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Research Article,

Development of Bronchial Stent for High Ciliary Function in Respiratory Tract

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Abstract:

A balloon expandable tracheal stent is used to broaden the respiratory system, primarily to avoid tracheal rings from collapsing or causing central airway obstruction (CAO). The research relates to a stent that improves air flow in the "windpipe" or "trachea tract" by limiting the amount of surface area covered by the stent, allowing cilia to function normally. Furthermore, the stent decreases mucus collection and tissue granulation within the stent, which has improved anti-migration properties due to flare ends, is suited for custom size, and reduces the risk of airway perforation and erosion. A therapeutic substance is coated on the stent to avoid infection at the treatment site.

Keywords: Trachea, Bronchial Stent, and Central Airway Obstruction

Introduction:

The trachea is a cartilaginous tube that connects the pharynx and larynx to the lungs. Since the second part of the 20th century, airways stents have been utilized to treat trachromatic disorders. Tracheal collapse or central airway obstruction can occur for a variety of reasons, including asthma, lung cancer and lung tumour. Shortness of breath on exercise, frequent cough, barking cough, syncope during coughing bouts, recurrent respiratory infection, expiratory wheezing, and failure to clear secretion are all signs of tracheomalacia. The trachea is composed of 15 to 20 strong cartilage rings. The C-shaped incomplete cartilage tissue ring makes up the windpipe. Muscle and connective tissue make up the back section of each ring. Tracheal collapse, also known as tracheomalacia or Central Airway Obstruction (CAO), is caused by any of the following factors: dysfunction or function impartment of the tracheal ring or trachea. Shortness of breath on exercise, frequent cough, barking cough, syncope during coughing bouts, recurrent respiratory infections, expiratory wheezing, and failure to discharge secretions are all common signs. The proportion of collapse during exhalation is used to classify the severity of collapse: mild (70-80%), moderate (81-90%), and severe (>90%). The sickness is also diagnosed with a Pulmonary Function Test, Dynamic Expiratory Computed Tomography, and Dynamic Flexible Bronchoscopy. The silicone stent, on the other hand, is less expensive, but it is prone to mucus buildup, which can lead to clogging and infection. When compared to their metallic equivalents, silicone stents are more prone to migrate. Furthermore, silicone stents necessitate the use of a medication to aid mucus clearance, as well as periodic monitoring bronchoscopies in conjunction with stent revision. In more severe cases, invasive techniques are used to widen the windpipe and maintain its patency. An airway stent is a hollow tube that is put into individuals who have a blockage in their central airway. It is made of biocompatible medical-grade silicone or a nickel-titanium (nitinol) alloy. A central airway stent is a thin tube that is put into the patients airway. It can be used to prevent a tumour from

spreading into the airway and manage airway fistulas. Corticosteroids and beta agonists are medicinal drugs that widen the windpipe and keep it open. An airway stent improves airway patency, but it has a detrimental effect on the windpipe. It is necessary to remove the stent in children as they get older. Because persistent stent implantation has a high risk of airway injury, stent removal can be difficult. The stent is constructed of nickel - titanium (nitinol) alloy or silicone and has a unique shape that allows it to be readily implanted.

Material and methods:

The trachea is a tube-like structure made of cartilage that begins in the larynx and ends in the bronchi. It is made up of roughly 15 to 20 rings, which expand and contract during inhalation and exhalation. An airway stent is a thin, cylindrical tube that is put into individuals who have a blockage in their central airway. It is made of biocompatible medical-grade silicone or a nickel titanium (nitinol) alloy. The friction between the stent and the mucosa must be kept to a minimum. Windpipe collapse is currently prevented with tubular silicone stents and self-expanding metallic/polymeric stents.

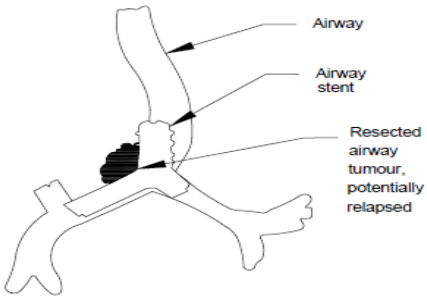

Fig. 1 - Condition of trachea after Implantation

Fig. 2 - Plugging and infection of trachea

Implantation:

Rings or circles are used to connect each ring or circle, and either one or both ends of the stent have flared ends. Rings are either fully circular or have a variant of that shape. Rings can have one or more convex (hill) and concave (valley) portions, with the depth of the concave region varying from one portion to the next or being the same. Depending on the stent size, the number of rings/circles vary from 2 to 100. The ring or circle may include concave and convex regions, ranging from 4 to 1000 and 1 to 100. From top to lower, the layout of rings with alternate convex and concave regions is the same. The number of links connecting two rings/circles can range from 2 to 40. The length and diameter of the stent also influence the number of connections used. A stent has four linkages between two rings/circles that are fitted at 0 ^{o}, 90 ^{o}, 180 ^{o}, and 270 ^{o}. The links in the next ring/circle in another incarnation are in a shift pattern. The shifting link can be set to any angle between 1 and 90 degree. The tracheal stent has a one-of-a-kind construction with many components, such as rings and links. It is supposed to be more flexible while yet being strong. Each ring has a little bulgy appearance. The stent is made up of two pieces, rings and links. In this particular cell form, the link elements are in the shape of a "petal shape". It is made up of two elements: rings and links, which are aimed to provide a lower and more consistent crimping profile. The link pieces are shaped like a diamond and have a diameter ranging from 0.2 to 1.2 mm. This petal-shaped cell was sandwiched between two rings at a distance that was equal or offset. This cell form crimps even more over the balloon. Cell length and width are both in the range from 5 to 15 mm and 10 to 20 mm, respectively.

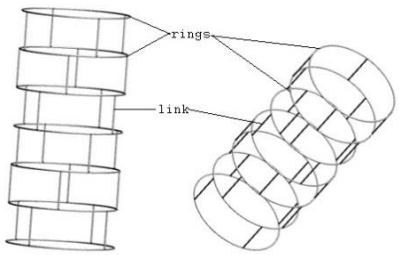

Fig.3- Straight link and Ring structure of trachea

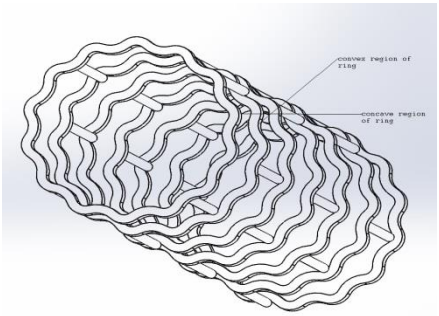

Fig. 4 -Convex and concave region of rings

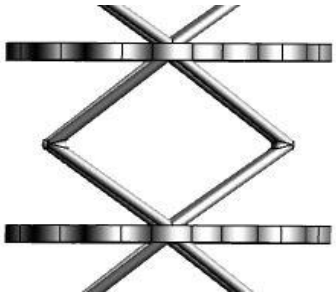

Fig. 5 - Diamond shape link between two rings

Result and Discussion:

Around 23% of patients with chronic bronchitis, 14% with chronic cough and 13% with lung disease had evidence of Excessive Dynamic Airway Collapse (EDAC) while undergoing bronchoscopy. The tracheal is made of about 15-20 rings of tough cartilage which keep the airway open. Treatment with systemic or topical corticosteroids and beta agonists assist in relieving obstruction. An airway stent is an endobronchial prosthesis that support and maintain patency of the hollow tubular windpipe. The function of airways stents is to exert radial forces which maintain luminal patency thereby providing relief form the symptoms associated with CAO including dyspnea, stridor, cough and hemoptyses from disruption of airway vessels. A stent may also be used to obstruct extension of a tumor into the airway or help in the healing or management of airway fistulas. Airway stent may lead to airway erosion perforation or the formation of granulation tissue. Tubular silicone stent and braided self-expanding metallic / polymeric stent used to prevent windpipe collapse. Silicone stents require drug to help with mucus clearance, frequent surveillance bronchoscopies with stent revision. The stent give superior elasticity and torsion property which is better fit with the airway geometry and movements including coughing. The stent also preserves the mucociliary / cilia function in airway mucosa and have minimal or no migration property. By adopting simple insertion (mini or non-invasive) methods reducing the risk of complication arising from insert procedure. The circular ring has the convex and concave region which arrange alternatively. The link provided here can be help in maintaining patency of the windpipe by providing framework which prevents collapse of the stent. The more number of links decrease the free surface area of mucociliary movements. The stent consist the flared end at both side (proximal and distal) which helps in preventing migration of stent during coughing. The Stent designed in such a way that to achieve enough strength, radial strength and flexibility to maintain integrity of windpipe. Each ring has slightly bulgy appearance which generate pressure on wind pipe wall that prevent migration of stent. The petal shape cell comprises enough flexibility and radial strength to achieve desire result at treatment site. The shape of cell comprises blunt edges which prevent the damage occur at treatment site during deployment. The petal shape provides spring back effect during compression which also maintain patency of windpipe as well as prevent migration of the stent. The cells also provide enough radial strength to provide support tracheal and function according to breathing pattern and stent comprises diamond shape flexible links.

Conclusion:

The research concluded that the stent/implant prevent the collapse or central airway obstruction. The stent also prevents mucus accumulation, tissue granulation and windpipe obstruction. The stent also used for pulmonary disease and tracheobronchomalacia for maintaining airway tract patency. An airway stent may use to obstruct extension of tumor into the airway, healing or management of airway fistulas, support the airway well against tracheal collapse or external compression.

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