Original Research Article

Anaesthesia for Laparoscopic Donor Nephrectomy-Unique Challenges in Management – A Retrospective Analysis of 40 Cases

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INTRODUCTION

Laparoscopic surgeries have gained popularity over open surgeries for their little scar, less pain and short hospital stay. A significant rise in laparoscopic donor nephrectomies in the recent times have been as a result of good graft function and evolution of anaesthetic and surgical expertise and understanding.

We have evolved and standardised perioperative anaesthesia and with close observation of surgical steps and needs.in this study a retrospective analysis of 40 cases of laparoscopic donor nephrectomies has been done. The findings, improvements and recommendations have been evaluated and documented.

AIMS AND OBJECTIVES

- To understand and apply anaesthetic principles to the surgical needs of laparoscopic donor nephrectomy.
- To provide safe anaesthesia for the donor and ensure optimal conditions for both the donated and the remaining native kidney.
- To manage the effects of hypercarbia and positional changes.

MATERIALS AND METHODS

- Study population-all donors selected by nephrology team for live renal donation
- Study period- Jan 2024-Oct 2024.
- Study place-DSMCH, Siruvachur.

Methods

After thorough pre anaesthetic evaluation written and video consent as per nephrology protocol and elaborate counselling, patients were wheeled in, premedicated with midazolam induced with

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fentanyl (2mcg/kg) and propofol paralysed with vecuronium 0.1mg/kg Intubated with armoured endotracheal tube and positioned laterally with surgical side up, shoulder roll and back support. Nitrous oxide was avoided and medical air used instead with oxygen 33% and isoflurane ½ MAC. Nitroglycerine infusion and propofol infusion were started alongside induction to later rise in blood pressure and prevent awareness. Ventilator settings were adjusted to maintain ETCO2 around 32-35mmhg and IAP maintained around 15mmhg. Pulse, ETCO2, MAP after intubation, after positioning, after insufflation by 3, 15, 20and 45 minutes. The findings were tabulated and results were analysed.

RESULTS

82.5% of our donors were females. 84% of donors underwent left nephrectomy, the surgical dissection was better facilitated with MAP <80mmhg. As nitrous oxide was not used as it would promote bloating of bowel the 0.5% infusion of propofol and nitroglycerine titrartion which was started alongside induction induction of anaesthesia maintained the hypercarbia induced hypertension. The 3 minute and 15 minutes post insufflation pulserate found to increase with end tidal carbondioxide (p=0.001, 0.014 respectively).

CONCLUSION

Avoidance of nitrousoxide in laparoscopic donor nephrectomy seemed to be compensated by 1mg/ml infusion of propofol at around 15ml/hr and nitroglycerine 0.25 to 0.5mg/hr. we observed that maintaining pulserate and MAP from induction at anaesthesia prevented surges after carbondioxide insufflation. The organ preserving surgery done by laparoscopy has not been much discussed in anaesthetic perspective. Our experience with 40 cases has been shared in this paper.

KEYWORDS

Laparoscopic Donor Nephrectomy, Nitroglycerin, Pneumoperitoneum, Hypercarbia Propofol Nitrous Oxide

INTRODUCTION

Kidney disorders of any degree are increasing in incidence due to faulty food habits, dietry factors, sedentary life style, altered biological clock which act as contributory factors.

Low fixed specific gravity of urine, shrunken kidneys, extensive calculous disease all contribute to progression of chronic kidney disease to end stage renal disease (ESRD)

The options for end stage renal disease would be renal replacement therapy either hemo or peritoneal dialysis as the needs of the patients disorder may be or renal transplantation.

Though live donor has always proved favourable outcomes cadaver donor are equally coming up as safe and successful alternative, thanks to the nationwide awareness of organ donation and scientific advancement in immunosuppresants pharamacopiae.

Anaesthesia for donor nephrectomy itself has evolved side by side with surgical Techniques, needs for positioning, preparation of graft, vascular dissection management of warm and cold ischemia time, depth and pain relief both in intraoperative and postoperative period have evolved over the time since the first renal transplant in 1954 by Doctors Murday, Merrill and Hartwell at Bostons peter bent Brigam hospital on identical twins.[1]

Surgery has evolved a long way from open donor nephrectomy to laparoscopic donor nephrectomy.

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Smaller scar, lesser post-operative pain, short postoperative stay have improve patient compliance for organ donation especially kidney.

As for the advantages the needs of the laparoscopic surgery are different. The article examines the journey of anaesthesia for these evolving techniques, the challenges, safety measures, our experience and finally few reccomendations.

Aims and Objectives

- To prevent ischemia and acidosis and preserve functions of both graft kidney and native kidney.
- To provide safe environment for the postoperative solitary kidney status.
- To reduce sympathetic stimulation which may trigger renal vasoconstriction.
- To provide optimal surgical conditions for vascular dissection and organ retrieval.

METHODS AND MATERIALS

- Study population-all donors selected by nephrology team for live renal donation.
- Study period- Jan 2024-Oct 2024.
- Study place-DSMCH, Siruvachur.

Pre operative evaluation of the donor as per TRANSTAN and nephrology protocol was carried out meticulously for all the donor. Special emphasis on respiratory functions such as spirometry with FEV1/FVC and MEFR were considered and appropriate instructions for deep breathing exercises incentive spirometry and budesonide nebulization were given to withstand the carbondioxide pneumoperitoneum. After thorough pre anaesthetic evaluation written and video consent as per nephrology protocol and elaborate counselling, patients were wheeled in, premedicated with midazolam induced with fentanyl (2mcg/kg) and propofol paralysed with vecuronium 0.1mg/kg Intubated with armoured endotracheal tube and positioned laterally with surgical side up, shoulder roll and back support.

Nitrous oxide was avoided and medical air used instead with oxygen 33% and isoflurane ½ MAC. Nitroglycerine infusion and propofol infusion were started alongside induction to later rise in blood pressure and prevent awareness.

Ventilator settings were adjusted to maintain ETCO2 around 32-35mmhg and IAP maintained around 15mmhg. Pulse, ETCO2, MAP after intubation, after positioning, after insufflation by 3, 15, 20and 45 minutes. The findings were tabulated and results were analysed.

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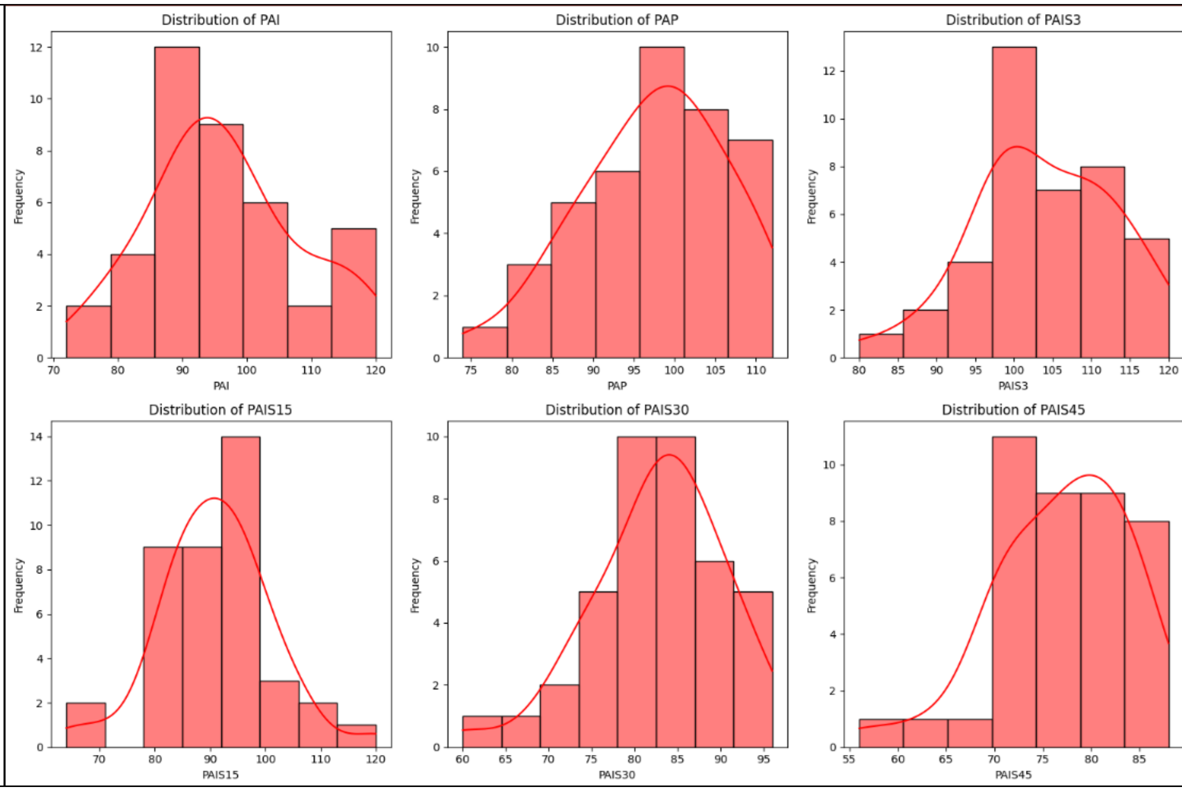
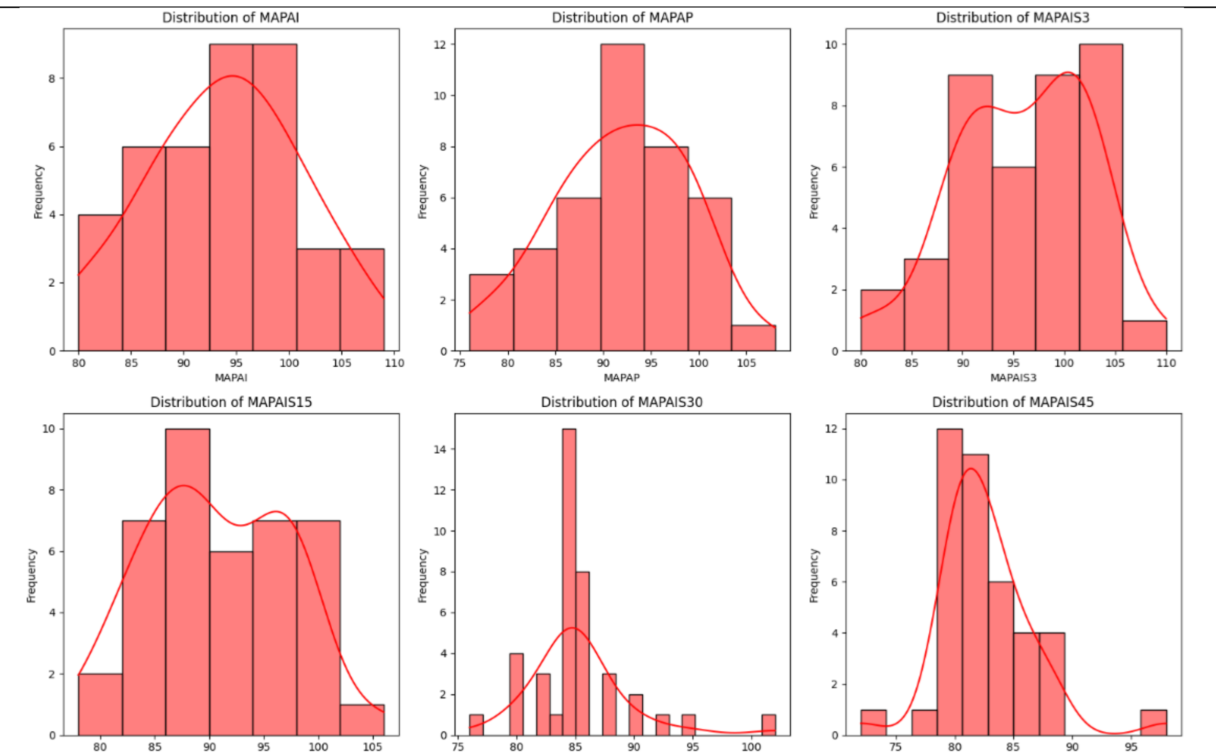


Graph 1: Distribution of PAI, PAP, PAIS3, PAIS15, PAIS30, PAIS45



Graph 2: Distribution of MAPAI, MAPAP, MAPAIS3, MAPAIS15, MAPAIS30, MAPAIS45

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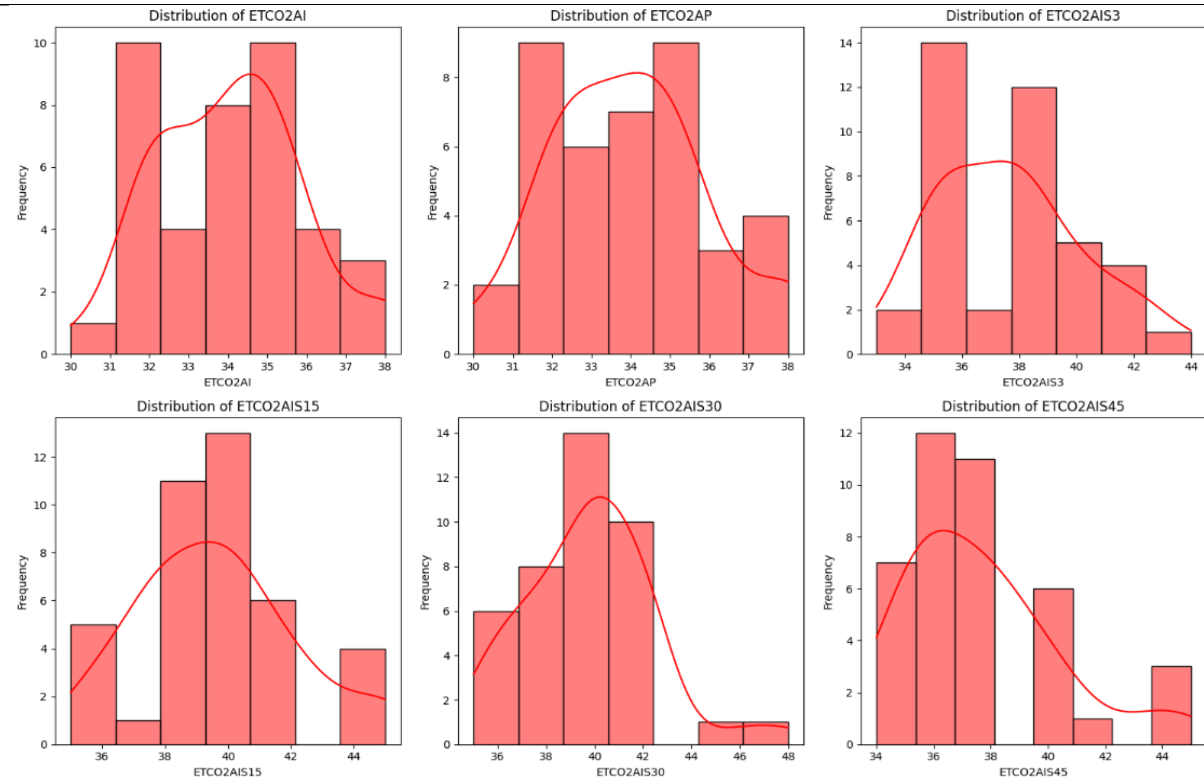

Graph 3: Distribution of ETCO2AI, ETCO2AP, ETCO2IS3, ETCO2AIS15, ETCO2AIS30, ETCO2AIS45

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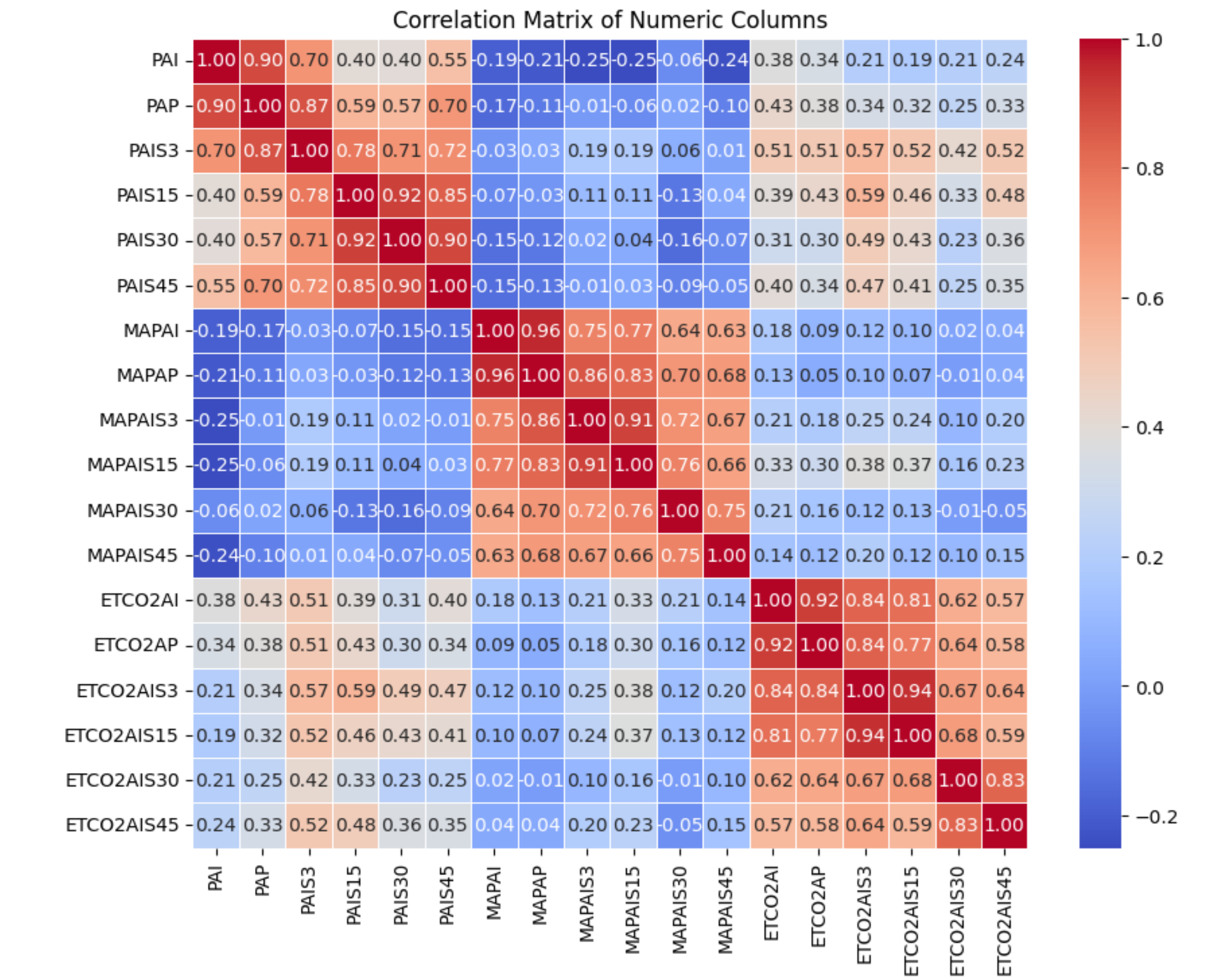

Graph 4: Correlation Matrix of Numeric Column

All donors were normal people without any system comorbidities pulse rate and blood pressure changes were closely monitored in the pre, intra and post-operative period. Other factors which could affect pulse and blood pressure such as intra-abdominal pressure and CO2 flow standardized not more than 15mm mercury. The correlation matrix plotted between pulse, MAP and ETCO2 during intubation 3, 15, 30mins of insufflation shows good relation betweenETCO2 values with pulse rate (P=0.001). As MAP was managed by baseline titration of nitroglycerine, probably changes were shown up in pulse rate. As all donors had normal pulmonary functions, the rise in end tidal carbondi oxide during pneumoperitoneum was easily manageable by volume control ventilation.

DISCUSSION

Laparoscopic donor nephrectomy through first performed in 1995, started being widely done since 2010. Large serves has been published from institute of kidney diseases, civil hospital campus, Ahmedabad-2013 article state challenges in steep trendelenberg position.

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In our centre LKT is done in the lateral position with a 5cm width of roll under the dependent shoulder. Careful positioning of neck on the head gel dough nut to maintain the neck level in the same plane of the patients trunk is done.

The patient is positioned at the edge of the operating table to facilitate easy access for the surgeon to procure umbilical subcostal and subumbilical ports and a small pfanensteil incision to deliver the renal graft thereafter. An extra flank port may be added to insert a blunt spatulated retracter which gently pushes the mesocolon and omentum to improve vision and access.

Kidney being a retro operational organ is approached transperitoneally as shown in the diagrams.[2]

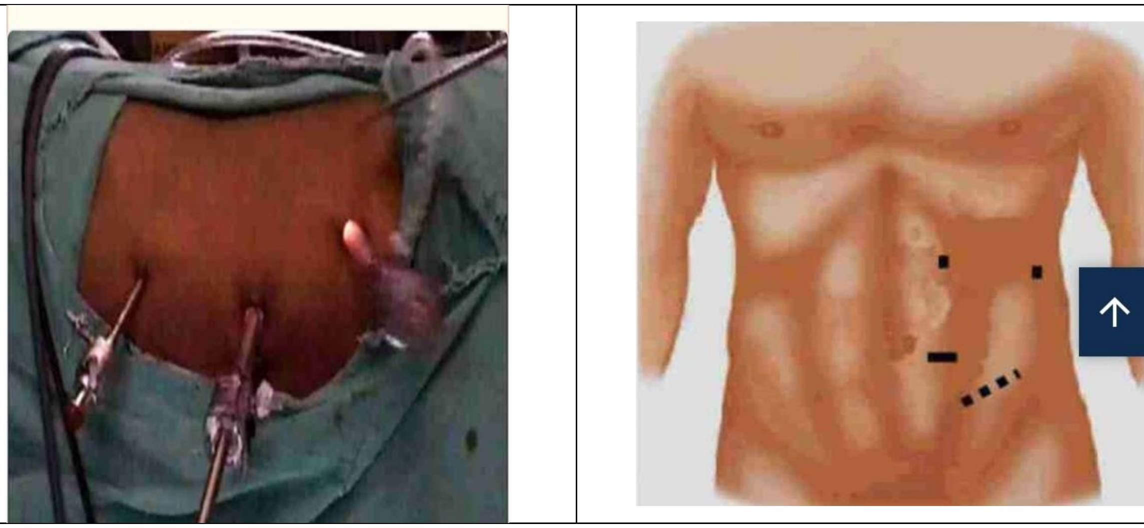

Image 1:

Key issues to be addressed by anaesthesiologist in laparoscopic donor nephrectomy include.

1) Steady MAP from induction up to withdrawal of pneumoperitoneum around 80-90mmhg.
2) Avoid bowel distension by adequate relaxation and replacing nitrous oxide with air.
3) Adequate depth of anaesthesia and pain relief
4) Using renal safe drugs and ensure adequate renal output
5) Post operative pain relief to avoid sympathetic stimulation and vasoconstriction

The renal safe drugs used for recipient of the graft has been chosen with the donor also except vecuronium for atracurium with a view of postoperative solitary kidney in the donor. Propofol, fentanyl, vecuronium and isoflurane were used while sevoflurane and nitrousoxide were avoided. Of these the properties of propofol and nitroglycerine have been used for our advantage.

Pharmacology and Applications of Intra-Operative Drugs

Propofol

Propofol is a sedative hypnotic neuroprotective induction agent. Its mechanism of action involves a positive modulation of the inhibitory neurotransmitter gamma-aminobutyric acid (GABA). Rapid onset of action with depressive hemodynamics make it an ideal induction agent. The high protein binding namely 95-99% primarily to serum albumin and hemoglobin along with a potent active metabolite makes its use as continuous infusion to reduce awareness in the intra operative period. Hepatic metabolism of propofol by glucuronidation atC1-hydroxyl group as well as hydroxylation by cyt2B6 and 2C9 also occurs to form 4-OH propofol. This metabolite has 1/3 hypnotic activity of

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propofol and this helps to maintain depth, reduce awareness and control heart rate and MAP. Volume of distribution is 60ltr/kg half life at initial distribution has t1/2= 1.8-9.5 minutes. Second redistribution t1/2= 21-70 mis and terminal elimination phase t1/2=1.5-31hrs. Maintanence of infusion by variable rate infusion method. Uses 0.025 to 0.075/kg/min IV and judges clinical response to propofol by pulse, MAP and need for increments of relaxants. In the absence of nitrous oxide and usage of steady concentration of isoflurane of ½ to 1 MAC the propofol infusion at a concentration of 0.1% at a rate of 15-40ml/min by syringe pump provided adequate sedation and stable hemodynamics. [3]

Nitroglycerin

NTG is a vasodilator drug acting both on uterus and veins. Hemodynamic changes associated with pneumoperitoneum in laparoscopic surgeries includes hypertension and tachycardia. Pneumoperitoneum along with position change causes increase in MAP, SVR and increase in ETCO2. NTG infusion was used to manage the hemodynamic effects due to pneumoperitoneum. In other study, NTG infusion was started before CO2 insufflation at a rate of 0.5mcg/kg/min and titrated according to BP to maintain MAP around 80-90mmhg. NTG generates nitric oxide, which stimulates production of cGMP to cause peripheral vasodilation. NTG has an elimination half time about 1.5 mins. CO2 pneumoperitoneum in laparoscopic surgery-pathophysiologic effects and clinical significance. Increased IAP &increased CO2 – increases portal, increases venous blood flow, increases venous stasis, increases gfr, decreases TI, decrease pulmonary compliance. Intraop acidosis and hypercarbia occurs.[4]

W journal of laparoscopic surgery 2014: 7 (1) 33-40 (jan-april)[5]

- Features of ideal gas for insufflation in laparoscopy
- Anti knock/fire proof/limited ability absorption
- Rapid excretion
- No burns
- No effects on intravascular embolization soluble in blood
- Colourless
- Comparison of gases used for pneumoperitoneum CO2, He, N2O, Air
- CO2 has maximum solubility & diffusion and next is nitrous oxide
- No risk of burns with helium and nitrogen

Physiological Effects of Pneumoperitoneum during Laparoscopy[6]

a) Intraoperative acidbase changes in RS, CVS, hemodynamics, liver functions and ICP
b) Arterial blood gas shows increase in PaCO2 and decrease in bicarbonate
c) Peak inspiratory pressure, respiratory rate and minute ventilation increase in laparoscopy
d) Tiffeneau index (TI)- FEV1/FVC differentiates airflow limitations from restrictive abnormalities
e) TI is reduced In intraoperative and until 2PODby 15.5%
f) The intraabdominal pressure rise causes splanchnic vasoconstriction, reduced blood flow through IVC, renal portal vein all result in decreased venous flow to heart. Increased SVR is the consequence of activation of neurohumoral vasoactive systems.

Use of Nitrous Oxide in Laparoscopy[7]

Nitrous oxide or dinitrogen oxide also called laughing gas colloquially is an important adjuvant in general anaesthesia.

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Second gas effect and concentration effect improves optimal utilization of inhalational agent which is used along with fresh gas flow. However several studies have proved the risk benefit ratio of nitrous oxide usage till more towards risk than benefit.

Metabolism of nitrous oxide is 0.004% and biological half-life is only 5mins with respiratory route as main excretory route.

Serious concern of nitrous oxide as atmospheric pollutant and major scavenger of ozone. The concentration of nitrous oxide in atmosphere has been calculated as 333 parts per billion in 2020 increasing at 1 part per billion annually.

The mechanism of action of nitrous oxide in anxiolysis is contributed to enhanced activity of GABA receptors and glycine receptors. It weakly inhibits AMPA, kinate, GABAC and 5HT3 receptors.

Analgesic effect is due to inhibition of N- methyl D aspartate, 30-40 times more soluble than nitrogen, nitrous oxide enters air space and expands it. Hence bowel distension is common drug pneumoperitoneum created in laparoscopy.

In laparoscopic donor nephrectomy the concern for nitrous oxide usage is high as it may significantly abstract surgical view and access. As vascular dissection is key in donor nephrectomy in obstructed view due to usage of nitrous oxide makes surgery unpleasant and unsafe. Hence the main and foremost request of the surgeons would be avoidance of nitrous oxide[8]

Nitrous oxide diffuses into and accumulates in spaces containing air or other immobile gases with potentially deleterious physiological consequences. Clinically relavent examples include intravascular air emboli, pneumothorax, air in the inner chamber of the ear, intravitreal gas bubbles, intrathecal air, pneumocephalus and air in the gastrointestinal trac. Air filled spaces contain mostly nitrogen, a gas that composes 78%of air but is 30 fold less soluble in blood than nitrous oxide. Thus N2O diffuses down its pressure gradient from blood and surrounding tissues into air filled spaces, whereas N2 elimination from these spaces is far slower, even with inspired PN2=0. As N2O enters and the total number of gas molecules in an air space increases, it will expand in volume, increase in pressure or both depending on the compliance of the tissues surrounding the air filled spaces.

In highly complaint air filled spaces, such as intravascular air bubbles or small pneumothoraces, N2O accumulation increases the total volume of gas with minimal changes in pressure. Air spaces expands as N2O enters until the PN2O within the air space matches that in surrounding blood, establishing equilibrium. The maximum potential gas volume expansion in a highly compliant space is V/Vinit=1/1-PN20.

Thus administration of 50% N2O can doble air space volume, whereas 67% can potentially triple airspace volume. Expansion of gastrointestinal gas volume by N2O may impede surgical exposure or abdominal wound closure. Gas space compartment compliance eventually decreases as volume expands resulting in increased pressure.

CONCLUSION

Avoidance of nitrousoxide in laparoscopic donor nephrectomy seemed to be compensated by 1mg/ml infusion of propofol at around 15ml/hr and nitroglycerine 0.25 to 0.5mg/hr. we observed that maintaining pulserate and MAP from induction at anaesthesia prevented surges after carbondioxide insufflation.

It is mandatory that donors have to be absolutely safe and pain free with pleasant experience of surgery and anaesthesia. The conduct of anaesthesia greatly influences surgical outcome and excellent graft performance in the recipient.

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Maintaining an ideal MAP, prevention of hypercarbia induced hemodynamic changes and acidosis as in our technique appears simple and easy to practice even in hospitals with basic infrastructure.

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