Ultrastructural & Analytical Methods in Life Sciences

LS.6.P176
Novel cross-linking structure between mitochondrial outer membranes in chicken retinal pigment epithelial cells revealed by rapid-freeze deep-etch technique

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Keywords: rapid-freeze deep-etch technique, mitochondrial outer membrane, cross-linking structure

Mitochondria are highly dynamic. They frequently change their morphology by fusion and fission. These dynamic processes are important for mitochondrial function, and defect lead to neurodegenerative diseases. Several large GTPase such as Drp1, Fis1, Mfn1,2, OPA1 have been recently identified as key molecules in mitochondrial fission or fusion. However, structural data concerning association between adjacent mitochondria are quite limited.

In the present study, mitochondria in chicken retinal pigment epithelial (RPE) cells were examined with rapid-freeze deep-etch technique. In the basal region of RPE cells, various sized mitochondria were highly packed to form a distinct domain, where larger mitochondria were located at the center and smaller ones were at periphery (Fig. 1A). Distance between adjacent mitochondria was quite stable. High magnification showed that mitochondria outer membranes were cross-linked by a novel structure resembling a “pear”. This characteristic cross-linker was composed of basal globular structure shaped like a slightly leaned snowman (21-25nm wide, 20-27nm high) and apical thin filamentous structure (3-6nm wide, 11-19nm long) (Fig. 1B). Some mitochondria were cross-linked to other organella such as ER membranes by filamentous structure (5-9nm wide, 19-25nm long), which differed in shape from the intermitochondrial structure. Some mitochondria had focal contacts to adjacent mitochondria, where parallel curved arrays were occasionally found on the cytoplasmic true surface of the outer membrane (Fig. 1C). Center to center distance of the arrays is 9-10 nm. Theses arrays are similar to those observed in dynamin and Dnm1 helices (1), suggesting that this focal contact with parallel arrays is the site of mitochondrial fission.

These observations may indicate that the pear–shaped intermitochondrial cross-linker plays an important role in keeping and controlling mitochondrial morphology and might be also involved in mitochondrial fission/fusion events.

1. J. A. Mears, L. L. Lackner, S. Fang et al. (2011) Nature Struct Mol Biol 18, 20-27.

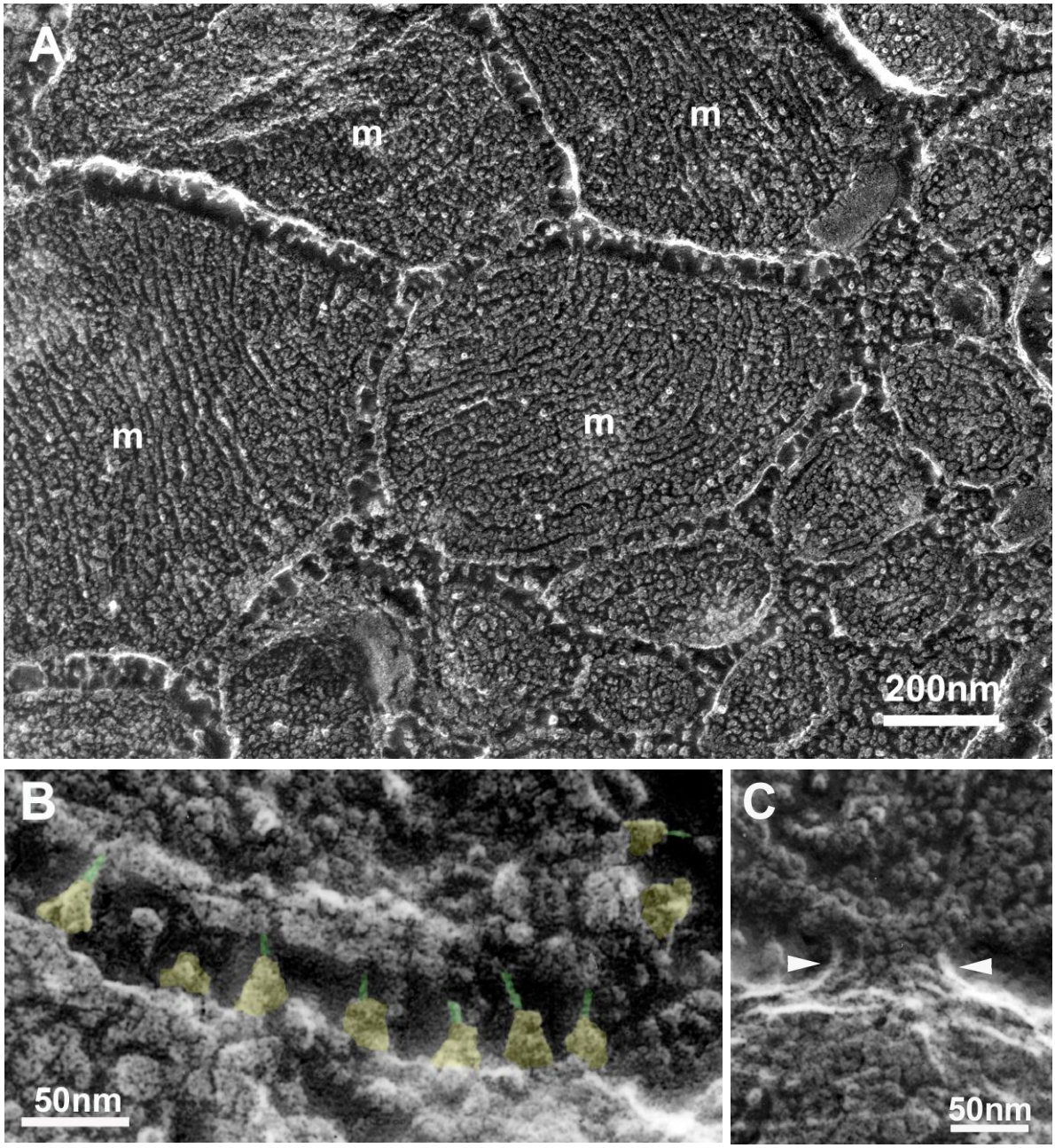

Figure 1. Rapid-freeze deep-etch view of mitochondria in chicken RPE cells. (A) Mitochondria (m) are tightly packed and distance between adjacent mitochondria is quite constant. Globular and filamentous structures are found between mitochondria. (B) Higher magnification of intermitochondrial structure. Mitochondrial outer membranes are cross-linked by pear-like structures which is composed of basal globular part shaped like a slightly leaned snowman (colored in yellow) and apical thin filamentous part (colored in green).(C) At the focal contact between adjacent mitochondria, parallel curved arrays (between arrowheads) are seen on the cytoplasmic surface of mitochondrial outer membrane.