

Lidocaine added to a tracheostomy tube cuff reduces tube discomfort

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Purpose: To examine whether lidocaine diffusion across an endotracheal tube cuff affects tracheostomy tube discomfort.

Methods: Two tracheostomy tube cuffs were inflated with 5 ml lidocaine 4% solution and air at 20 cmH₂O, and then placed in 20 ml distilled water at 37°C. After vigorous stirring, 100 µl of this water was then sampled immediately then 1, 2, 4, 8, 24 hr later to measure lidocaine concentration by high-performance liquid chromatography. Sixteen patients undergoing tracheostomy following oral cancer resection were randomly assigned to two groups: lidocaine (n=8) and placebo (n=8). A tracheostomy tube cuff was inflated with 5 ml lidocaine 4% or saline 0.9% and air to a cuff pressure of 20 cmH₂O, in the lidocaine and placebo groups respectively. Tube discomfort was evaluated using a visual analogue scale at 0, 0.5, 1, 2 and 4 hr after lidocaine or saline administration. Neither analgesics nor sedatives was given during the evaluation period.

Results: Lidocaine time-dependently diffused across the tracheostomy tube cuff. Thirty and 60 min after cuff inflation lidocaine concentrations in the water bath reached approximately 8 and 17 µg·ml⁻¹ representing 160 and 340 µg in 20 ml of water, respectively. The VAS decreased from 53.5 ± 10.6 to 25.1 ± 9.8 mm ($P < 0.01$) 0.5 hr following lidocaine administration which continued until the end of evaluation period. In the placebo group, VAS did not change.

Conclusion: Lidocaine diffusion across the tracheostomy tube cuff reduces tube discomfort.

Objectif : Vérifier si la diffusion de lidocaïne au travers du ballonnet du tube endotrachéal a un effet sur l'inconfort lié à la canule de trachéotomie.

Méthode : Deux ballonnets de canules de trachéotomie ont été gonflés avec une solution contenant 5 ml de lidocaïne à 4 % et de l'air dans 20 cmH₂O, et placées ensuite dans 20 ml d'eau distillée à 37 °C. Après avoir vigoureusement agité le mélange, on a immédiatement prélevé 100 µl de cette eau, puis 1, 2, 4, 8, 24 h plus tard, pour mesurer la concentration de lidocaïne par chromatographie à haute performance. Seize patients devant subir une trachéotomie à la suite de la résection d'un cancer oral ont été répartis au hasard en deux groupes : lidocaïne (n=8) et placebo (n=8). Une canule de trachéotomie à ballonnet a été gonflée avec 5 ml de lidocaïne à 4 % ou une solution salée à 0,9 % et de l'air jusqu'à une pression 20 cmH₂O, chez les patients des groupes lidocaïne et placebo, respectivement. L'inconfort du tube a été évalué à l'aide de l'échelle visuelle analogique à 0; 0,5; 1; 2 et 4 h après l'administration de lidocaïne ou de solution salée. Aucun analgésique ou sédatif n'a été administré pendant la période d'évaluation.

Résultats : La diffusion de la lidocaïne au travers du ballonnet de la canule de trachéotomie était fonction du temps. Trente et 60 min après le gonflement du ballonnet, les concentrations de lidocaïne avaient atteint environ 8 et 17 µg·ml⁻¹, ce qui représentait 160 et 340 µg dans 20 ml d'eau, respectivement. Les valeurs de l'EVA ont diminué de 53,5 ± 10,6 à 25,1 ± 9,8 mm ($P < 0,01$) 0,5 h après l'administration de lidocaïne, laquelle a été poursuivie jusqu'à la fin de la période d'évaluation. Dans le groupe placebo, l'EVA n'a pas montré de modification.

Conclusion : La diffusion de la lidocaïne au travers du ballonnet de la canule de trachéotomie a réduit l'inconfort lié au tube.

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FOLLOWING oral cancer resection with radical neck dissection, most patients undergo tracheostomy to avoid postoperative upper airway obstruction from laryngeal edema. These patients suffer from considerable tube discomfort, and sedatives and analgesics are titrated until the tube is tolerated. However, there is a risk of respiratory depression following opioid or minor tranquilizer administration.

Sconzo *et al.* reported that lidocaine diffuses across the cuff of an endotracheal tube.¹ This is because the cuff is manufactured from polyvinyl chloride and acts as a semipermeable membrane. In addition, Huang and colleagues have also reported considerable lidocaine diffusion across endotracheal tube cuffs.² In a study by Navarro and Baughman lidocaine from an endotracheal tube cuff was sufficient to produce some local anesthetic action as it was reported that there was a reduction of postoperative sore throat.³

In this study, we examined whether lidocaine diffuses across the tracheostomy tube cuff that is routinely used in our hospital, and whether placing lidocaine in the tracheostomy cuff reduced tube discomfort.

Methods

The protocol was approved by our University Ethics Committee.

In vitro study

Two tracheostomy tubes (ϕ con GBII tracheostomy tube, ID 8.0 mm, Fuji Systems, Tokyo) were used in this study. The tube cuff was inflated with 5 ml lidocaine 4% solution and air at 20 cmH₂O, and then placed in 20 ml distilled water at 37°C. Following vigorous stirring 100 μ l of this water was sampled immediately and at 1, 2, 4, 8, 24 hr later. The concentration of lidocaine in the samples was measured by high-performance liquid chromatography. The lower detection limits were 0.2 μ g·ml⁻¹ and the intra-assay coefficient of variation was 5.2%.

Clinical study

Sixteen adult patients undergoing tracheostomy following oral cancer resection were randomly assigned to two groups: lidocaine group (n=8, 59.9 \pm 4.5 [SE] yr, male/female=5/3) and placebo group (n=8, 57.3 \pm 2.7 yr, male/female=6/2). The following protocol was performed on the 2nd postoperative day when patients did not require large dose of analgesics and sedatives.

All patients were blinded to study drugs. The tracheostomy tube cuff was inflated with 5 ml lidocaine 4% or saline 0.9%. The cuff was further inflated with air until cuff pressure reached 20 cmH₂O. Tube dis-

comfort was evaluated by visual analogue scale (VAS: 0 mm = no discomfort; 100 mm = worst possible discomfort) before and at 0.5, 1, 2 and 4 hr after cuff inflation with lidocaine or saline.

Neither analgesics nor sedatives were given during the evaluation. If patients required analgesics or sedatives during the evaluation, they were excluded from the study.

Statistical analysis was by Repeated Measures ANOVA followed by Fisher PLSD for intra-group comparisons and by unpaired t test for between-group comparisons. A $P < 0.05$ was considered significant. All data are expressed as mean \pm SEM.

Results

There was a time dependent increase in the concentration of lidocaine recovered from the incubation medium (Figure 1) indicating that lidocaine diffused across the tracheostomy tube cuff.

In patients who received a tracheostomy tube with a lidocaine containing cuff the VAS decreased from 53.5 \pm 10.6 to 25.1 \pm 9.8 mm ($P < 0.01$) 0.5 hr after lidocaine administration and the effect was maintained until the end of the evaluation period. In the placebo (saline) group there was no reduction in VAS (Figure 2).

Discussion

The present study suggests that considerable amounts of lidocaine diffused across the tracheostomy tube cuff and was sufficient to reduce tracheal tube discomfort. The maximum reduction in discomfort was observed at 30 min although diffusion continued to increase in a time dependent manner. Thirty and 60 min after cuff inflation, lidocaine concentrations in the water bath reached approximately 8 and 17 μ g·ml⁻¹ repre-

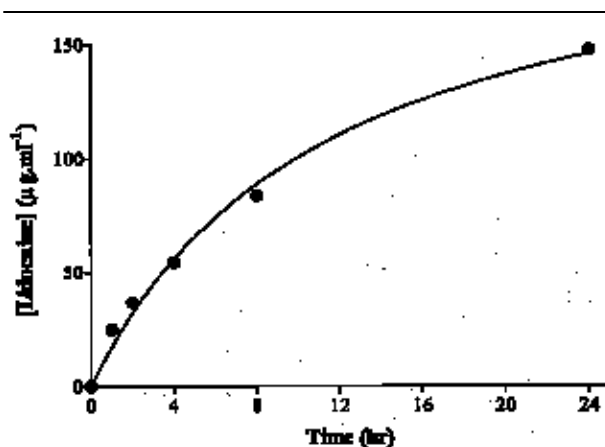


FIGURE 1 Lidocaine diffuses across the tracheostomy tube cuff in a time dependent manner. Data are mean of two experiments.

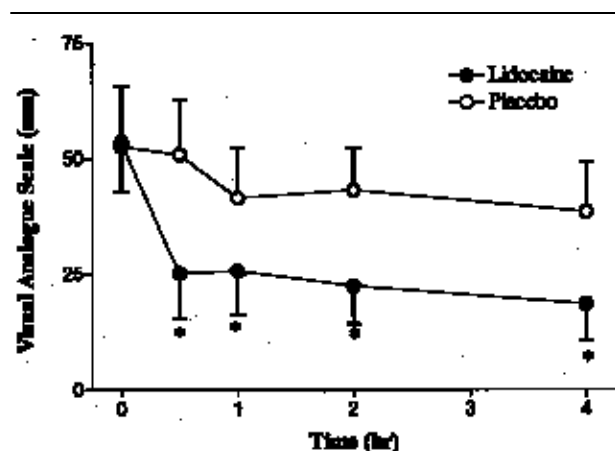


FIGURE 2 Lidocaine from the tracheostomy tube cuff reduces tube discomfort. All data are Mean \pm SEM. * $P < 0.01$.

senting 160 and 340 μg in 20 ml of water, respectively. These data are in good agreement with those of Sconzo and colleagues of 46 and 360 μg .¹

The amount of lidocaine that diffused through the cuff after 30 min was only 170 μg in total. Lidocaine concentrations of 140 μM (i.e., equivalent to about 650 μg in our 20 ml bath) are required to produce a 50% reduction in Na^+ channel activity.⁴ It should be noted that this *in vitro* data is for homogenous solutions and, in the present study, the concentration of lidocaine where the cuff touches the tracheal surface would have been considerably higher. This small amount of lidocaine is sufficient to produce a demonstrable local anesthetic action, i.e. reduced irritation in the area contacted by the cuff.

In the present study lidocaine produced approximately 50% reduction in tube discomfort VAS (from 53.5 ± 10.6 (SEM) to 25.1 ± 9.8 mm). These data are in good agreement with those of Navarro and Baughman who found that 5.5 ± 1.4 (SD) ml lidocaine 4% in the cuff reduced postanesthetic sore throat by about 50% (severity score: from 18.7 ± 27 (SD) to 7.9 ± 18.1 and 25.6 ± 27.5 to 14.5 ± 24.8 one and 24 hr following anesthesia).²

It is possible that increasing the lidocaine concentration in the cuff may reduce discomfort severity by more than 50%. However, as the concentration of lidocaine in the cuff increases, accidental cuff rupture becomes a problem that may result in local anesthetic toxicity. We do not recommend use of higher concentrations.

Whilst tube discomfort is primarily caused by cuff irritation, coughing produced by the irritation increas-

es airway secretions, which exacerbates coughing and, hence, produces more discomfort. Intravenous and topical lidocaine are well known to reduce the cough reflex.⁵⁻⁷ Therefore, even though lidocaine diffusion does not completely block the direct cuff irritation, it may reduce the cough reflex, secretion and hence further discomfort. In addition, as Mallick and colleagues reported, lidocaine instillation also reduces total propofol and alfentanil requirements for endotracheal tube use in the intensive care unit.⁸ Lidocaine in the tracheal tube cuff might also reduce the need for sedatives and analgesics although this was not assessed in the present study.

In conclusion, the present data suggest that lidocaine diffuses through its cuff of an endotracheal tube and is sufficient to significantly reduce tube discomfort.

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