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# Optimization of tracheoesophageal fistula model established with T-shaped magnet system based on magnetic compression technique

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## Introduction

The magnetic compression technique has been used to establish an animal model of tracheoesophageal fistula, but the commonly shaped magnets present limitations of poor homogeneity of tracheoesophageal fistula and poor model control.

We designed a T-shaped magnet system to overcome these problems and verified its effectiveness via animal experiments.

## Materials and methods

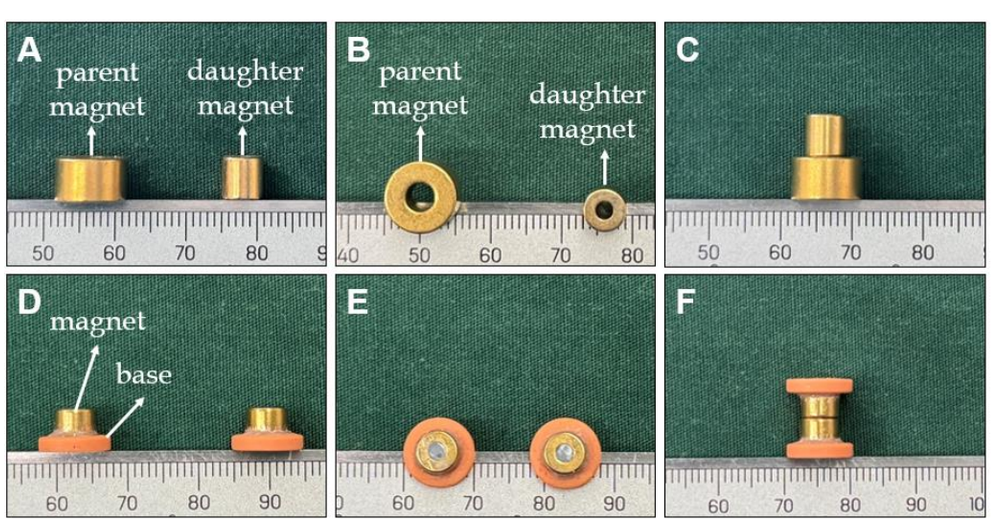


**Fig. 1 Conventional cylindrical magnets and T-shaped magnet scheme used for the magnetic compression technique.**
A-C. The daughter magnet and parent magnet used in the control group.
D-E. The T-shaped magnets used in the study group.

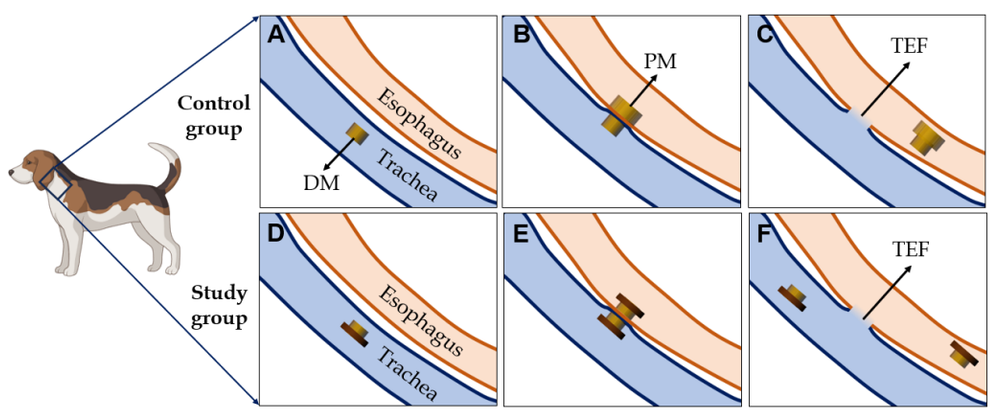


**Fig. 2 Schematic diagram of the magnetic compression process.**
A. The daughter magnet (DM) was inserted into the trachea of control dogs.
B. The parent magnet (PM) was inserted into the esophagus of the control dog where it was then attracted with the DM.
C. The PM and DM fall off into the distal end of the esophagus, and the tracheoesophageal fistula (TEF) is established in the control group.
D. The T-shaped magnet was inserted into the trachea of study dogs.
E. Another T-shaped magnet was inserted into the esophagus of the study dog where it attracted with the magnet in the trachea.
F. The magnets were removed under endoscopy and the TEF was established in the study group.

## Results

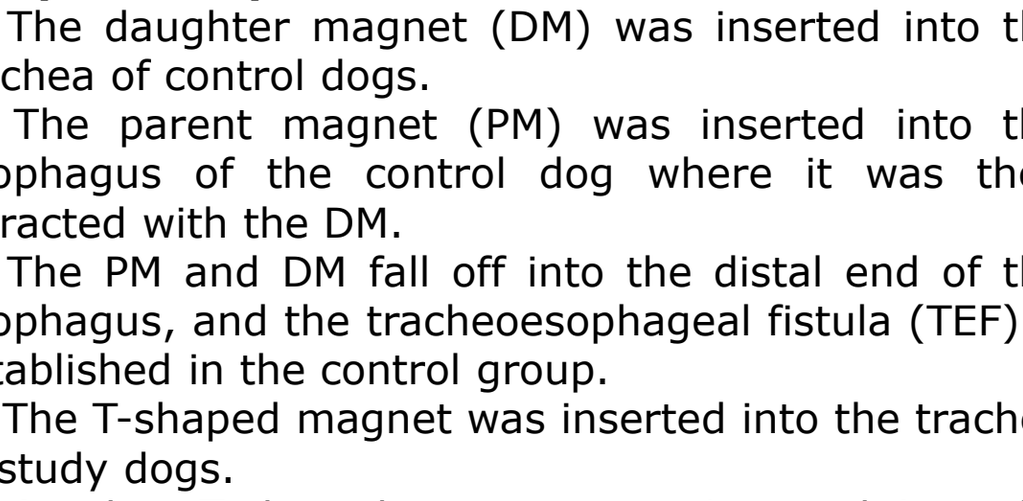


**Fig. 3 Surgical procedure.**
A. Endotracheal DM seen under endoscopy in the control group.
B. Endoscopic view of the esophageal PM in the control group.
C-D. Fluoroscopy showing that the PM and DM were coupled and retained in the target location in the control group.
E. Endotracheal magnet seen under endoscopy in the study group.
F. Endoscopic view of the esophageal magnet in the study group.
G-H. Fluoroscopy showing that the magnets were coupled and retained in the target location in the study group.

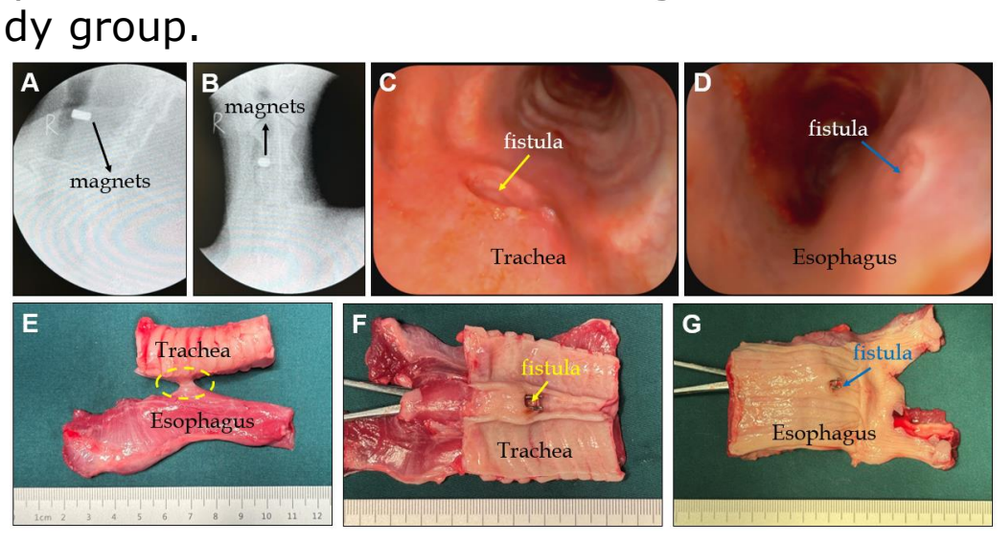


**Fig. 4 Gross TEF specimens from the control group.**
A-B. At 6–9 days after surgery, the magnets left the neck and entered the stomach.
C. Bronchoscopy showing a fistula located in the posterior wall of the trachea.
D. Gastroscopy showing a fistula located in the anterior wall of the esophagus.
E-F. The gross specimen of TEF.

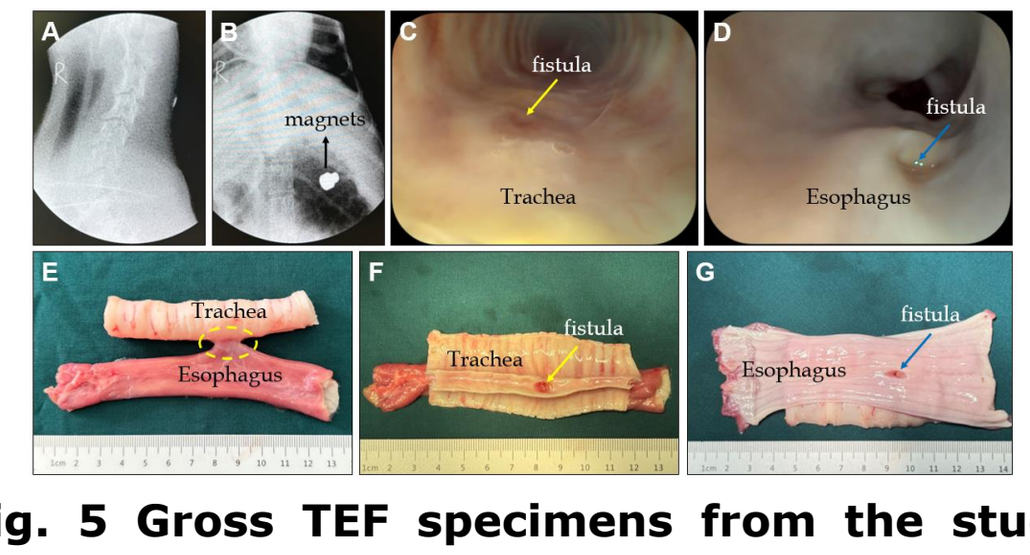


**Fig. 5 Gross TEF specimens from the study group.**
A-B. At 2 weeks after surgery, the magnet positions had not changed.
C. Bronchoscopy showing a fistula located in the posterior wall of the trachea.
D. Gastroscopy showing a fistula located in the anterior wall of the esophagus.
E-F. The gross specimen of TEF.

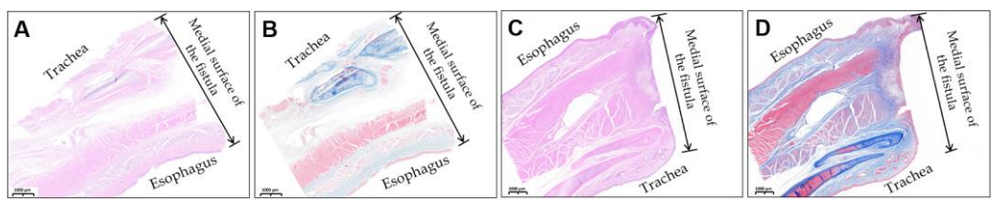


**Fig. 6 Histological analysis of TEF.**
A-B. HE and Masson trichrome staining of TEF from the control group.
C-D. HE and Masson trichrome staining of TEF from the study group.

## Conclusion

One limitation of the present study is the small number of experimental animals. Additionally, the observation time after TEF formation was shorter for the control group than the study group, and the observation time could be appropriately extended if effective methods could be applied to reduce the choking and pain of the control animals.

Use of the modified T-shaped magnet scheme is safe and feasible for establishing TEF and can achieve a more stable and uniform fistula size compared with ordinary magnets. Most importantly, this model offers better controllability, which improves the flexibility of follow-up studies.