Is CO2 gas unsufflator necessary for laparoscopic training in animals?1

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ABSTRACT – Objective – To verify the efficacy and safety of compressed air to produce pneumoperitoneum for laparoscopic surgery in pigs for a training program of residence. Methods - Dalland pigs weighing 15-17kg underwent general anesthesia and mechanical ventilation. They were divided in 3 groups: A – (38) the pneumoperitoneum was established with an automatic CO2 insufflator, B – (7) as in A except the CO2 gas was changed by compressed air, and C – (11) abdomen insufflation was obtained with compressed air directly from hospital pipe network system. Intra-abdominal pressure in all groups was kept between 12 and 15 mmHg. The laparoscopic procedures were performed distributed proportionally among groups: 20 bilateral nephrectomy, 20 dismembered pyeloplasty and 16 partial nephrectomy. Arterial blood sampling for gasometry was obtained before and 2h after establishment of pneumoperitoneum in 5 pigs of group C. Results – The cost of 25 4.5kg CO2 container used in group A was R$ 3,150.00 (US 1,050.00). The mean length time of surgeries in groups A, B and C were respectively: 181±30min, 196±39min e 210±47min (p<0.05). Respiratory alkalosis occurred in 3 out of 5 pigs of group C. No animal exhibited signs of gas embolism or died during surgery. Conclusion – The use of compressed air for laparoscopy in pigs was safe, reduced costs and did not require the use of an automatic gas insufflator.

KEY WORDS – Laparoscopy, Nephrectomy, Pyeloplasty, Partial nephrectomy, Pneumoperitoneum, CO2 gas, Compressed air.
INTRODUCTION

Kelling reported the observation of the abdominal cavity of dogs and humans through an air-filled abdomen for the first time in 1,902. This procedure named “coelioscopy” became a routine in humans in 1,914. To reduce the risk of a blind puncture of the abdomen, Goetzke developed an automatic needle in 1,918 and reported as ideal the practice of initially establishing a pneumoperitoneum using oxygen1. Since the development of the first automatic CO2 gas insufflator, in 1,9662, the practice of creating and maintaining the pneumoperitoneum was universally adopted using such a device. The method of animals’ abdomen insufflation with CO2 gas under physiological control in hands on laparoscopic training courses, or residency programs are now a standard procedure.

Considering the costs of maintenance of the automatic insufflator, the CO2 gas and the machine electric energy consume as well as the historical reference of air use for abdomen insufflation, it is worthwhile to try a cheaper method of abdominal insufflation by using compressed air in training programs. The aim of this study is to test the safety of air-compressed to establish pneumoperitoneum in our training program of laparoscopy.

METHODS

From September to September of 2,003, 52 Dalland pigs weighting 15-17kg (40-45 days of age) were used in the Urology laparoscopic residence-training program in the Laboratory of Experimental Surgery of the Hospital das Clínicas – FMRP-USP.

All animals received Ketamine (20mg/kg) as premedication and were submitted to general anesthesia induced with intravenous Thionembutal (40mg/kg) followed by endotracheal intubation, and mechanical controlled ventilation (Takaoka™ device) with 100% O2. Maintenance of anesthesia was accomplished through additional doses of Thionembutal as required. During the laparoscopic surgery hydration was carried out with intravenous physiologic saline at a speed of 4ml/kg/h.

The pigs were divided in 3 groups at random. In the group A with 38 animals pneumoperitoneum was established and maintained by an automatic CO2 gas insufflator (Asts™). In group B of 7 pigs, abdomen insufflation was performed as in group A but the CO2 gas was changed by air from the hospital network pipe of the central controlled air system. The pneumoperitoneum, in group C of 11 pigs, was produced directly with compressed air as in group B however without the use of the automatic insufflator. In all groups intra-abdominal pressure during laparoscopy was kept between 12 and 14mmHg. In groups A and B the pressure control was achieved by adjusting gas pressure and flow through the automatic insufflator. In group C air pressure was monitored through a manometer connected to the compressed air tubing system, and the pressure control was achieved by adjusting manually the valve opening of such system. All laparoscopic surgeries were performed with a Storz™ equipment.

The following procedures were performed: 20 bilateral total nephrectomy (A – 14; B – 3; C – 3); 20 bilateral dismembered pyeloplasty (A – 15; B – 3; C – 2); and 16 bilateral partial nephrectomy (A – 8; B – 4; C – 4).

The surgical time was registered for each animal. The number of CO2 gas containers consumed to operate on 38 pigs of group A was registered.

In 5 pigs of group C arterial blood sampling for gasometry was obtained before and 2h after establishing the pneumoperitoneum.

At the end of the surgery all pigs were sacrificed by a lethal intravenous injection of 10ml of sulfur ether.

DISCUSSION

Although at least 5 different gases or mixture of gases have been used to perform pneumoperitoneum, carbon dioxide is used almost exclusively. Such a gas is rapidly absorbed and excreted and does not support combustion. It is the most soluble in blood of all agents used for abdomen insufflation and is safer than oxygen, air and nitrous oxide (N2O) in preventing gas embolism3. However, there is no general agreement on the subject4. The absorption of CO2 into the blood contributes to hypercarbia, acidosis, and its tension is raised about 8mmHg in patients undergoing laparoscopy procedures with CO2 pneumoperitoneum when compared with patients with N2O insufflation5. Hypercarbia contributes to hypertension, tachycardia, cardiac arrhythmias, vasodilatation and myocardial depression. Patients breathing spontaneously with halothane-N2O-Oxygen anesthesia react by increasing their respiratory rate despite a reduction in tidal volume, but hypoxia, respiratory and metabolic acidosis may result6,7. It is well known that pneumoperitoneum reduces respiratory compliance and diaphragmatic movement11, so it is generally recommended that respiratory and acid-base homeostasis be maintained with mild hyperventilation under general anesthesia and use of endotracheal intubation12,13. In contrast with CO2 pneumoperitoneum, laparoscopy using abdomen wall retractor is not associated with hemodynamics or gas exchange14.

In dry atmospheric air at a barometric pressure of 760mmHg the partial pressures of the main valve opening of such system. All laparoscopic

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<th>Animals</th>
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<td>C5</td>
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* Before and after pneumoperitoneum; BE - base excess.

RESULTS

No death or adverse effect was observed during the surgery in any animal.

The operating time in each group was A – 181±30min, B – 196±39min and C - 210±27min (p>0.05).

The number of 4,5kg CO2 gas containers consumed in 38 pigs of group A was 25 with a cost of US$ 1,050.00. The air flow required to keep pneumoperitoneum in group C was 5-7L/min.

The results of gasometry are shown in Table 1.

The comparison of operating time among groups was performed by using the unpaired t test (Graphpad Prism, version 3.0). The level of significance was established as <5%.

CONCLUSION

The use of compressed air for laparoscopy in pigs was safe, reduced costs and did not require the use of an automatic gas insufflator.

RESUMO – Objetivo – Testar a eficácia e segurança do pneumoperitônio com ar comprimido para cirurgias videolaparoscópicas em porcos em treinamento de residência médica. Métodos – Porcos da raça Dalland de peso variável de 15 a 17kg foram submetidos a uma anestesia geral e respiração controlada. Eles foram divididos em 3 grupos: A – 38 animais com pneumoperitônio feito com insuflador automático de CO\textsubscript{2} usando este gás; B – 7 animais sujeitos ao mesmo procedimento exceto que o CO\textsubscript{2} foi substituído por ar comprimido; e, C – 11 animais em que o pneumoperitônio foi feito com ar comprimido diretamente da rede hospitalar. Nos 3 grupos a pressão intra-abdominal foi mantida entre 12 e 14mmHg. Os procedimentos realizados foram distribuídos proporcionalmente nos 3 grupos: nefrectomia bilateral – 20, pieloplastia desmembrada – 20 e nefrectomia parcial – 16. Antes e 2h após o pneumoperitônio foi colhido sangue arterial para gasometria em 5 porcos do grupo C. Resultados – Foram consumidos 25 torpedos de 4,5kg de CO\textsubscript{2} a um custo total de R$ 3.150,00 no grupo A. A duração média da cirurgia nos grupos A, B e C foram respectivamente: 181±30min, 210±47min (p>0.05). Alcalose respiratória foi observada em 3/5 porcos testados do grupo C. Nenhum animal apresentou sinais de embolia gasosa ou faleceu durante o procedimento. Conclusão – O uso de ar comprimido para laparoscopias em porcos mostrou-se método seguro com redução de custos e tornou desnecessário o uso de insuflador automático.


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Study of corpus callosum in experimental hydrocephalic wistar rats

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ABSTRACT – Purpose: Hydrocephalus causes countless cerebral damages, especially on the structures around the ventricles. Hydrocephalic children present deficiencies in the nonverbal skills more than in the verbal skills, and not always reversible with an early treatment. As the corpus callosum has an important role in the nonverbal acquisition it is possible that the injuries in this structure are responsible for the cognitive dysfunctions of these children. This present study tries to establish the alterations caused by hydrocephalus on the corpus callosum of developing Wistar rats, induced by intracisternal injection of kaolin. Methods: Seven, fourteen and twenty one days after the injection, the animals were killed, and the corpus callosum was dissected and prepared for the study of the axonal fibers. Results and Conclusion: The seven-day old rats in hydrocephalus development presented a delay in myelination in relation to the control rats. With the fourteen-day old rats in hydrocephalus development the corpus callosum showed a recovery of myelin, but with the twenty one-day old rats in hydrocephalus development the axonal fibers were damaged and reduced in number.

KEY WORDS: Corpus callosum, Hydrocephalus, Myelin, Wistar rat, Development.

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