A technique for intrapleural cannulation in experimental animals

Quantitative determinations of the mechanical properties of the respiratory system often necessitate measurement of the pressure acting across the lungs, the so-called transpulmonary pressure. This pressure gradient can be determined by measuring the pressure outside the lungs but inside the chest wall (i.e., the intrapleural pressure) and subtracting the pressure at the opening to the airway. In man, intrapleural pressure changes can be estimated from the pressure in a small compliant balloon partially filled with air and inserted into the thoracic oesophagus. In anaesthetized laboratory animals it is convenient to measure intrapleural pressures directly. In practice, a cannula, which commonly consists of a hypodermic needle or similar device, is inserted through one of the intercostal spaces directly into the pleural cavity of the animal (Nadel & Widdicombe, 1962). Pressure changes within the intrapleural space are then transmitted via an air or liquid-filled system to a suitable pressure recording apparatus.

We encountered a number of problems with such a procedure for obtaining intrapleural pressures in anaesthetized dogs. For example, if the cannula was placed too near the myocardium, the intrapleural pressure waves had cyclic variations synchronous with the heart beat superimposed upon them. At times these superimpositions were large enough to make interpretation of respiratory events difficult and this in turn necessitated removal and relocation of the cannula. The physical nature of the hypodermic needle also presented problems. Unless held firmly in place by a cumbersome arrangement of clamps, the needle often moved during chest excursions and occasionally ceased transmitting pressures. In addition, small blood clots and other tissue debris occasionally became lodged in the tip of the needle, and so gradually dampened the pressure fluctuations. Further, post-mortem examination of animals often revealed a localized area of damaged lung tissue at the site of the cannulation procedure, presumably caused by continuous sliding of the involved lobe over the sharp point of the needle.

We now describe a technique similar to that of Amdur & Mead (1955) which we have used successfully to measure intrapleural pressure in anaesthetized dogs and which circumvents some of the aforementioned difficulties. The cannula which we use consists of a length of polyethylene tubing (PE 205), one end of which is connected to an appropriate pressure transducer. To minimize the likelihood of extraneous matter interfering with pressure transmission, we drill a number of small holes in the terminal inch of the cannula. Burrs around the drill holes are smoothed. The thoracic cavity is penetrated using a three to four inch length of twelve gauge, stainless steel needle stock, bevelled slightly at one end. Equal success in entering the pleural space has been achieved either by penetrating the chest wall at the level of the 5th or 6th intercostal space or by penetrating cephalad through the diaphragm. Using the former approach, the skin and intercostal muscles are punctured at a point along the upper surface of a rib to avoid damage to the intercostal blood vessels. The cannula, previously placed within the lumen of the steel tubing, is then slowly advanced into the thoracic cavity until pressure fluctuations in phase with respiration are observed. If excessive, cardiac-related superimpositions appear in the pressure record, the cannula is gently manoeuvered until a point is found at which the pressure trace is relatively smooth, and the steel tubing withdrawn. We find that by inserting the steel tubing at an angle perpendicular to the long axis of the animal and slightly lateral to the midline, the cannula can be guided into the thoracic cavity parallel to the inner aspect of the chest wall where cardiac effects are minimal.

The outside diameter of the cannula (0·082 inch) nearly coincides with the inside diameter of the steel tubing (0·085 inch). These dimensions are selected to assure against the accidental creation of a large pneumothorax during cannulation. Indeed, we sometimes find it necessary to inject a small volume of air through the cannula and into the intrapleural space before pressure recording can be initiated.

The lightness and flexibility of the polyethylene cannula permit it to ride along easily with thoracic movements and once properly positioned within the pleura it continues to transmit pressures faithfully for long periods of time. At the conclusion of our experiments we routinely perform a thoracotomy to confirm location of the cannula. Gross examination of the lungs at this time reveals little or no damage to pulmonary tissue resulting from the cannulation procedure.

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Effect of temperature changes on the tone of perfused mesenteric arteries of rat and on the perfusion pressure responses to sympathetic nerve stimulation and injected noradrenaline

Exposure of cat cutaneous vessels to cold reduces the vasoconstrictor response to nerve stimulation and injected catecholamines (Folkow, Fox & others, 1963). Rogers, Atkinson & Long (1965), using the perfused mesenteric arteries of dog, found that a decrease in temperature of the perfusion fluid from 37° to 27° increased the basal-line perfusion pressure and the responses to nerve stimulation and injected catecholamines. They suggested that it might be due to the decreased luminar diameter at lower temperatures which may have resulted in increased physical efficiency of the vascular smooth muscle and this in turn increased the perfusion pressure responses to nerve stimulation and intra-arterially injected catecholamines.

The present study on the mesenteric arteries of rat perfused with Tyrode solution indicate that responses to sympathetic nerve stimulation and injected noradrenaline are affected differently with change of temperature of the perfusion fluid.

Female albino rats, weighing 250–300 g were used. The superior mesenteric artery was isolated, cannulated and removed together with its small resistance vessels as described by McGregor (1965). A Harvard peristaltic pump (Harvard Apparatus Co., Model 1210) was used to perfuse the cannulated artery with Tyrode solution at a constant flow of 25 ml/min. The solution was gassed with 5% carbon dioxide in oxygen. The temperature of the solution was changed by cooling or heating the water circulating around the perfusion coil. The responses were recorded manometrically using a frontal writing lever. Before cannulation of the artery, when the pump was operating and the flow was 25 ml/min, the pressure was 60 mm Hg. When the vessels were being perfused at the same rate the pressure was 85 mm Hg. Thus the average basal perfusion pressure during an experiment was 25 mm Hg.

The perivascular nerves were stimulated using a bipolar platinum electrode with a Grass stimulator (biphasic rectangular pulses of 20 V; 1 ms; at 7/s). Noradrenaline was injected directly into the cannula leading to superior mesenteric artery over a period of 5 s by Palmer pump (F-30).