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Historical Article

The shift in the indications for the tracheotomy between 1940 and 1955: an historical review

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Abstract

In the period between 1940 and 1955 the indications for tracheotomy were extended. For centuries tracheotomies were performed to treat obstructive diseases of the upper airway (hypopharynx, larynx, trachea). With the end of the second World War tracheotomy was indicated more and more for the therapy of lower airway disturbances.

Medical empiricism is thought to be responsible for the gradual shift in the indications during that period from upper to lower airway disturbances. Knowledge about the underlying principles of respiratory physiology was, however, already present at the end of the 19th century, but the shift in the indications did not occur until relatively recently. For many victims of World War II the discovery of the beneficial effect of a tracheotomy in a variety of traumatic disorders may have come too late.

Key words: tracheotomy; History of Medicine; Respiratory system

Introduction

In studies on the history of medicine the tracheotomy has always been a popular subject, since this operation is a rather spectacular life-saving procedure.

Very few medical procedures are so well-known and have been so extensively described. In the literature on the history of the tracheotomy most data is, however, concerned with surgical techniques and the description of many interesting cases. Relatively little attention has been paid to the indications for a tracheotomy in the past. The surgical technique has not basically changed for more than a century, but the range of indications has widened, especially between 1940 and 1955. Until 1940 the aim of a tracheotomy was predominantly to create an alternative airway in order to prevent suffocation in patients with upper airway obstruction. After World War II surgeons gradually became aware of a much broader range of application. They discovered the beneficial effect of tracheotomy in a variety of respiratory disorders, some of them in the lower airways. Long before this took place the principles of the underlying respiratory physiology were well-known. Therefore, the aim of the present investigation is not only to give a short historical documentation of the development in the indications for tracheotomy especially between 1940 and 1955, but also to try and illustrate how surgical empiricism and medical science have played separate roles here. Finally it is suggested that this upheaval in the indications for tracheotomy came too late for many victims of World War II.

Historical notes

The tracheotomy has probably been known for about 3500 years (Frost, 1976), but it was performed only rarely until 1800. Before 1800 only 50 life-saving tracheotomies had been described in the literature (Biefel, 1983; Biefel and Pirsig, 1988).

The tracheotomy did not become part of the routine surgical armamentarium until the middle of the 19th century. Prescott and Goldthwaite (1891) could already trace 23,941 tracheotomies in the literature in 1891. Until the beginning of the 20th century indication number one was diphtheria, for which the large majority of tracheotomies was performed. The other cases already represent the whole variety of classical indications for tracheotomy, e.g. cases of upper airway obstruction due to infections such as syphilis, tuberculosis, acute and chronic laryngitis, typhus, scarlet fever and peritonsillar abscess, as well as non-infectious conditions such as traumas and burns of the larynx, laryngos-

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pasm due to epilepsia and tetanus, benign and malignant tumours, foreign bodies and bilateral abductor paralysis.

Besides these, a tracheotomy was also recommended for the first time for special cases of lower airway disorders and in some cases it was even applied successfully. According to Oborin (1964) the possibly therapeutic effect of tracheotomy was mentioned as early as 1858 in cases of intoxication by CO_2 and other poisonous gases. In 1858 Snow, who is considered the first official anaesthetist of the world, used the tracheotomy to administer chloroform for narcotizing infants with croup. In 1873 Trendelenburg reported 25 tracheotomies and the use of his tamponade canule to administer the narcotic gases in defined quantities and to prevent blood and secretions from running into the lungs during large operations of the jaws, the mouth, and the larynx. In 1880 Karl Hueter introduced the tracheotomy to perform 'bronchial toilet' and artificial respiration in two patients with acute diffuse bronchial catarrh. In the 19th century, however, it was considered a revolutionary idea to perform a tracheotomy in patients with lower airway disorders.

Until 1940 the indications for the tracheotomy did not change basically. It was almost exclusively the treatment of patients with upper airway obstruction that was envisaged. This changed rapidly after 1940. The development started in the early Thirties. In 1932 Wilson published the use of the tracheotomy in patients with bulbar poliomyelitis for the first time. The only advantage mentioned here was an easy access to the lower airways in order to facilitate the removal of secretions by aspiration. The successful use of a tracheotomy in a case of myasthenia gravis was reported in 1934 (Figi, 1934). In 1936 Jackson and Jackson described the use of a tracheotomy in the case of a child with an acute laryngotracheobronchitis. Here the procedure was also intended merely to make easy removal of tracheobronchial secretions possible. In the Forties more and more reports were published which were concerned with the new range of indications. Galloway (1943) reported on the use of the tracheotomy in two cases of bulbar polyomyelitis in 1943. According to Despons (1958), 75 similar cases were published in 1946, and in 1947 Forbes *et al.* reported on 26 cases of bronchopneumonia being treated successfully by means of a tracheotomy.

Later bulbar poliomyelitis in particular gradually became an accepted indication for a tracheotomy. Widespread use could be observed during the epidemic of poliomyelitis in Copenhagen in 1952, which was described by Lassen in 1953. Initially the tracheotomy appeared to be useful not only for an improvement in respiration and the possibility of aspirating retained secretions but also, later on, for the application of intermittent positive pressure breathing via a cuffed canula in the tracheostoma (Engstrom, 1954). The success of the procedure, particularly in cases of bulbar poliomyelitis, ensured that the medical profession gradually became aware of the value of the tracheotomy in cases of respiratory insufficiency, regardless of the underlying disease. Upper airway obstruction in a choking patient was no longer the only reason for creating a tracheostoma. Consequently, in the beginning of the Fifties an enormous extension of the indications took place. Between 1950 and 1955 numerous publications appeared (Biefel, 1983) in which all kinds of neurological disorders were regarded as valid indications: coma, brain tumours, infectious disorders, vascular brain diseases, intoxications, post-neurosurgical problems, head injuries, multiple sclerosis, syringobulbia etc. The tracheotomy also proved its value in many cases of thoracic disorders, such as chest traumas, tumours, and after thoracic surgery. In 1952 von Leden recommended the tracheotomy for all those patients that are unable to expel tracheobronchial secretions efficiently. Carter and Giuseffi (1951) were the first to consider the tracheotomy a useful procedure in thoracic surgery, particularly in cases of crushing injuries of the thorax. After 1955 the tracheotomy became a routine procedure in nearly all cases with respiratory insufficiency, and has proven to be an effective and relatively safe procedure. While in the 19th century the tracheotomies performed for upper airway obstruction and those done for disorders in the lower airways were in the ratio of 90:10, nowadays the reverse is the case with 20:80. Also, the number of tracheotomies has increased enormously. With the introduction of endotracheal intubation at the end of the last century a real competition between the two procedures developed, which ended in a deliberate complementary use of both. When assisted ventilation during a relatively short period is required transoral or transnasal endotracheal intubation is an alternative. Only the length of the period during which artificial respiration may take place without a tracheostoma is still a matter of discussion.

Tracheotomy and respiratory physiology

Respiratory physiology has been regarded as a separate discipline in medical sciences for nearly a century. An important part of the research by respiratory physiologists has been directed towards the mechanics of breathing, since conditions in which there is a decrease of the elasticity of the lungs (asthma, emphysema, etc.) are very common. The description of the different lung volumes, measured by means of spirometry, dates from the middle of the 19th century (Heyden, 1950). Detailed historical reviews on this matter were given as early as 1925 (Knipping, 1925), 1933 (Hurtado and Boller, 1933), and 1939 (Aslett *et al.*, 1939). When a tracheotomy is carried out the total lung capacity and some lung volumes are changed. Some aspects of the mechanics of breathing should be mentioned here in particular. A reduction of the so-called dead space is one of the most important features to be dealt with in tracheotomy patients. The dead space was well-known among respiratory physiologists and, long before World War II, numerous publications had appeared dealing with the physiological importance of this dead space. Excellent publications on this matter

appeared as early as 1894 (Loewy, 1894), 1913 (Krogh and Lindhard, 1913–1914a and b), and 1915 (Rohrer, 1915). The main features of this dead space will be summarized shortly here. The dead space is the amount of gas circulating in the respiratory tract during one breathing cycle without reaching the alveoli and therefore without contributing to factual respiratory functioning. The term 'dead space' is somewhat misleading since, it does have some physiological importance in the conditioning of the respiratory gases with regard to humidity, temperature and inhaled particles. The dead space accounts for the fact that the alveolar ventilation is less than the total ventilation. The alveolar ventilation (Va) depends on the tidal volume (TV), the dead space (DS), and the frequency of respiration (f) according to the formula (Va = f. (TV–DS). This indicates that the alveolar ventilation is improved when the dead space is reduced. The quotient DS/TV should be mentioned here as well. This quotient is elevated in cases of emphysema and the size of the dead space is presumably a contributory factor to inadequate respiration. Therefore it can be expected that in cases of emphysema a reduction of the size of the dead space will have some therapeutical effect. Consequently in all disorders where an improvement in alveolar ventilation is required, a reduction of the dead space will certainly be useful.

The knowledge about the role of the dead space in the physiology of respiration was already discussed extensively in the literature at the beginning of this century, as explained above. By definition the dead space should be located mainly in the upper airways. Therefore a reduction of the size of the dead space can be brought about by a tracheotomy in order to influence respiration in the lower airways. It took several decades, however, before this logical conclusion was drawn by doctors dealing with all kinds of respiratory diseases.

Discussion

For more than 3,000 years the tracheotomy was performed exclusively in order to deal with obstructive disorders in the upper airways. It was a revolutionary idea to apply the same procedure in cases with lower airway disturbances such as restrictive respiratory insufficiency. Even if this idea was already there in the 19th century it could only be exploited when the ground for it was prepared, after 1940, the year which represents a turning point in medical history, the beginning of the modern era of antibiotic treatment, intensive care medicine etc. Bulbar poliomyelitis was one of the first and most striking examples of a disease with central impairment of respiratory functions where a tracheotomy appeared to have a beneficial effect. The extension to the various other indications was the logical consequence. The tracheotomy has proven its value in all cases where respiratory insufficiency was present or could be expected, regardless of the underlying disease. This extension of the indications does not appear to be the result of thorough scientific work. It is likely that it has been discovered accidentally and therefore has an empirical basis. The mechanisms of the (patho)physiology of breathing were well known long before the tracheotomy appeared to have a therapeutical effect in numerous respiratory and non-respiratory disorders. Long before this extension of the indications for the tracheotomy took place a large amount of scientific work had been done in respiratory physiology and at that time the knowledge of the physiological significance of dead space and alveolar ventilation was present. One can only speculate on who is responsible for this. The surgeons, because they were not aware of the physiological principles? The respiratory physiologists, because they had failed to give concrete advice?

During World War II about 55 million people died, most of them as a result of combat actions. It is likely that millions of them died of some form of respiratory insufficiency due to a variety of traumatic disorders such as abdominal, chest and head injuries. There is no doubt that many of these patients could have been saved if a tracheotomy had been carried out. Even in the primitive circumstances of a battlefield hospital this procedure can be performed easily, as the surgical technique is relatively simple. We have to assume, however, that the majority of the doctors on the battlefields of World War II were not aware of the fact that such a simple procedure could often save the lives of their patients. It is sad to realize that the medical world was on the verge of discovering this fact. It is tentatively concluded that a tragedy in medical practice took place during World War II, because the surgical technique of the tracheotomy was known, but the indications for it were not. An unestimable number of lives could have been saved during World War II by using a simple and at that time well-known procedure: the tracheotomy.

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