Medical & healthcare, Regenerative medicine

Discovery of a novel function of the cell nucleus that makes internal organs left-right asymmetrical

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Abstract

Our research group revealed that the nuclei of visceral muscle cells that surround the digestive tract were densely aligned along the anterior-posterior axis when the digestive tract becomes left-right asymmetric. This result was obtained by newly developed technologies using combination of time laps analyses and computer modeling, which allowed us to measure the movement of nuclei in live *Drosophila* embryos. In addition, studies with genetic mutants in which the left-right asymmetry of the digestive tract were randomized showed that nuclear alignment is necessary for the left-right asymmetry of the digestive tract. These studies demonstrate that cell nucleus functions not only to store genes, but also to utilize its physical strength to control morphological changes of internal organs.

Background & Results

We revealed that the alignment of cell nuclei is necessary for the internal organs to become left-right asymmetrical shape. The nucleus is the largest organelle in eukaryotic cells. Since DNA (deoxyribonucleic acid), which constitute genes, exists in the nucleus, it has been thought that the storage of genes is the role of the nucleus. Here, our research group has developed a technique involving a time lapse analysis and computer modeling, which enable to measure the movement of nuclei in the digestive tract of live *Drosophila* embryos (Fig.1). We found that the nuclei of visceral muscle cells that cover the digestive tract are densely aligned in the anterior-posterior direction. We clarified that this dense alignment is necessary for the shape of the digestive tract to be left-right asymmetric. Like the human internal organs, the *Drosophila* digestive tract has a left-right asymmetrical shape. In the genetic mutants in which the nuclei of muscle cells are not aligned, the left-right asymmetry of internal organs becomes randomized. Since the nucleus is the hardest structure in the cell, it is thought that the nuclei densely aligned acts like a strut. The aligned nuclei support the structure of the digestive tract like a pole in a tent, and help to change the structure left-right asymmetrically (Fig.2).

Significance of the research and Future perspective

These studies revealed that the cell nucleus functions not only to store genes, but also to utilize its physical strength to control morphological changes of internal organs. It is expected that this result can be applied as a technique for controlling the morphology of regenerated organs using organoids.

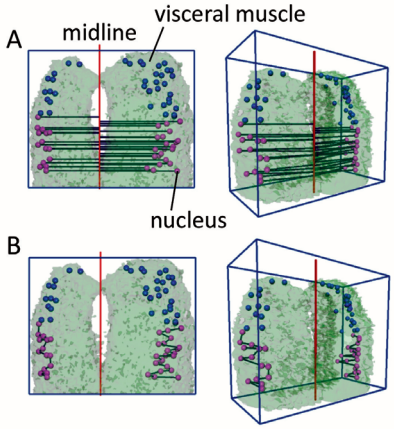

Fig.1 We developed a video analysis technique that enables time lapse three-dimensional measurement of the motility (A) and alignment (B) of the visceral muscle nuclei.

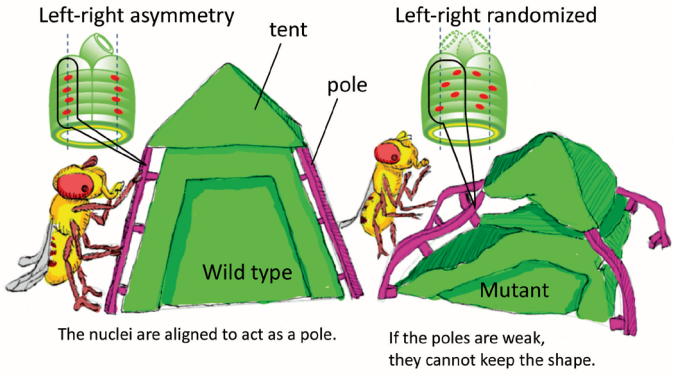

Fig.2 The nucleus is the hardest structure in the cell. It is aligned and acts like a pillar as the role of 'building material'. Aligned nuclei support the structure of the gut and left-right asymmetrical shape changes during development.

Patent
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