

Discussion

DR J. MORRISON SMITH (Birmingham): I wonder if I could ask Dr Stretton, if it is known roughly at what levels this phenomenon of dynamic compression occurs in normal and in diseased conditions?

DR T. B. STRETTON: As I understand it, in normal individuals, as soon as you start to make the intrathoracic pressure positive during an expiration, dynamic compression will take place somewhere, probably in the lower end of the trachea. As you breathe harder and harder, to maximum expiratory effort, it moves closer to the alveoli, to somewhere at lobular bronchial level. I don't know of information on this in diseased states; except that diseased states will clearly, from simple mechanics, affect the segment over which this is taking place. As you well know, there have been radiographic demonstrations of people with severe airway obstruction showing the trachea just collapsing during forced expiration; one can see this down the bronchoscope very easily, the mucosa just shuts off. That it occurs, is easy to observe; but how far upstream it is occurring, I don't think we know.

PROFESSOR L. REID: Dr Stretton, would you feel then that the claim that was made at one stage, that in asthma and bronchitis one could distinguish the level at which this occurred, which never seemed to me very convincing, would you feel that this really hasn't been of much help, even bronchographically?

DR STRETTON: I don't think so.

DR P. J. D. HEAF: I'd like to ask Professor Reid about the normal amount of secretion in the normal bronchial tree: I agree that we don't produce sputum, but do we produce mucus and other secretions, and how much? I've always imagined that there was really quite a lot of secretion in the normal bronchial tree, and that this was eliminated by the ciliary action, and swallowed. But I got the impression while you were talking that this was probably not true.

PROFESSOR REID: Again, nobody knows how much a human produces in 24 hr. I think there is secretion within the 24 hr, probably even of a certain amount of fairly thick, what we will call the gluggy mucus; there is a certain amount of that secreted, but nobody has measured it in the human. Any ideas that we have got of it are based on animal studies which are not very reliable or very satisfactory, the method was simply to tip the animal and to collect the liquid that flowed out in 24 hr. Now, if you take those studies and you extrapolate for size, then you do come up with the fact that probably something like 100 ml to round it up, would be the sort of order of amount that might be collected from the human bronchial tree in 24 hr. Nobody can tell you, even in an animal, whether or not that was the periciliary, the thin stuff, or much thicker; but I think one's got to accept that there must be, with ciliary action, a certain amount of liquid coming up. I think one has also got to be clear that the zoologists who are studying this are not sure how much of what was an effective ciliary beat of the liquid that surrounds the cilia has in fact, shifted up. It was Kilburn, wasn't it, who estimated that with a decrease in the circumference of transporting airways from many metres in the bronchioles to 5 cm in the human trachea, and with a mucus layer of constant thickness throughout

the bronchial tree, then a fantastic waterfall of mucus would arrive at the larynx. Clearly, this doesn't happen. So, perhaps (i) we are in fact absorbing it as it passes up, or (ii) there is some mechanism (and the brush cell is such a nice one that it's a temptation to put it up) or (iii) it may be that it is absorbed through all cells or (iv) if, in fact, you don't shift the whole of this layer, it is probable that you are only shifting effectively the upper layer, that as the ciliary beat is a whip and a slow withdrawal, that it's probably only the part close to the tip that is shifted (the part down below may even be in a state of oscillation); so it may be that relatively less of that fluid gets up. But certainly it is absorbed, we don't drown ourselves in what is coming up from the bottom of the funnel.

DR F. J. PRIME: Can Professor Reid tell me, is there any animal evidence at any rate, of a difference in concentration of dry weight material in secretion obtained from the depths of the lungs, as distinct from in the trachea? I am wondering whether some of the moisture that you exhale in fact comes from this as it is coming up, and therefore diminishing its volume.

PROFESSOR REID: Nobody has done it. And I think, if one can take it to a little more clinical context, we can also tell you that if we take casts on groups of asthmatic patients, broadly one can divide them into two types: those that have the same macromolecular dry weight as the sputum of patients adduced the day before and after, suggesting that the plug is, shall we say, a normal secretion, but there is some minor thing that has altered its physical property, an ion-causing cross-linking (or the shearing we have talked about. But there is a group of asthmatics where we do get casts that have got a higher dry weight yield, which suggests that there is absorption of fluid within the lungs.

DR P. L. KAMBUROFF: Also, if I may say something, when we do mechanical provocation studies with ultrasonically spun water vapour, then you inhale about 0.4 ml/min, and in 10-20 min you would be taking in something like 8 ml of water, which disappears: it must be absorbed.

PROFESSOR REID: And probably from airways, yes. If I can just finish up on that one, I would emphasize we don't know, but again, talking to Staub recently, they have been impressed that with some of their oedema studies, they are getting a large amount of water out, but it is across airways it seems. So that I think everything we are saying, including this, suggests that we have a large shift of water across the trachea, and the only other bit of evidence to add to this is that studies have shown that the difference in electrical charge across the membrane implies that there is a very big shift in water. Now, they were asking what the membrane could be, because one feels that the single layer of epithelial cells are not perhaps likely, or they might explain it, but they were using the membrane as part of the trachea (the posterior part in Petia's picture where there is hardly any cartilage and it is all muscle and glands) and as they had taken off the superficial part of that, they would in fact have included the duct cells. So it does seem to me that we have still got the possibility that there is a big shift in water, and it may be in two directions.