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SCIENTIFIC ARTICLE

In vitro evaluation of the method effectiveness to limit inflation pressure cuffs of endotracheal tubes☆

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KEYWORDS
Method;
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Abstract
Background and objective: Cuffs of tracheal tubes protect the lower airway from aspiration of gastric contents and facilitate ventilation, but may cause many complications, especially when the cuff pressure exceeds 30 cm H_2O. This occurs in over 30% of conventional insufflations, so it is recommended to limit this pressure. In this study we evaluated the in vitro effectiveness of a method of limiting the cuff pressure to a range between 20 and 30 cm H_2O.
Method: Using an adapter to connect the tested tube to the anesthesia machine, the relief valve was regulated to 30 cm H_2O, inflating the cuff by operating the rapid flow of oxygen button. There were 33 trials for each tube of three manufacturers, of five sizes (6.5–8.5), using three times inflation (10, 15 and 20 s), totaling 1485 tests. After inflation, the pressure obtained was measured with a manometer. Pressure >30 cm H_2O or <20 cm H_2O were considered failures.
Results: There were eight failures (0.5%, 95% CI: 0.1–0.9%), with all by pressures <20 cm H_2O and after 10 s inflation (1.6%, 95% CI: 0 5–2.7%). One failure occurred with a 6.5 tube (0.3%, 95% CI: −0.3 to 0.9%), six with 7.0 tubes (2%, 95% CI: 0.4–3.6%), and one with a 7.5 tube (0.3%, 95% CI: −0.3 to 0.9%).
Conclusion: This method was effective for inflating tracheal tube cuffs of different sizes and manufacturers, limiting its pressure to a range between 20 and 30 cm H_2O, with a success rate of 99.5% (95% CI: 99.1–99.9%).

☆ Study conducted at the Hospital Central da Irmandade da Santa Casa de Misericórdia de São Paulo, São Paulo, SP, Brazil.
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PALAVRAS-CHAVE
Método;
Insuflação;
Balonetes;
Cânulas;
Pressão

Avaliação *in vitro* da eficácia de método para limitar a pressão de insuflação dos balonetes das cânulas endotraqueais

Resumo
Justificativa e objetivo: Os balonetes das cânulas traqueais protegem as vias aéreas inferiores da aspiração de conteúdo gástrico e facilitam a ventilação pulmonar, mas podem provocar diversas complicações, principalmente quando a pressão do balonete supera 30 cm H_2O. Isto ocorre em mais de 30% das insuflações convencionais, sendo recomendada a limitação desta pressão. Neste estudo avaliou-se in vitro a eficácia de um método para limitar a pressão dos balonetes à faixa entre 20 e 30 cm H_2O.
Método: Utilizando um adaptador para conectar a cânula testada ao aparelho de anestesia, regulou-se a válvula limitadora deste a 30 cm H_2O, insuflando o balonete por meio do acionamento do botão de fluxo rápido de oxigênio. Realizaram-se 33 testes para cada cânula de três fabricantes, de cinco tamanhos (6.5 a 8.5), utilizando três tempos para insuflação (10, 15 e 20 segundos), totalizando 1485 testes. Terminada a insuflação, mediu-se a pressão obtida com um manômetro. Pressões >30 cm H_2O ou <20 cm H_2O foram consideradas falhas.
Resultados: Ocorreram oito falhas (0,5%; IC 95%: 0,1–0,9%), sendo todas por pressões <20 cm H_2O e após insuflações de 10 segundos (1,6%; IC 95%: 0,5–2,7%). Uma falha ocorreu com cânula 6.5 (0,3%; IC 95%: −0,3–0,9%), seis com cânulas 7.0 (2%; IC 95%: 0,4–3,6%), e uma com cânula 7.5 (0,3%; IC 95%: −0,3–0,9%).
Conclusão: Este método mostrou-se eficaz para insuflar os balonetes de cânulas traqueais de diferentes tamanhos e fabricantes limitando sua pressão à faixa entre 20 e 30 cm H_2O, com incidência de sucesso de 99,5% (IC 95%: 99,1–99,9%).

Introduction

When high pressure and low volume (HPLV) or high volume and low pressure (HVLP) endotracheal tube cuffs are inflated, they exert pressure on the tracheal wall and may lead to mucosal ischemia. This is directly related to the occurrence of complications in up to 90% of patients, including discomfort, sore throat, granuloma formation in the vocal cords, hoarseness, and serious complications such as recurrent laryngeal nerve and vocal cords paralysis, bloody sputum, tracheal-esophageal fistula, and tracheal rupture.[1–4]

There are several methods for injecting air into the tracheal tube cuff. The gold standard method is the direct measurement of cuff pressure ($C_{pressure}$) with calibrated manometer, analog[5] or digital,[6] and is recommended in adult and pediatric patients.[5,7–9] However, its use is not routine in Brazil.

The injection of air into the cuff with a syringe is the most used method. This method is simple, fast, and low cost, but the relationship between the volume of injected air and the resulting cuff-to-tracheal wall pressure ($C–T_{pressure}$) is nonlinear, causing cuff distention in 30–98% of cases,[7,8,10,11–13] depending on the population studied, endotracheal tube used, and the clinical context.[14]

Other methods to limit the $C–T_{pressure}$ have been proposed, such as the techniques of minimal occlusive volume (MOV) and minimum leak technique (MLT), but without scientific confirmation of clinical benefit.[6] Pressure adjustment alternative techniques have been suggested or are under development, using modified endotracheal tubes,[15] special syringes,[16] and hospital equipment available in the units,[17–21] however without eliminating the need for additional equipment.

When the circular system is used as the pressure source to inflate the tracheal tube cuffs, it is possible to limit the maximum pressure in the system through the adjustable pressure relief valve (APRV), also called pop-off valve, making it impossible for the CP and $C–T_{pressure}$ reach values higher than the maximum set by the APRV adjustment. In order to do this, simply adapt the output of the circular system to the Luer-type entry of the endotracheal tube pilot balloon—a method not found in the scientific literature.

The possibility of limiting the pressure within the cuff to safe levels using a simple, widely available, and low cost method can reduce the occurrence and magnitude of various complications, many of them serious. This issue motivated the present study designed to evaluate an in vitro efficacy of endotracheal tube cuff insufflation method, with the internal pressure set between 20 and 30 cm H_2O.

Method

An in vitro experimental study of the efficacy of a method for endotracheal tube cuff inflating was performed. Given the nature of this study, the assessment by the Institution Research Ethics Committee was waived.

Sample size calculation was based on previous studies, which demonstrated that the incidence of pressure in the range of 20–30 cm H_2O with conventional method of