3-D Bio-printed Artificial Trachea

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***Abstract*—This paper talks about some of the options for patients who require tracheal resection or replacement. It discusses some of the issues with some of these options, and talks mainly about the 3-D bio-printed trachea created using stem cells and bone marrow cells.**

I. Introduction

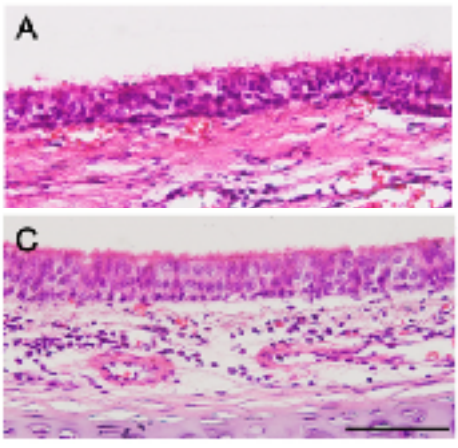
Tracheal resection has very limited applicability. There are many different tracheal replacement and resection strategies, but the best method remains to be identified. There have been many recent advanced in tissue engineering and 3D printing that allow us to come up with better methods. This journal specifically talks about using epithelial cells and bone marrow-derived cells to 3-D print artificial tracheas. In this experiment, the tracheas were tested on rabbits.

II. Methods

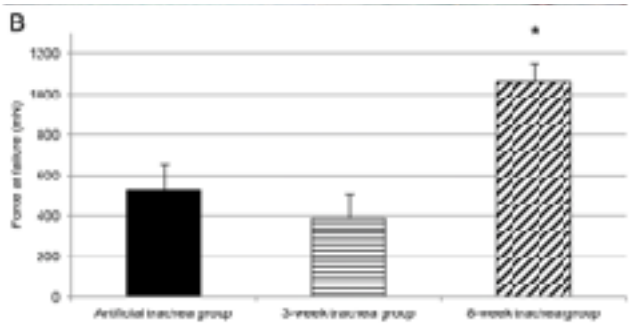
Some of the various strategies that are used for tracheal resection and transplantation are artificial prosthesis and tissue transplantation, but these are not always clinically applicable. 3-D bio-printing artificial tracheas is also another commonly used strategy, but can often cause many complications. Due to recent advances we are now able to bio-print using many more materials including living cells. In these experiments, researchers extracted bone marrow-derived stem cells, epithelial cells, and endothelial cells from rabbits and rats. The cells were used to print the artificial tracheas which were surgically transplanted into the animals. Each of the animals were assessed under multiple categories such as mechanical strength of tracheas, histological examinations, and presence of GAG (glycosaminoglycan).

III. Results

When comparing the histopathologic findings of the artificial trachea and a normal trachea, the artificial trachea formed healthy respiratory epithelium. As you can see in the figures below, the artificial trachea(A) had a rough cell arrangement compared to the normal trachea(C), but it was confirmed that it grew a healthy ciliated columnar epithelium within the first 8 days after transplantation.

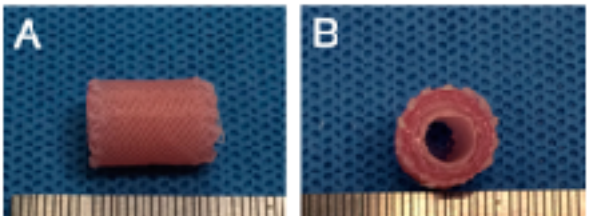


During the mechanical portion of the assessment, each of the tracheas were assessed by increasing tension until they reached force at failure. The artificial tracheas had no significant difference compared to the normal tracheas.



IV. Discussion

Some of the advantages of being able to use living cells when 3-D bio-printing is that the body is much less likely to reject the new trachea compared to using a scaffold when printing the trachea. Another benefit of the artificial trachea is that it is physically so similar to a normal trachea, even microscopically and cellularly. Although a 3-D bio-printer that is able to print organs is a very expensive machine, the act of actually creating the artificial organs is economically-friendly. Ethically, this method of creating organs is much more respected because you are using biocompatible materials, including stem cells and epithelial cells. Additional experiments must still be performed before this is used, but this will have practical clinical application in the future.



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