

Effect of tracheal stenosis at different locations on airflow in the trachea and main bronchi

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ABSTRACT

Tracheal stenosis is known to disturb the flow dynamics in human airway which may lead to breathing difficulties. In order to understand the tracheal stenosis effects to the flow behavior, this work investigates the presence of stenosis at different locations along the trachea wall and explores on how significant the flow could possibly be altered. The stenosis was patched to the healthy trachea models at five regular locations proposed by medical practitioners. All of the models were then subjected to moderate breathing conditions with inhalation flow rate of 45 l/min (Reynolds number 3012). The changes in the flow behavior due to the different locations of the stenosis were then examined to determine the pattern of breathing difficulties. K-epsilon model was used to model the turbulent flow conditions. The results show that the presence of stenoses was proven to produce moderate to severe pressure drop as the locations of the stenoses moved closer to the bifurcation region. For all cases studied, significant change in the velocity pattern was observed which suggests distorted flow rates into the bifurcations. The overall conclusion confirms that the presence of stenosis closer to the bifurcation area will have greater effect to the flow dynamics.

KEYWORDS:

pressure and velocity patterns; Stenosis locations

REFERENCES

1. Spittle, N., McCluskey, A. Lesson of the week: Tracheal stenosis after intubation. (2000) *British Medical Journal*, 321 (7267), pp. 1000-1002.
2. Schuurmans, M.M., Bolliger, C.T. Silicone airway stents. (2004) *Interventional Pulmonary Medicine. Lung Biology in Health and Disease*, 189, pp. 215-238
3. McCaffrey, T.V. Classification of laryngotracheal stenosis. (1992) *Laryngoscope*, 102 (12), pp. 1335-1340.
4. Yang, J.-H., Jun, T.-G., Sung, K., Jin, H.C., Young, T.L., Pyo, W.P. Repair of long-segment congenital tracheal stenosis. (2007) *Journal of Korean Medical Science*, 22 (3), pp. 491-496.
5. Hammer, J. Acquired upper airway obstruction. (2004) *Paediatric Respiratory Reviews*, 5 (1), pp. 25-33.