Tracheal Fenestration*

Experimental Aspect

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Tracheal fenestration is defined as the surgical creation of an opening in the cervical trachea provided with door-like skin valves. The skin valves are made so as to close over the tracheal opening. The valves must be held apart to gain access to this opening. This procedure offers an easy entrance into the tracheobronchial tree, which can be kept open or closed at will.

In the following we are reporting the method of tracheal fenestration on dogs. We were prompted to do these experiments by the belief that there was a long felt need for an easy route for suctioning and medicating the bronchial tree in a variety of otherwise nonmanageable, chronic diseases involving the lungs and bronchi.

The surgical technic of the fenestration was worked out by one of us (E. E. R.). These experiments began in December, 1954. A total of 34 operations were performed on 18 dogs. Twenty of these operations on 11 dogs were required to arrive at the present method which was performed for the first time on the 17th of June, 1955.

A step-by-step description of the operation (Operation No. 4) is as follows. A five inch long transverse incision is made over the anterior aspect of the lower third of the neck. The incision is extended in such a way that one skin flap is outlined above and one below the level of the initial transverse incision. These skin flaps extend about one inch in a transverse direction beyond the midline (Fig. 1). Through the original transverse incision, the platysma is incised in a transverse direction to about an inch distant to the right and left of the midline. The trachea is then exposed by splitting the strap muscles. A 1 1/4 cm. length of two neighboring tracheal cartilages are excised with the underlying mucosa. The newly created tracheal window edges are covered with inverted full thickness skin. On the right and left sides of the window, this is accomplished by inverting the distal margin of each of the skin flaps and fixing them to the tracheal mucosa with interrupted figure 8 sutures of 0 silk. The upper and lower margins of the tracheal window are covered by inverting the angle of the triangular skin surface above and below also with figure 8 sutures of 0 silk. The skin flaps are doubled without dissecting them from

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the underlying subcutaneous tissue layer. The approximated edges of the flaps are kept together with interrupted 000 silk sutures forming a skin valve on the right and left sides of the tracheal window (Fig. 2). In order to bring these valves into an opposing position, on 0 silk through and through mattress suture is placed near the upper and lower margins of the base of the valves, going from right to left and vice versa.

**Figure 1:** Shows the skin incision with the skin flaps already outlined.—**Figure 2:** Shows the completed operation with the arrows directed towards the opposing skin valves.—**Figure 3:** Represents a fenestration 41 days after the operation and shows the skin valves in a relaxed position and covering the tracheal window. Arrows and finger point to the valves.—**Figure 4:** Demonstrates the fenestration with the valves stretched, displaying the skin lined tract leading to the tracheal window.
Fourteen operations of this type were performed on 14 dogs. Seven dogs were operated for the first time. They are all alive and the fenestrations are in good condition. The remaining seven dogs were operated one to four times prior to carrying out the final type of operation. Four of these dogs are alive with the fenestrations in good condition. Three died with signs of respiratory difficulties caused by softening of a long segment of the cervical trachea by the fenestrations created at each operation.

To record our experiences with the type of operation which led to the final method described above, we present them in chronological order.

**Operation 1:** Through a transverse cervical incision two opposing full thickness skin flaps were developed. The cervical trachea was exposed by cutting through the platysma and splitting the strap muscles in the midline. One and one-fourth cm. length of two neighboring tracheal cartilages were removed by subperichondreal method. The underlying mucosal mucosa was split longitudinally and two opposing mucosal flaps developed. Each of these mucosal flaps was sutured to the corresponding skin flap with interrupted 000 silk. The mucocutaneous flaps were doubled and their edges approximated with 000 silk interrupted sutures.

Nine operations of this type were performed on six dogs. This procedure did not work out because within 24 hours the flaps tore apart at the mucocutaneous junction and later the skin flaps became nonviable.

**Operation 2:** This operation was similar to 1 with the exception that the one and one-fourth cm. length of the two neighboring tracheal cartilages were excised with the underlying mucosa and the opposing full thickness skin flaps were inverted into the lumen of the trachea through the window and sutured to the tracheal mucosa at that level.

The four operations of this type performed on four dogs failed because the skin flaps did not remain viable.

**Operation 3:** This operation was performed in three stages. First, a transverse skin flap was outlined by a horizontal "U" shaped incision going through the entire thickness of the skin. The skin edges then were approximated with 000 interrupted sutures. After 14 days elapsed, the same skin flap was outlined again. The flap was dissected from its underlying tissue layer and doubled. The edges of the doubled skin flap were approximated with interrupted 000 silk sutures. After an additional 14 days, the underlying cervical trachea was exposed, and a one and one-fourth cm. length of two neighboring cartilages with the underlying mucosa were excised. The free edge of the doubled skin flap was inserted into the trachea through the window and sutured to the inner surface of the tracheal window edge.

Seven operations of this type were performed on seven dogs. Of these, only one led to a successful fenestration with one door-like skin valve on it. The cause of the failure was that these skin flaps became at least partly nonviable.

Twenty operations, as described above (1, 2 and 3), were performed on 11 dogs. Five of them are alive. One had "Operation 3" performed with successful fenestration. Four were reoperated again and are listed among the successful "Operation 4" fenestrations. The remaining six are dead. Three of these were listed among the dead on which "Operation 4" as a repeat procedure was performed. The other three died after "Operation 1" or "Operation 2" was performed as a repeat procedure. These dogs died with signs of respiratory difficulties caused by softening of too long a segment of the cervical trachea by the fenestrations performed at each operation.
Successful fenestrations healed from 19 to 55 days after the operation. Figure 3 represents a fenestration 41 days after the operation and shows the skin valves in a relaxed position and covering the tracheal window. Figure 4 demonstrates the fenestration with the valves stretched, displaying the skin lined tract leading to the tracheal window.

By the time the tracheal fenestration is healed, it has a completely skin-lined or epithelialized tract on the neck, leading to a skin-lined or epithelialized opening of the cervical trachea. The skin valves keep the tracheal window covered unless they are stretched in an outward direction, which opens the route to the window. Of course, when desired, the tracheal fenestration can be closed permanently by surgery. The fenestrated dogs can easily be catheterized or bronchoscoped through this opening. This possibility makes them excellent subjects for experimental studies.

The desirability of tracheal fenestration of the type here described suggested itself to us by observations of patients with conventional tracheostomy and metal cannula. In fact, the difficulties experienced in the use of the latter for prolonged suctioning and medication of the tracheobronchial tree have led us to seek the advantages of tracheal fenestration. Having demonstrated the feasibility of the fenestration in animals, we are naturally turning our attention to its usefulness and its applicability in patients. We are not yet in a position to report experience in clinical cases in which this new method has been performed. However, in support of our proposal of tracheal fenestration it seems justified to discuss some of the clinical aspects which distinguish it from conventional tracheostomy as now practiced. This will be presented in detail in a succeeding publication.

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SUMMARY

Experiments leading to a satisfactory operative technic in the production of fenestration of the trachea of dogs are presented. The advantages of the fenestrated animals as experimental subjects are emphasized. The clinical possibilities of a window in the cervical trachea are discussed with particular reference to the management of widespread pulmonary suppuration.

RESUMEN

Se presentan experimentos para obtener una técnica operatoria conveniente de fenestración de la tráquea en el perro. Se recalcan las ventajas de los animales “fenestrados” experimentalmente. Las posibilidades clínicas de contar con una ventanilla en la tráquea cervical se discuten, especialmente en lo que se refiere al tratamiento de la supuración pulmonar difusa.
RESUME

Les auteurs présentent les expériences qui ont permis une technique opératoire satisfaisante pour l'ouverture de la trachée chez les chiens. Ils insistent sur les avantages des animaux "fenêtrés" comme sujets expérimentaux. Ils discutent les possibilités cliniques d'une fenêtre dans la trachée cervicale en insistant particulièrement sur le traitement de la suppuration pulmonaire extensive.

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