

in six, and a change of voice in one. We could find no relation, however, between these symptoms and the age at the time of operation, the duration of ventilation, or the results of the respiratory function tests.

### Tracheal tomography

We performed tomography of the strictured area and measured the degree of stenosis in the lateral and in the antero-posterior view, taking an average radius for the calculation of the area of trachea at the stricture. This figure we expressed as a percentage of the normal tracheal area separately measured. The results show that all of the patients examined had a stenosis of some degree, varying from 12% to 84% of the normal tracheal area. This conflicts with previous findings.<sup>3-7</sup>

It was difficult always to be certain of the site of the stricture relative to the tracheostomy stoma, although the scar was located by a skin marker. Our impression was that almost all stenoses (37) were due to constriction at the site of the stoma (fig 1) and only in three patients was there clearly a stricture due to the cuff (fig 2). In each of these there was also a stricture at the stoma site.

We found that the average area of the strictured trachea was 49% of normal, and in those patients with symptoms referable to the lesion the stenotic area was 40% of normal, whereas in the symptom-free group it was 56% of normal. Therefore, although it was not possible to establish a close relation between the stenosis and functional disability, as reported by some authors,<sup>8</sup> these figures suggest that symptoms increase with the degree of stenosis, although some patients with pronounced stricture formation had no observable disability. It was revealing to encounter a fit young football-playing dental student who had undergone tracheostomy when 13 years old, and had an average tracheal diameter of only 3 mm at the stenosis (12% of normal). He had no exercise intolerance, and his only symptom was some stridor, accompanied by a remarkable whistling sound, which instantly located him on the field of play. He had a mildly increased residual volume measurement, and his distal tracheal diameter was larger than that proximal to the stenosis.

It was not possible to relate the degree of stenosis to the method of tracheostomy used. Of recent years in this hospital a flap has been used, but several patients had developed a pronounced "pouch" in the lateral view where the flap had been involved in the healing of the stoma (fig 3). One patient volun-

teered that he had to put his finger over the stoma when coughing to raise sputum, and the pouch appeared to be behaving like a hernia.

The cause of stricture is multifactorial.<sup>4-9</sup> Of the many reasons given, the surgical technique is only one. Infection, the size of the tube, the movement of the tube due to the ventilator, the changing of position of the patient, the inflation of the cuff, the duration of the cannulation, have all been incriminated, and all probably contribute. We gained the impression that our results are improving slightly but this may be due to improved equipment and nursing care as much as to improved surgical technique.

It seems that too little attention has been given to the closure of the tracheostomy stoma, and it would appear that a formal surgical closure of the trachea (if a flap has been used) and of the tissues of the neck in layers should lessen residual disability from the scar and from the strictured area.

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