In 1989, an American manufacturer of non-invasive patient monitoring technology named Masimo founded by electrical engineer Joekiani introduced SET (signal extraction technology) that could measure accurately the perfusion index from the arterial signals. [7] It can help to determine early vessels compression in either upper limb in LDP surgery. So, this study is planned to know the variation in hemodynamics (PI, BP, SPO_2, Pulse rate) in LDP surgery at dependent and nondependent arm in lateral position surgery.

Aim:

Non-invasive blood pressure (NIBP) and other hemodynamic parameters monitoring in lateral decubitus position (LDP) surgery between dependent & nondependent arm under general anesthesia.

Primary objective was NIBP difference between dependent and non-dependent arm in lateral position. **Secondary objectives** were correlation of Perfusion Index with Non-invasive blood pressure in dependent & non- dependent arm and hemodynamic parameter changes between two arms in lateral Position.

MATERIAL AND METHODOLOGY:

After getting approval from institutional ethical committee and CTRI approval **(CTRI/2021/10/037059)**, this observational cross-sectional study was conducted in total 26 patients undergoing lateral decubitus position surgery (pyelolithotomy) under general anaesthesia at tertiary care center of South Gujarat between period of October 2021 to June 2022.Informed consent was obtained from all the patients who were willing to participate in the study. Considering average 2-3 lateral position surgery per month under general anesthesia as per previous years data at new civil hospital Surat and due to covid pandemic a smaller number of cases were enrolled in this study.

Inclusion criteria were ASA class I to III, Age between 18 to 70 years and Surgery in lateral decubitus position under general anaesthesia. Whereas exclusion criteria were Patient refusal, critically ill patient (hypotension, arrythmia & extensive organ dysfunction, peripheral vascular disease, arteriovenous fistula), Patient in whom pre operation systolic Blood Pressure and diastolic Blood Pressure difference in both arms more than 20- and 10-mm Hg respectively and Body Mass Index >30 kg/m^2. Patients' detailed pre anesthetic check-up (PAC)was done before surgery. At the end of PAC, eligible patients were informed about our study and who gave informed written consent were included in study and explain about procedure in detail.

According to AHA, arm circumference was measured proximal to

antecubital fossa for the selection of appropriate NIBP cuff. After taking consent on the day of surgery, in recovery room (pre operative), all monitors were attached like individual NIBP cuff for both upper arm, ECG, SPO_2 probe. We have used one multipara machine to collect NIBP data with changing just connector to patient's NIBP cuffs to prevent instrument reading related bias. Perfusion index was measured by MASIMO machine[8].

Pre induction during intra op, all the basic vitals were observed & documented. Post induction also pulse rate, BP, SPO_2, PI was measured and documented from both the upper arms. Post induction after taking vitals from both arms patient were given Right/Left lateral position as per surgery by available consultant anaesthetist.

After Lateral Decubitus Position pulse rate, SBP, DBP, MBP, PI, SPO_2 was documented from baseline (0 minute) to every 5minute in both arms until 45 minutes. After 45 minutes all these parameters were recorded at every 15minute until surgery over. During surgery in LDP for PI data difference between two upper arms found more than 25%, correction was provided by reposition. Once the surgery was finished again after supine position all the parameters were noted. Patient was extubated & before shifting patient from Operation Theatre to recovery room all final data were measured. Primary outcome was Blood pressure and Perfusion index difference in dependent and non-dependent arm intra operative and secondary outcome: Correlation of blood pressure changes with perfusion index difference.

Statistical Analysis:
In this prospective observational analysis, continuous variables were expressed as Mean ± SD using Microsoft excel programme. All statistical analysis was performed using EPI info TM, version 7.2. 2020. A paired t-test analysis of the pre and post lateral decubitus position as well as for dependent and non-dependent limb of the patients were done. P value < 0.05 was considered as statistically significant.

RESULTS:
Demographic Data: During pre-anesthetic checkup demographic data age, sex, height, weight, body mass index (BMI) of 26 patients tabulated in table No.1.

Table No .1. Demographic Data:

	MEAN(N=26)	SD (N=26)	(N)PERCENTAGES
Age (years)	36.19 years	12.54 years	
Sex Male			(N= 12) 46% M
Female			(N=14) 54% F
Height (cm)	158.76 cm	10.48 cm	
Weight (kg)	52.5 kg	10.70 kg	
BMI (kg/m^2)	20.94 kg/m^2	4.61 kg/m^2	

N=number of patients, BMI= body mass index, cm- Centimeter, kg-Kilogram.

Table No.2 Recovery Room: Vital Parameters:

Parameters	Rt UL(N=26)		Lt UL(N=26)		P value
	Mean	± SD	Mean	± SD	
Pulse (Rate/Minute)	90.1538	16.3944	88.7692	16.5004	0.9745
SBP (mm Hg)	118.538	15.0366	116.692	15.7677	0.8142
DBP (mmHg)	77.5385	07.0723	77.3846	07.6893	0.679
MBP (mmHg)	91.3846	09.0909	90.1154	10.5046	0.4751
PI	03.5542	02.3875	03.3273	02.2819	0.8228
SPO_2 (%)	99.5384	0.7605	99.3846	0.7524	0.9575

SBP-systolic blood pressure, DBP- diastolic blood pressure, MBP-mean blood pressure, PI- perfusion index, Rt- right, Lt- left, UL- upper limb.

Table No.3 Duration Of Surgery

Duration of surgery (hour)	Number of patients (%)	No of times Corrected PI	BMI>25kg/m^2(number of patients)
0-1 hour	(N=2) 07.70%	2 times	N=1
1-2 hour	(N=8) 30.77%	17 times	N=2
2-3 hour	(N=16)61.53%	36 times	N=3

DISCUSSION:
One of the most important variables for patient assessment in Intensive Care Unit (ICU), hospital or clinic is the ability to measure vital signs accurately. So, patients undergoing surgery under general anesthesia, monitored anesthesia care, regional anesthesia, sedation needs to be monitored intermittently and as well as when required. Among these vital signs blood pressure monitoring is most commonly used which is measured invasively or non-invasively. [1]

The American Society of Anesthesiologists (ASA) recommends in the standards for basic anesthetic monitoring, that BP should be monitored in all anesthetized persons at least at 5-minute intervals. The same recommendation (BP at least 5 min) was incorporated into the World Health Organization's "Guidelines for Safe surgery 2009". [13]

For NIBP monitoring most common method used is Automated Oscillometric Device Method. Patients are operated in lateral decubitus position (LDP) in which BP varies with arm and body position. [3] Perfusion index (PI) derived from a pulse oximeter which assesses peripheral perfusion dynamics and vascular tone.[6]

Blood Pressure And Position:
In this study, we had measured non-invasive blood pressure (SBP, DBP, MBP) by multi para monitor at both arms in LDP surgery by individual NIBP cuffs.

Present study we included only ASA I to III patients posted for pyelolithotomy surgery in LDP under general anaesthesia. But, in our study we excluded critically ill patients, having ASA IV and V. Invasive BP monitoring is mostly used for high-risk patients and when procedures related morbidity/mortality is high.

For arterial cannulation there are many complications like infection, bleeding, thrombosis, pseudoaneurysm formation. It is costly, time-consuming and also require skill to insert. On other side, intermittent NIBP monitoring is non-invasive, easy, cost effective. So, we have used intermittent NIBP monitoring for ASA I-III patients posted for surgery in Lateral position.

In present study all demographic data (Age, Gender, Body Mass Index) were comparable (P>0.05) as shown in table no 1.

Thomas Kaufmann et al (2020) [12] studied non-invasive blood pressure by oscillometry method with invasive blood pressure and showed a low mean difference in NIBP compared to invasive blood pressure monitoring for critically ill patients. But no evidence discovered suggesting that outcomes of critically ill patients better with continuous invasive than intermittent non-invasive blood pressure monitoring.[12].

Recovery room & Pre-Induction:
As par shown in table no 2 in recovery room all hemodynamic data were comparable (p>0.05) for both the arms in supine position. After shifting patient to operation theater, ECG, pulse oximeter, NIBP were attached to both arms and PI measured by MASIMO, all vital parameters were recorded.

Anju S Thomas et al (2020) [1] and Ho-Shiang Huang et al (2014) [15] compared hemodynamic before induction in supine position they recorded MAP baseline, pre induction they showed no significant differences between them.

Post Induction:
After induction, again Pulse rate, SBP, DBP, MBP, SPO_2 in both arms were recorded and were comparable in supine position.

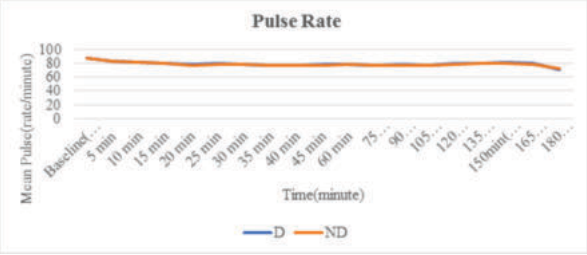
We have compared P value of PI from pre induction to post induction of both arms and it shows P> 0.05 which was not significant. PI from pre induction to post induction for right arm (Mean ± SD) of PI were (3.2188±2.3697) & (4.2011±3.117) and for left arm (2.9426±2.1910) & (3.9623±3.0912) respectively. Changes of PI between pre induction and post induction, P value (0.17) and (0.09) for Right and Left arms respectively. At time of induction of anaesthesia, effect of anaesthesia drugs has uniform effect for both upper limbs, it causes not major changes between both upper limbs. Ho-Shiang-Huang et al (2014) [15] had compared data of PI pre and post induction and they found similar data on vasodilatation.

Post Lateral Decubitus Position (LDP):
The lateral decubitus position most commonly used for thorax, renal stone and hip surgery. When a kidney rest is used for LDP, it must be properly placed under the dependent iliac crest to prevent compression

of the inferior vena cava. The dependent arm should be placed on a padded arm board and Both arms should not be abducted more than 90 degrees. The dependent axillary vessels are at risk of pressure injury in LDP. To prevent compression, an axillary roll or beanbag is placed between the chest wall and the table just caudal to the dependent axilla. In LDP, we have to monitored pulse volume in the dependent arm for early detection of compression to axillary vessels. Low pulse oximeter readings of perfusion index and pulse volume can be an early sign of compromised circulation. [9] Usually, nondependent arm has lower BP & Perfusion Index initially but as surgery progress it leads to various hemodynamic changes as well as compression of axillary vessels at either limb.

Aim of our study was comparison of hemodynamic parameters between dependent and non-dependent arm.

1)Pulse Rate: For pulse rate Baseline (mean ±SD) of dependent(D) and non-dependent (ND) arm were (87.6538 ± 16.6972) per minute and (87.0.385 ± 17.545) per minute respectively.



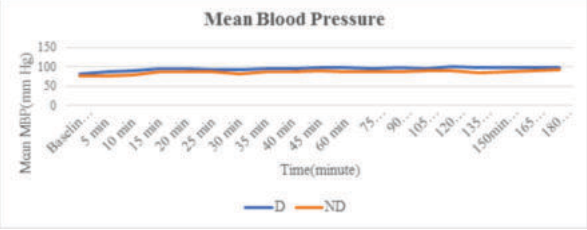
Graph No. 1. Mean Pulse (rate/minute)

M. Yokoyama et al (2002) [3] conducted study of hemodynamic effect in 20 patients with pulse-rate in lateral decubitus position for nephrectomy and for lung surgery founded no significant change in pulse-rate between dependent and nondependent arm. Kinsella et al (2006) [16] conducted study on total thirty-two term pregnant women in lateral recumbent position found no significant changes in pulse-rate in either limb.

In lateral decubitus position due to axillary vessel compression radial artery can be compressed and over the period during surgery pulse volume can be low/feeble on palpation. But with proper position and with cushion/padding it can be prevented.

In this study we have measured difference of pulse-rate in both the upper limbs and throughout the study the value was > 0.05 in all position. So, no significant difference in pulse-rate in LDP.

2)Systolic Blood Pressure (SBP), Mean Blood Pressure (MBP), Diastolic Blood Pressure (DBP):
There was higher mean blood pressure in dependent arm than nondependent arm. After LDP Systolic blood-pressure (SBP), Diastolic blood-pressure (DBP) & Mean blood-pressure (MBP) when compared between dependent (D) and nondependent arm (ND) (intergroup) showed no significant changes except at 40 minutes for DBP(P<0.0433) but clinically non-significant.



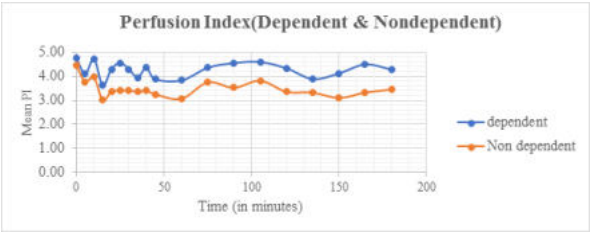
Graph No. 2. Changes in Mean blood pressure (mm Hg) between both arms.

As compared to our study, M. Yokoyama et al (2000) [3] conducted in hemodynamic stable patients, lateral position had no clinical effect on hemodynamic variables under general anesthesia.

Blood pressure changes related with different diseases, Aries MJ et al (2012) [17] studied variations in blood pressure in stroke unit patients in different body positions. In lateral position, BP measured significantly lower in the uppermost arm (around 12 mm Hg in both arms) and significantly higher in the right lowermost arm (around 6 mm Hg) compared to the supine position.

S. Gopalakrishnan et al (2018) [14] conducted community based cross-sectional study on evaluation of inter arm difference in BP. About 14.2% participants had a difference of 10-15 mm Hg which were moderate risk for vascular disease. And 6.1% participants had difference of > 15 mm Hg, which were high risk for vascular events. We also have used same IAD difference in our study in exclusion criteria.

3)Perfusion Index:
PI values ranges from 0.02% (very weak) to 15% (strong) and can be measured noninvasively. It can help to determine vessel compression also. In present study for PI measurement, there was no significant changes between dependent and nondependent arm(p>0.05) throughout study.



Graph 3. Correlation of Perfusion index between dependent & nondependent arm.

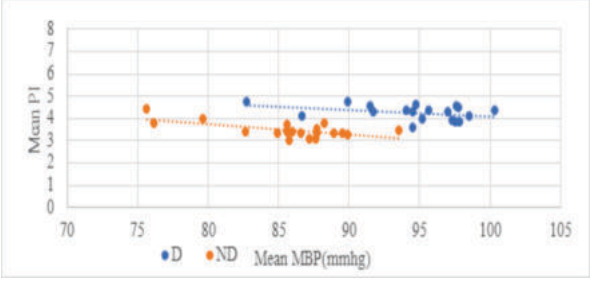
Hakan Tapar et al (2018) [2] studied the effect of patient positions on perfusion index.

They observed highest PI (7.8 ± 3.8) in Trendelenburg position and lowest in (5.0±2.5) in sitting position. They found no relationship between patient positions and SBP, DBP or pulse rate between two upper limbs. Ho-Shiang-Huang et al (2014) [15] studied on total 61 patients in different six position to assess perfusion index. They have found after induction PI increases due to propofol relaxes blood vessels and decrease sympathetic tone in supine position.

Global tissue perfusion can be assessed by clinically (from skin coldness, paleness, mottling and prolongation of capillary retention time) and biochemically (using serum lactate and central venous oxygen saturation). PI is one of the rapid indications of microcirculation changes which may help early to detect disturbance in circulation and hypoperfusion. [2]

In our study total 55 times arm repositions were done for low PI reading compared to other upper limb while taking data. This early repositions were possible in this study due to PI monitoring at intervals of 5 minute initially and later interval of 15 minute in both the arms.

Correlation between Blood Pressure (BP) and Perfusion Index (PI): In present study, graph no.4 shows average mean blood pressure (MBP) changes with linear small dotted line during study whereas larger dots represented mean PI changes during study. In the beginning just after induction blood pressure drops due to induction agent and at the same time perfusion index reading was increased mainly due to global vasodilatation and due to low sympathetic tone [6]. There can be great variation in PI and multiple factors can interfere while measurement of PI.



Graph No.4 Correlation between MBP (mmHg) and PI (%) in both arms

In lateral decubitus position surgery, NIBP measurements using both

upper arms ossilometry method showed a non-significant mean blood pressure difference but with individual patients this may vary. This result was noticed in this study as we had frequent data documentation of BP and PI and did early correction of position/ compression by observing PI changes of two arms (>20% difference of PI) to improve microcirculations. That little higher mean BP (non-significant) in dependent limb was observed due to hydrostatic force in lateral decubitus position.

4) SPO_2:

Post LDP, for SPO_2 baseline (mean ± SD) of Dependent (D) and Nondependent (ND) were (99.7308 ± 0.5335) % and (99.7692 ± 0.5870) % respectively. When we compared between D and ND arm, data shows no significant changes ($p > 0.05$) for SPO_2 throughout the study.

Post-surgery (After supine):

After surgery finished, again supine position given to patient and all vitals were recorded in both arms and all data were comparable($p>0.05$). Ho-Shiang Huang et al (2014) [15] conducted study on perfusion index during uretero-renal-scopy stone manipulation in supine position. Post-surgery in supine position they had found no any significant difference between two arms.

Duration of Surgery:

We have done total 55 times arm repositions in this study for low PI reading comparing to another arm. For 0–1 hour surgery we had done 2 times arm reposition. Total 17 times arm reposition were done for 1–2-hour surgery. For 2–3-hour lasting surgery we had done total 36 times arm reposition.

If any single upper limb has low PI data compared to other upper limb in lateral decubitus position surgery, can give early idea about vessel compression So, we had done frequent arm reposition by comparing PI values between two arms to improves perfusion. This shows pressure changes can be there in either axillary vascular structure over the period even though proper padding which can be early detected by PI monitoring.

In our study total 6 patients have BMI >25 kg/m^2, from these 5 patients needed frequent arm reposition due to low PI reading compare to another upper arm. Among these 3 patients surgery lasts 3 hours needed more arm reposition.

Post Operative:

After extubating the patient, again all vitals (Pulse rate, SBP, DBP, MBP, PI, SPO2) were recorded in both arms and all data were comparable($p>0.05$).

STRENGTHS OF THE STUDY:

NIBP cuff were used as per recommended by AHA as per arm circumference, Proper cushioning and padding were done at both axilla and various pressure points to maintain uniformity, we have conducted this study only in pyelolithotomy, NIBP machine was calibrated at regular interval during the study, all the readings of PI were conducted by MASIMO Radical 7 pulse oximeter to prevent equipment related bias.

Limitations Of The Study: Due to covid pandemic from 2020 to 2021 less cases were enrolled, for widespread application study can be done with invasive arterial blood pressure monitoring system.

CONCLUSION:

It is concluded that intermittent Non-Invasive Blood Pressure (NIBP) is well correlated in either upper limb in Lateral Decubitus Position (LDP) surgery under general anaesthesia. But, as anaesthesia and surgery progress, Perfusion Index (PI) changes can be there due to perfusion changes with anaesthetic medication, blood/fluid loss as well as with compression of vessels. Major PI difference between two arms provides important information regarding compromised micro perfusion in surgical patient and an early indication for reposition of arm. High Body Mass Index (BMI) and long duration surgery have strong correlation with PI changes in LDP surgery.

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