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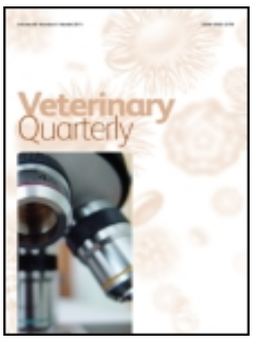

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Experiences with the silicone T-tube in man and dog

E. Th. Edens[1], A. J. Venker-van Haagen[2]

SUMMARY *Silicone T-tubes are particularly useful for long-term stenting of the laryngotracheal airway. Silicone is useful when non-autogenous non-reactive soft material is wanted for use in the human and animal body. Two case reports illustrate the use of the silicone T-tube.*

INTRODUCTION

The silicone T-tube was first described in 1965 (2) and used particularly for long-term stenting of the laryngotracheal airway, and more than ninety cases successfully treated with silicone T-tubes were reported by the same author (3). In recent years the incidence of tracheal stenosis in man due to intubation or tracheotomy has increased markedly. The increased use of positive pressure ventilation in critical patient care is the cause of this pathology.
Reports of favourable results of the treatment of tracheal stenosis with silicone T-tubes led to the wide use of T-tubes in the treatment of human cases of stenosis due to trauma. The good results obtained motivated the use of the same method in a dog with severe tracheal damage.

CASE REPORTS

Case 1: In a 19-year-old woman a large traumatic tracheal-oesophageal fistula was closed but the surgical intervention was complicated by the development of a severe tracheal stenosis (Fig. 1), resulting in heavy stridorous breathing and dyspnea. A silicone T-tube (Fig. 2, 3, 4) was inserted into the stenotic trachea and was removed 1½ years later. Tracheoscopy revealed a slight mucosal structure (Fig. 5) but there was no stridorous breathing.

Case 2: A 9-year-old male miniature poodle was left alone in a car during a hot summerday in Germany. The owner found the dog in a state of severe dyspnea. The local veterinary practitioner performed a tracheotomy and sent the dog home for further treatment. When the tracheal canula was removed the dog again became dyspneic and marked subcutaneous emphysema developed. The dog was then referred to the Small Animal Clinic, University of Utrecht.
On admission the dog was depressed. The tracheotomy wound was closed with sutures and the region around the wound was inflamed. There was mild dyspnea and a respiration rate of 40/minute, pulse rate of 114/minute, and body temperature of 37.4° C.
Auscultation of the lungs was hampered by the presence of subcutaneous emphysema. During the initial clinical examination the dyspnea increased and signs of shock developed. Orotracheal intubation and O_2 treatment followed. Radiography and surgical exploration of the trachea revealed a nearly total loss of continuity of the trachea in the region of the stoma. The proximal part of the trachea was axially rotated 45° to the distal part. The soft tissue around the stoma was discoloured because of trauma and apparent contamination. After consultation with the first author the dog was intubated via the stoma with a no. 6 silastic cannula[3] (Fig. 6) in expectation of the arrival of a silastic T-tube. End-to-end anastomosis was rejected because of contamination of the area. The dog was placed in an oxygen cage in an atmosphere of 40% oxygen (there was an extensive mediastinal emphysema) and 70% humidity (because of the cannulation).

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[2] University Small Animal Clinic, State University of Utrecht, Utrecht, The Netherlands.
[3] Dow Corning Int. LDT. Chaussee de La Hulpe, 177, B-1170 Brussels, Belgium.

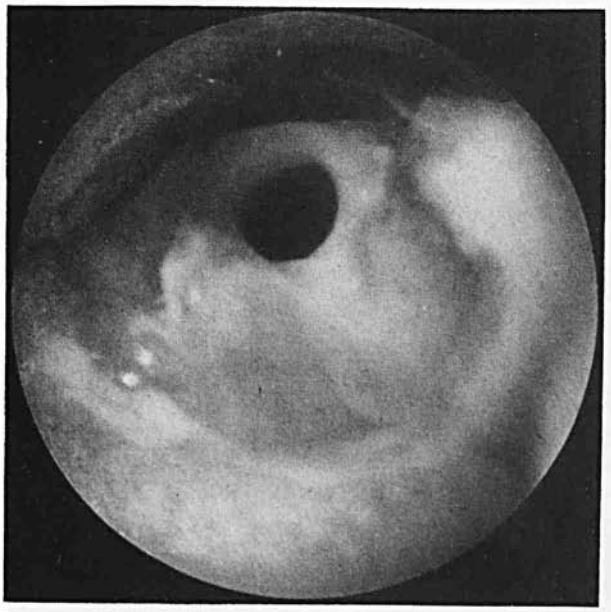

Fig. 1. A severe tracheal stenosis in a 19-year-old woman.

Four days later the tracheal cannula was removed and a 10 mm silicone T-tube[1] was introduced via the tracheostoma (Fig. 7). Six weeks later the T-tube was removed. Tracheoscopy two weeks after the removal of the prosthesis revealed a nearly normal trachea with a slight indication of scar tissue (Fig. 8). There were no signs of coughing, stridor or dyspnea.

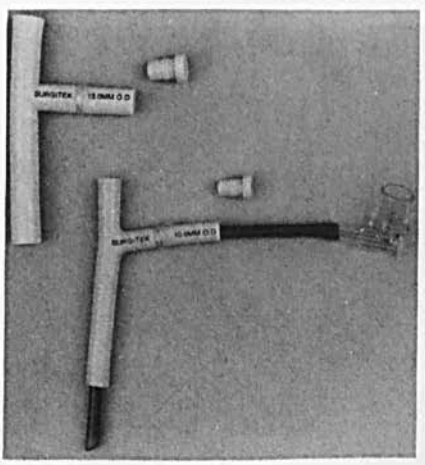

Fig. 2. Silicone T-tubes. The protruding (in this picture horizontal) limb is usually closed but can be opened to introduce oxygen or anaesthetic gases.

Fig. 3. The T-tube is inserted into the stenotic trachea.

[1] Surgitek, Medical Engineering Corp. 3037 Mt. Pleasant Street, Racine, Wisconsin 53404, USA.

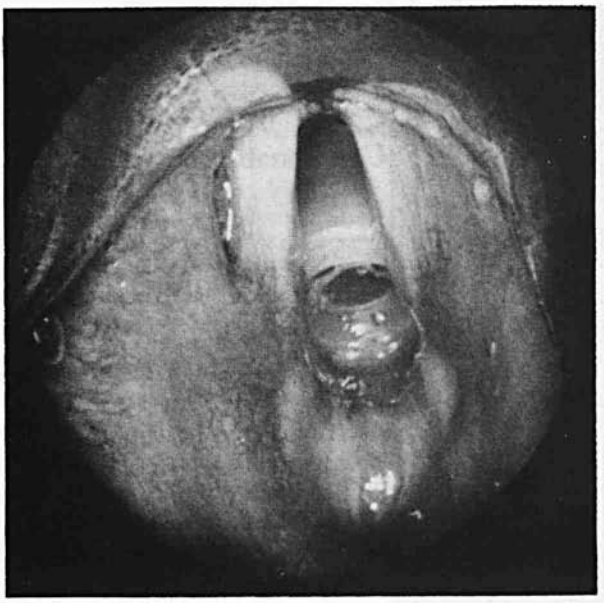

Fig. 4. During laryngoscopy the proximal end of the T-tube is apparent just caudal to the vocal folds.

DISCUSSION

Silicone rubbers have been found extremely useful when a non-autogenous soft material is needed for use in the human or animal body. Silicone is the popular term used to describe a group of organosilicone compounds based on a molecular chain of alternate silicon and oxygen atoms. Depending on the length of the chain and the organic group attached to the silicon atom, these compounds range from water-thin fluids to solid resins and adhesives.

The characteristics of silicones have been described as follows (4):

— not physically modified by soft tissue;
— chemically inert;
— non-carcinogenic;
— induces no inflammation or foreign body reaction;
— produces no state of allergy or hypersensitivity;
— modifiable;
— may be sterilised.

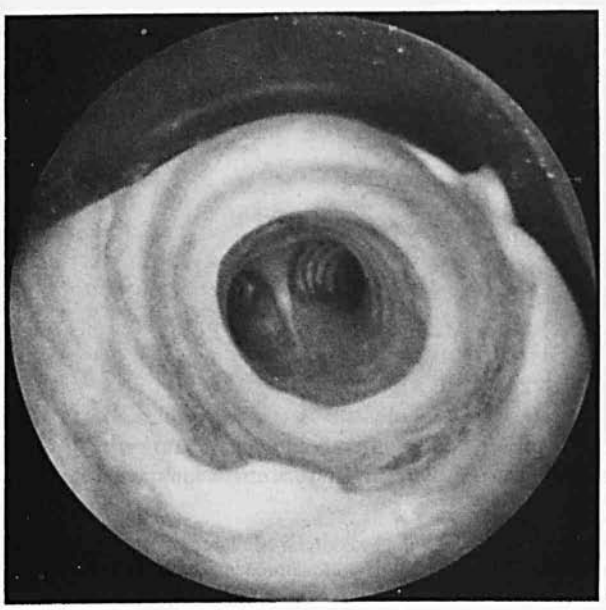

Fig. 5. After 1½ years the T-tube was removed. A slight mucosal stricture indicated the location of the former stenosis.

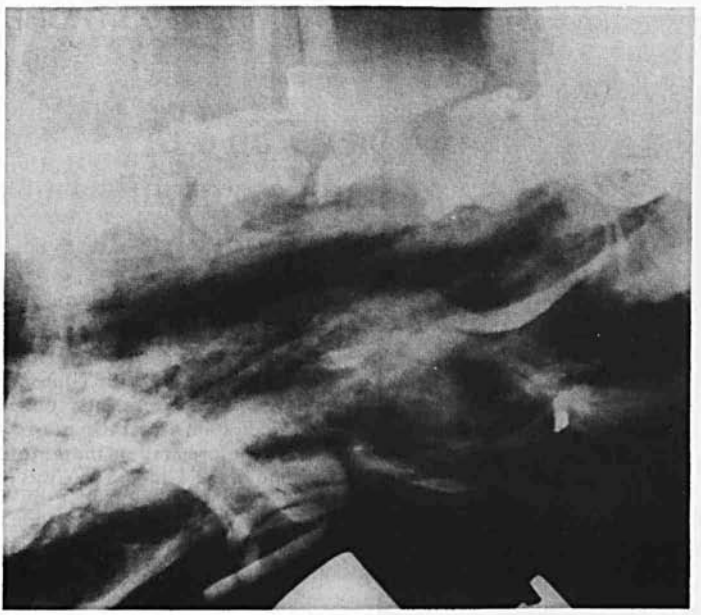

Fig. 6. In a 9-year-old male miniature poodle a silastic cannula was inserted into the tracheal rupture to maintain normal respiration. Note the emphysema.

All disorders of the human laryngotracheal airway characterised by narrowing of the lumen are of interest for application of the silicone T-tube. The lesion may be congenital (cricoid stenosis, narrow trachea), neoplastic (primary, ingrowth, compression), traumatic (intubation, cannulation, cuff effect, anastomosis) or caused by infection ('crusting' tracheitis).

Congenital disorders and primary tumours are rare but compression by an enlarged thyroid gland (malignant or benign) occurs commonly (1). The increased use of positive pressure ventilation in critical patient care has been accompanied by a marked increase in the occurrence of tracheal stenosis due to translaryngeal intubation or tracheotomy. During positive pressure ventilation there is not only the lateral pressure of the cuff against the tracheal wall but also the movements of the respirator, causing a shearing action on the tracheal mucosa.

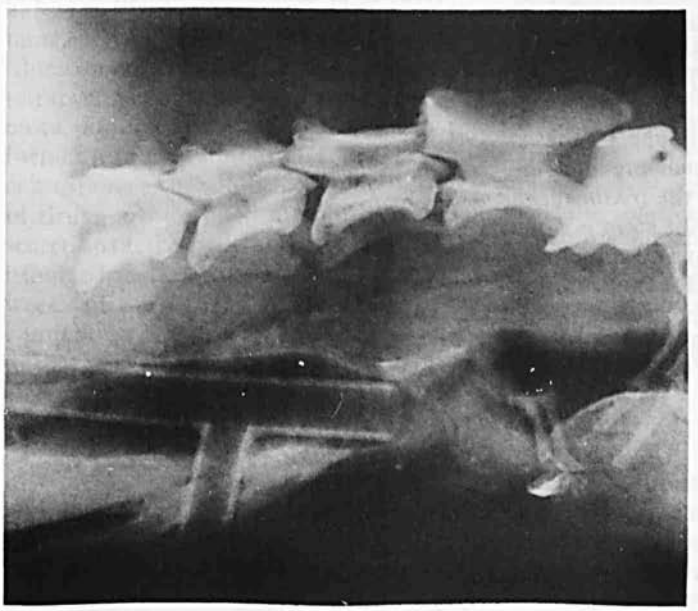

Fig. 7. The T-tube is introduced via the tracheostoma.

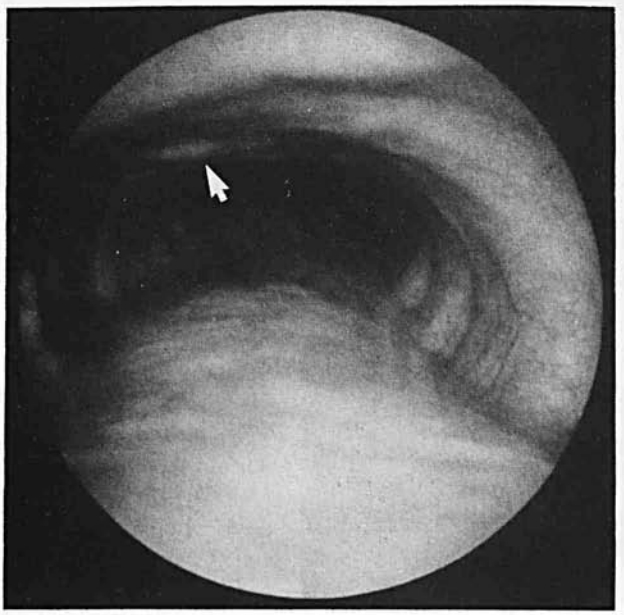

Fig. 8. After 6 weeks the T-tube was removed. Two weeks later only a slight indication of scar tissue (arrow) marked the former site of the protruding limb of the T-tube. There was no stenosis.

Initially there is inflammation of the damaged mucosa but after prolonged intubation, ischaemia may occur. Secondary infections with *Staphylococcus* and *Pseudomonas* cause deep necrosis of the tracheal wall, resulting in exposure and subsequent sequestration of parts of the tracheal rings. The development of reactive proliferation of granulation tissue often occurs, together with collapse of the tracheal wall. The clinical signs caused by stenosis of the tracheal lumen usually occurs two to three weeks after decannulation (1).

In these cases the use of silicone T-tubes is most promising, not only to prevent further strictures but also in the *treatment* of severe strictures. The T-tube stent is often left in place for 3-6 months and sometimes for a longer period (1, 3). Hospitalisation is not necessary, the social behaviour of the patient is normal, and speaking and coughing are undisturbed.

CONCLUSION

Even in severe tracheal trauma, introduction of a silicone T-tube is a feasible treatment. Introduction of the tube is simple and the patient experiences minimal discomfort.

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