Abstract Title: Endotracheal Tube Innovation: Embedded Flexible Mesh

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Background/Introduction: Endotracheal intubation is a fundamental anesthetic procedure in which a tube is inserted through the mouth or nose to maintain an airway. Once firmly in place, the endotracheal tube (ETT) normally retains its rigid curvilinear shape. One form of an ETT known as oral RAE tubes used commonly for otolaryngology procedures has a pre-formed bend at the distal end of the tube for clearance of the surgical site and reduction of kinking and obstruction. However, oral RAE tubes are limited since the depth of insertion is pre-determined and the pre-formed kink is unadjustable. There also exists reinforced tubes, standard ETT embedded with concentric steel rings meant for flexibility and resistance to kinking[1]. However, these are limited by their incomplete kink resistance, and inability to retain shape after bending unless through taping or tying. For facial and intra-oral surgeries, the anatomy significantly varies between patients, leading to a need to improve existing endotracheal tubes and combine the best features of reinforced ETT and oral RAE. Furthermore, similar constraints can be seen in the pediatric population; given that the surgical field and oral airways are much smaller, decreasing the room for error and increasing the possibility of total airway occlusion, in addition to the inconsistent lengths and distances of the pre-formed kink among brands and manufacturers[2].

Methods: The general approach was guided through the biodesign process, clearly defining the problem and implementing the solution while keeping the core needs of the patient and practitioner in focus. Market landscape, financial, cost-estimate, and stakeholder analyses were performed. The current standard of care ETT, oral RAE tubes, and reinforced ETT adult and pediatric versions were broken down into vital points, shortcomings, and inefficiencies. Design criteria were then established to lead our concept generation. Materials include nitinol and stainless-steel wire.

Results: The concept selection process yielded the idea of incorporating a stent-like metallic mesh framework embedded within the ETT plastic wall, ideally allowing the lumen to remain fully patent and fully adjustable. The degree and direction of the kink were essential parameters to be adjustable. Additional design elements are optical transparency to be able to view the "misting" of the ET tube for confirmation of intubation, and incorporation of modularity to be able to add and remove the flexible mesh section as needed with other attachments, brands, and tube types. The optimal mesh geometry, length, and material are currently being tested.

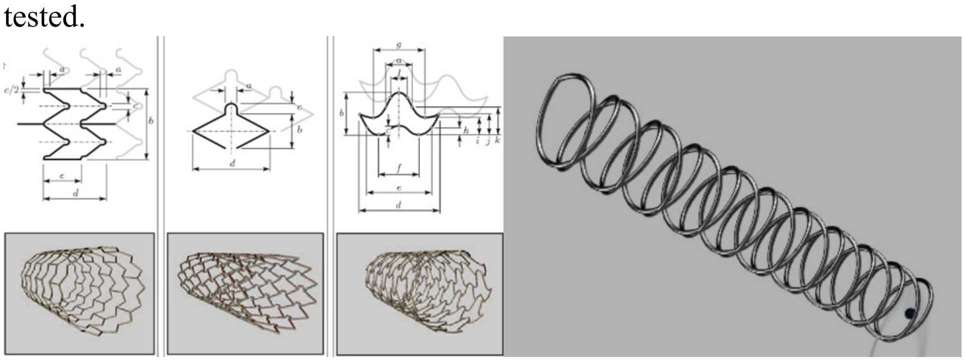

Figure 1: Mesh geometry variations of intricate patterns (left) and simple loop coil (right)

Conclusion: Our work demonstrates the need for an improvement in oral RAE tube design. Patient anatomy, limited otolaryngology operating space, and pediatric populations pose problems. The luxury of a fully adjustable distal component has major value in the operating room for the surgeon and the anesthesiologist. Future direction resides in optimizing the design and testing with in-vitro models.

References:

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