Editorial

Long tracheal replacement or the philosopher's stone

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Short tracheal resection with a termino-terminal anastomosis is typically a safely performed procedure. However, replacement of segments longer than 50% of the tracheal length in adults and 30% in children has become a great challenge in thoracic surgery. Different tracheal substitutes have been attempted, both experimentally and in clinical practices, to replace long tracheal segments. These include synthetic materials, non-tracheal grafts, tracheal allografts, tailored tube conduits and most recently, biomaterials (1).

Synthetic grafts and non-tracheal grafts

Initial attempts with synthetic grafts and non-tracheal biological tissue were associated with the need for tracheal stenting and prosthesis in order to maintain airway patency (2). Presently, the use of stents carries significant problems. It increases the risk of developing granulation tissue with subsequent obstruction, risk of infection and erosion into adjacent structures, as well as migrations (3).

Tracheal allografts

The use of cadaveric tracheal allografts faces two primary obstacles. The first of these involves achieving good vascularization of the new tracheal graft, which is dependent on the compliance of a complex system of several branches (4). In order to overcome this hurdle, the new graft may be folded into a vascular pedicle, which will then feed the allograft. It will then be transplanted with the trachea in the orthotopic position (5). Recently, Delaware's group have successfully presented their results in 6 patients, who were able to be extubated and weaned from immunosuppression (6).

The second major difficulty involves restoring the tracheal endothelium. Initially, some groups stated that endothelial replacement is key to avoiding the development of granulation tissue, which could then cause airway stenosis and reduce the immunogenic response (7). However, other groups suggested that endothelial replacement of the new graft is not mandatory, as it could be prompted by intense coughing (8).

Tailored tube conduits

Several pedicled autologous tissues have been used to replace and recreate tracheal structure and function, avoiding vascularization and epithelialization problems. However, the issue of maintenance of structural patency arises once again. The omentum, bladder or skin, in combination with autologous cartilage or synthetic materials, have been reported to be in use (9). These techniques allow immediate replacement and avoid immunosuppression. This is of special interest to oncological replacements.

Bioengineered tissue

To resolve these concerns, some groups are currently developing 3D-printed bio-artificial tracheal scaffolds, which are further covered with chondrocytes. These have shown promising results, with lower rates of tissue necrosis and epithelial loss (7).

The need for long tracheal segment replacement is an infrequent but still unresolved surgical challenge. It faces three main obstacles: a necessity to mimic the mechanical properties of the trachea, graft viability and vascularization, and epithelial replacement (10).

The value of a successful tracheal replacement modality cannot be overstated. Several groups are leading the research in both animal and clinical experiments with promising results. 3D-printed scaffolds, vascular flaps and endothelial seeding appear to be the key for success.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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