An Attempt to Produce a Unilateral Smoking Dog Using the Contralateral Lung as Control*

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The carcinogenicity of tobacco tar for the skin of mice was proved by Wynder, Graham, and Croninger in 1953. Rockey and co-workers found that tobacco tar applied directly to the bronchial mucosa of dogs produced squamous metaplasia in 17 days. The same group stated that the ideal type of experimental exposure would be one that more closely simulated human exposure. This, they state, would involve exposure of animals through some unique smoking device to tobacco smoke.

We have attempted to produce a unilateral smoking dog. The dog smokes cigarettes through a broncho-cutaneous fistula; the contralateral lung, not exposed to cigarette smoke, serves as a control.

The first method used was that of anastomosing a two inch piece of 3/8 crimped teflon to the distal end of the left bronchus. Using sterile operating room technique and sodium pentothal anesthesia, the left

*Supported by the I. A. O'Shaughnessy Foundation, the Smith, Kline & French Foundation, and the Scanlan Instrument Company, St. Paul, Minnesota. The work was carried out in the Cardiac Research Laboratory of St. Joseph's Hospital.

FIGURE 1A: Left mainstem bronchus as it is transected at carina. FIGURE 1B: Left main stem bronchus open at distal end plus tracheal end closed. Insert shows teflon tube being anastomosed to distal left bronchus.

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FIGURE 2A: Teflon crimped tube anastomosed to left main stem bronchus. FIGURE 2B: Completed operation with teflon tube stitched to left posterolateral chest wall. Note portion of 3, 4, and 5 rib removed. Insert shows venting method to ipsilateral chest wall.

Thorax is opened through the fifth interspace. The pulmonary artery and vein are carefully dissected away from the left main stem bronchus which is, in turn, transected at its origin from the trachea (Figure 1A). The tracheal end of the bronchus is closed with interrupted 3-0 silk or catgut. The lung end of the bronchus was anastomosed to a short piece of crimped teflon (Figure 1B)—the same material used for arterial grafts. The teflon was brought through a button hole incision over the posterolateral aspect of the chest (Figure 2A). Portions of the 4th, 5th, and 6th rib were removed to prevent obstruction (Figure 2B).

FIGURE 3: Smoking dog. The cigarette is consumed in about two minutes.
FIGURE 4B: Method of venting the left main stem bronchus through right posterolateral chest wall. The length of ivalon is exaggerated for diagram purposes.

FIGURE 5: Tracheal graft in place with distal host trachea used to vent left bronchus to the right posterolateral chest wall. Insert shows line of tracheal transection and method of supplying respiration while trachea is transected.
Immediately on recovery, these animals are able to smoke cigarettes (Figure 3). However, it is difficult to prevent angulation of the teflon bronchial junction; it is more difficult to maintain a clear air way. After 10 to 12 days the animals develop infection around the teflon graft and/or pneumonia.

Since angulation presented an obstruction problem, we attempted the same procedure from the right side of the chest. This time, the teflon conduit was brought through the right posterior chest wall (Figure 4B insert). Again the animal was able to smoke on recovery; but again the animal developed uncontrolled bronchial secretions, infection and pneumonia. Many minor alterations were made in technique—some of which included soaking the teflon in a solution of penicillin, preoperative antibiotics, and bathing the dog for three consecutive days before surgery. None of these has been effective in the long run.

Next we tried tracheal transplantation. This required sacrificing an animal to obtain a donor trachea which was substituted for the distal half of the host trachea. The distal host trachea plus the left main stem bronchus was brought out through the skin and musculature of the right chest wall. Again we used the right chest wall to vent the left lung so as to avoid angulation (Figure 5). Collapse of the tracheal graft,

FIGURE 6: Method of ventilating dog while trachea is transected. Insert shows method of lengthening trachea by incising the annular ligaments between the tracheal rings.
pneumonia, and a newcomer (extensive, grotesque, subcutaneous emphysema) destroyed our smoking dogs in about 7 to 10 days.

The available animals are not the most healthy and vigorous. It seemed logical to produce, if possible, a unilateral smoker without use of any foreign material (homograft or otherwise). Klein reported that the trachea of the dogs may be stretched by successively incising to the depths of submucosa a sufficient number of the annular ligaments between the cartilagenous rings. Using this technique, it was possible to transect the right main stem bronchus at its origin, stretch out the trachea, transect six rings up from the carina, and directly anastomose the right main stem bronchus to the proximal trachea (Figure 6). The distal trachea with the left main stem bronchus is vented through the right postero-lateral chest wall. Again care is taken to avoid kinking or obstruction. The problem of relieving blood clots and secretions lead us

**FIGURE 7:** Proximal trachea anastomosed to the right main stem bronchus. The distal trachea vents the left main stem bronchus through the chest wall. Insert shows a close up of the operative procedure—note tracheostomy.
to the next step—that of concomitant tracheotomy (Figure 7). To a point, we can maintain a moderately clear tracheo-bronchial tree with ordinary suction. At post mortem examination, however, we find inspissated secretions far beyond our expectations.

The latest attempt is a more simple approach. The dog is operated through the right chest. A skin flap is prepared at the outset of the operation. The left main stem bronchus is divided at the carina and carefully anastomosed to the skin flap, so that the left main stem bronchus vents directly to the right posterolateral chest wall. This technique resembles that shown in Figure 4B insert with the difference being the method of venting which in this case is a prepared skin flap.

Infection, pneumonia, and inspissated secretion still stumble us in our attempt to produce a long lived unilateral smoker. The longest survivor by any technique thus far is six weeks. This, of course, is totally inadequate. We suspect that preoperative antibiotics should be discontinued. It is mandatory that the newly operated animal should be kept in a heavily humidified environment.

Perhaps a tracheal prosthesis such as described by Moncrief and Salvatore of Walter Reed Army Hospital may be the solution. They report experimental success with tygoflex, a plastic prosthesis for tracheal replacements. Perhaps with more assiduous tracheo-bronchial toileting and with a similar material, we may yet produce the smoking dog.

Dr. Oscar Auerbach has stated, "...over a ten year period I have not seen a case of bronchogenic carcinoma of squamous or oat cell (undifferentiated) who did not give a history of smoking." It seems logical that we should put this thesis to the test with our autocontrolled unilateral smoking dogs.

SUMMARY

An attempt has been made to produce a dog which can smoke cigarettes through one bronchus. The contralateral lung is left in its normal position to serve as an auto control.

Several different techniques have been employed including a small piece of crimped teflon as conduit for the experimental bronchus, bringing the experimental bronchus to the contralateral chest wall, homologous tracheal grafts, and tracheal lengthening procedures. The most promising method to date has been that of preparing skin flaps from which a tube is fashioned and anastomosed to the left mainstem bronchus.

Regardless of technique, thus far, the animals have developed pneumonia, atelectases, empyema, tracheobronchial obstruction, or subcutaneous emphysema. A few dogs have lived as long as three or four weeks and have been able to smoke cigarettes readily through a one way valve system.

RESUMEN

Se intentó hacer que un perro pueda fumar cigarrillos por uno de los bronquios. El pulmón contralateral es dejado en posición normal para que sirva como autocontrol.

Se han empleado varias técnicas, entre ellas una pequeña pieza de teflón estriado como un conducto hacia el bronquio en experiencia el que lleva a la pared torácica del lado opuesto, o bien por injertos traqueales homólogos o procedimientos de alargamiento del bronquio.

El método más prometedor hasta ahora, ha sido el de preparar colgajos cutáneos con los que hacen tubos que se anastomosan al tronco del bronquio principal.

Cualquiera que sea la técnica, hasta ahora, los animales han sufrido neumonía, atelectasia, empiema, obstrucción tracheobronquial, o enfisema subcutáneo.

Unos cuantos perros han vivido hasta tres o cuatro semanas y han sido capaces de fumar cigarrillos fácilmente a través de una válvula de un sentido.
RESUMÉ

L'auteur a tenté de préparer un chien de façon qu'il puisse fumer des cigarettes avec une seule bronche. Le poumon controlatéral est laissé dans sa position normale pour servir d'auto-contrôle.

Plusieurs techniques différentes ont été utilisées, comprenant un petit morceau de "teflon" servant de conduit à la bronche expérimentale, la mise de la bronche expérimentale à la paroi thoracique controlatérale, des greffes trachéales homologues et des moyens d'allongement trachéal. La méthode qui a été la plus favorable jusqu'à ce jour consistait à préparer des lambeaux de peau à partir desquels un tube était façonné et anastomosé à la bronche souche gauche.

Indépendamment de la technique, autant qu'on puisse le penser, les animaux ont été atteints de pneumonie, d'atélectase, d'émphyème, d'obstruction trachéobronchique, ou d'emphysème sous-cutané. Un petit nombre de chiens ont vécu pendant trois ou quatre semaines, et ont été capables de fumer des cigarettes à travers un système à valve unique.

ZUSAMMENFASSUNG

Es wurde ein Versuch unternommen, einen Hund so herzurichten, daß er Zigaretten durch einen Bronchus rauchen kann. Die kontralaterale Lunge wurde in ihrer normalen Lage belassen, damit sie als eine Selbstkontrolle dienen kann.

Verschiedene und differente Techniken wurden angewandt insbesondere eines kleinen Stückes eines gefalteten Teflon-Gewebes als Halt für den experimentellen Bronchus, um diesen mit der kontralateralen Brustwand zu verbinden, ferner homologe Luftrohrentransplantate und Verfahren zur Streckung der Trachea. Zur Zeit besteht die am meisten versprechende Methode darin, Hautlappenherdstellen zu bilden, aus denen ein Tubus gebildet wird, der mit dem linken Hauptbronchus anastomosiert.

Unbeschadet der Technik trat bisher bei allen Tieren eine Lungenentzündung, Atelektase, Empyem, tracheobronchialer Verschluß oder subkutanes Emphysem aus. Einige wenige Hunde lebten immerhin drei oder vier Wochen und waren imstande, ohne besondere Umstände Zigaretten durch ein Einwegklappen-system zu rauchen.

REFERENCES


5 Personal communication.