

How can the problem with stickiness in voice prostheses be solved?

A voice prosthesis consists of a valve that is placed in the wall that separates the trachea and esophagus. It helps people who have had their vocal cords removed, to speak again. However, there is one major issue with the device. In some models, the valve flap sticks to the valve seat, which makes it difficult for the user to speak. The question is: why does it stick and how can it be solved?

Due to the placement of the voice prosthesis, it comes into direct contact with airway mucus. The mucus seeks into the cavity of the prosthesis and adheres to the valve flap and valve seat. Mucus is therefore believed to be the number one factor that causes the valve to stick. The second most important factor is the surface properties of the valve flap and valve seat, as they determine how well the mucus sticks.

Atos Medical is one of the few companies in the world that manufactures voice prostheses. In this work, a pre-study was conducted to find out *what* makes the valve flap stick in one of their models. It was followed up by a literature study focused on adhesion, to understand *why* the valve flap sticks. As mucus, the most important factor in the stickiness problem, cannot be removed, focus was determined to be on surface properties instead. A potential solution to the problem was found when it was discovered that the surface properties of a material can be changed. By a surface

treatment, it is possible to either make it easier or more difficult for a substance (mucus in this case) to adhere to a surface. A treatment that makes the surface non-stick would be favorable in this situation.

To explore this potential solution, the surface properties of the valve flap and valve seat material were investigated, before and after different surface treatments. This was done by measuring the contact angle, the surface energy, and the opening pressure. The contact angle and surface energy gives an indicative measure of adhesion. The opening pressure, which is the minimum pressure needed to open the valve in a voice prosthesis, gives a direct measure of stickiness, when airway mucus is present at the interface. However, slime was used instead of mucus in the measurements and it cannot be guaranteed that the two substances have the same adhesive properties. The results indicate that the surface properties play a role in the stickiness problem, but no solid conclusions could be drawn.

In the end, surface treatments are extensively used in many industries to change the properties of a surface. The problem with stickiness in voice prostheses could potentially be solved by a surface treatment of the valve flap and valve seat, but further testing is needed to confirm this.