

Comision de Investigacion Cientifica de la Provincia de Buenos Aires, La Plata (Argentina)

Satellite cells of skeletal muscle fibers in human progressive muscular dystrophy

By

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With 5 Figures in the Text

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In the course of a study on the fine structure of human progressive muscular dystrophy a special kind of cell located between the two layers of the "surface membrane complex" of the muscle fiber was noticed. Since to our knowledge very few observations about this cell have been reported (MAURO 1961), none of them in human skeletal muscle, and their role and origin are hitherto unknown, it seemed of interest to describe their appearance in human pathologic muscle.

Materials and methods

The observations were made on biopsy specimens of five male patients with progressive muscular dystrophy. The material was routinely fixed with 1% buffered osmium tetroxide, embedded in Araldite according to LUFT (1961) and stained with LAWN'S (1960) potassium permanganate technique. The observations were made with a Philips 100 B electron microscope operated at 80 kV.

Results

In the five biopsies examined a large number of satellite cells was observed. In normal appearing muscle fibers they were seen as flattened cells located between the basal membrane and the plasma membrane of the muscle fiber extending through considerable lengths. The nucleus, centrally located, was fusiform in shape, with its larger diameter parallel to the muscle fiber axis. The chromatin was homogeneous and the nuclear envelope showed no special characteristics. The cytoplasm was scanty, being more abundant in the perinuclear zone. In favorable sections a well developed Golgi zone and some vesicles of rough-surfaced endoplasmic reticulum could be seen. The mitochondria were scarce and showed no special features. Below the plasma membrane a great number of pynocytotic vesicles was observed. The space between the plasma membrane of the satellite cell and the two layers of the surface membrane complex of the muscle fiber was homogeneous and of low electron density, measuring 300—1,000 Angstrom units. In the sarcoplasm immediately beneath the satellite cell many pynocytotic vesicles were seen.

In pathologic muscle fibers the satellite cells showed characteristic modifications. They increased their cytoplasm, and the cytoplasmic organelles were more prominent, especially the endoplasmic reticulum, which appeared as dilated sacs and vesicles bounded by a large number of ribosomes.

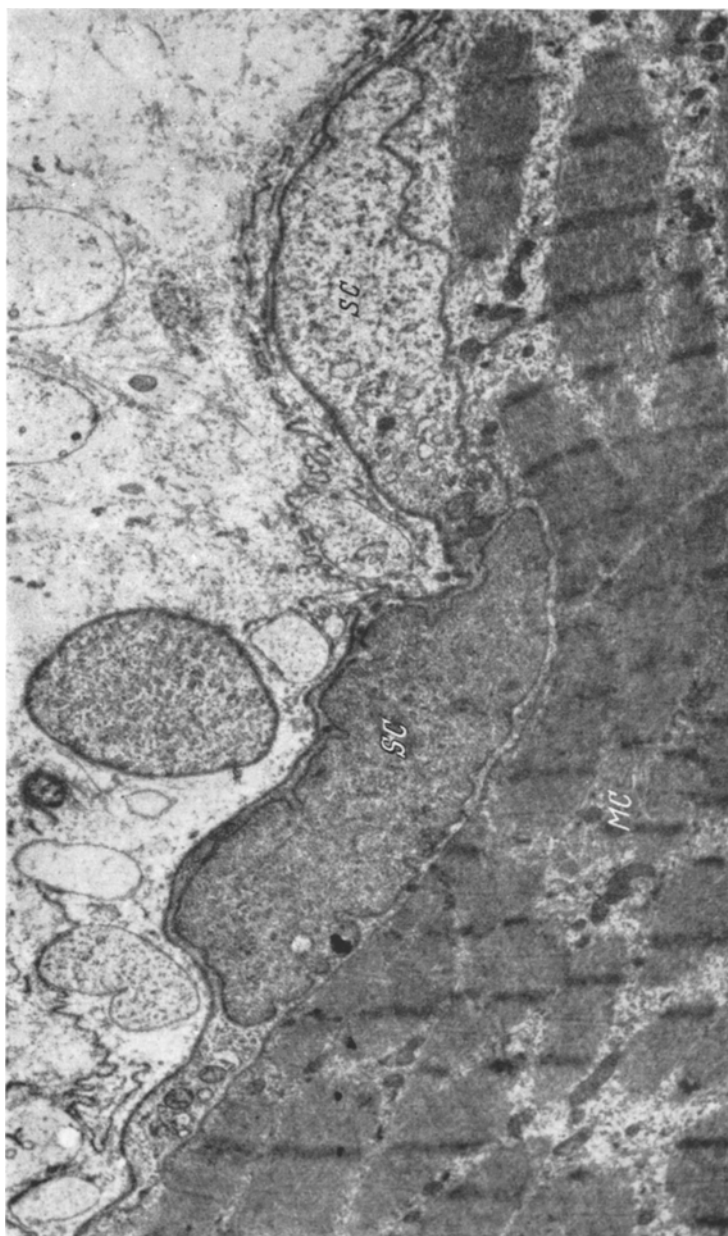


Fig. 1. Low power view of a satellite cell located between the basal membrane and the plasma membrane of the muscle fiber. SC satellite cell; MC muscle cell. Approximately $\times 6,000$

A striking fact was that in what appeared to be regenerating muscle fibers the satellite cells attained their maximum size, equalling sometimes the muscle fiber diameter or getting deeply into it.

Discussion

The knowledge about the role and origin of satellite cells is at present only speculative. In the first report about this cell MAURO (1961) pointed out that

they might be reserve cells or "dormant" myoblasts, ready to reproduce when the muscle fiber is damaged. He also considered the possibility that they might be wandering cells that have penetrated the basal membrane.

The active pynocytotic phenomena observed in the satellite cells and in the sarcoplasm beneath them induce us to think that the satellite cell might perform a trophic function, acting as an intermediate cell between the tissue space and the muscle fiber. This would be supported by the fact that they

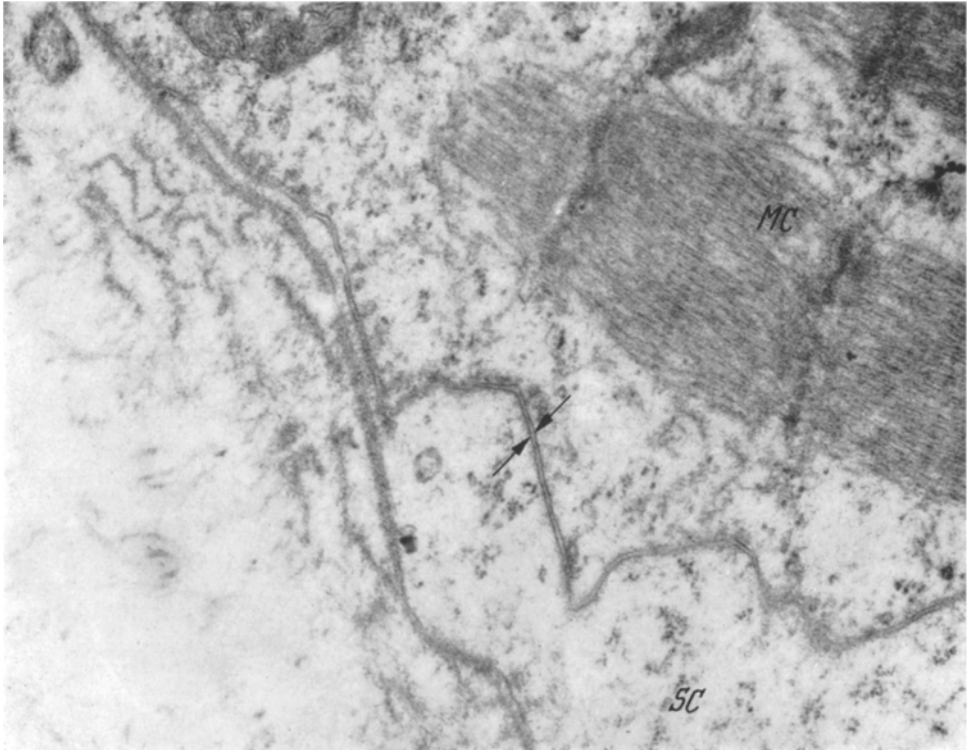


Fig. 2. Distal portion of a satellite cell. The arrows point to the plasma membrans of the satellite cell and the muscle fiber. A large number of small granules identified as ribosomes can be seen in the satellite cell cytoplasm. Approximately $\times 36,000$ (reduced to $19/30$)

hypertrophy when the muscle fiber is damaged and especially when it seems to be regenerating. In this way the satellite cell would have an important role in muscle regeneration, although not as a reserve cell or dormant myoblast, but rather as a cell which in close relationship with the regenerating muscle cell affords it in a trophic way. In our material we were not able to find evidence of a transformation of satellite cells in myoblasts.

Summary

In biopsy specimens of five cases of human progressive muscular dystrophy studied with the electron microscope a special kind of cell located between the two layers of the surface membrane complex of the muscle fiber is described. Based on the fact that they hypertrophy when the muscle fiber is damaged,

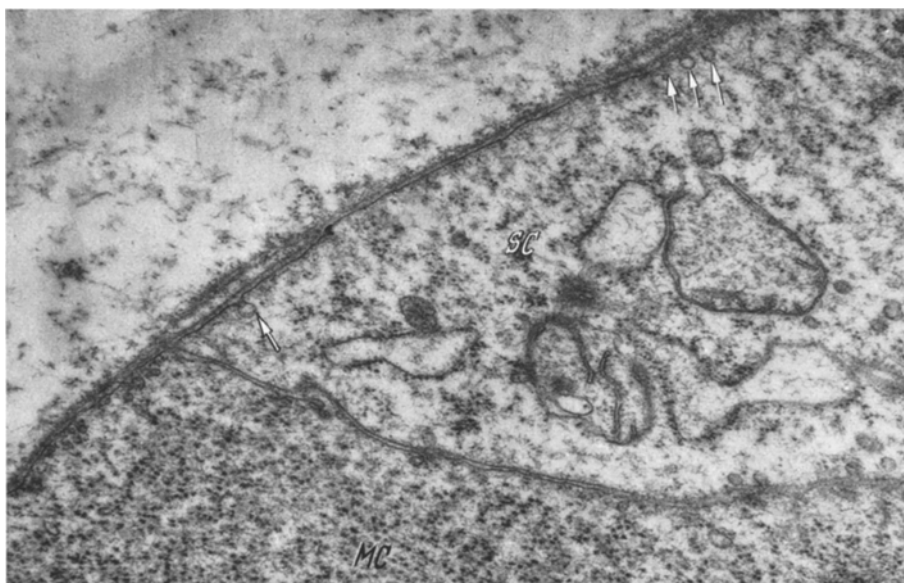


Fig. 3. Sharpened end of a satellite cell. At the arrows many pynocytotic vesicles may be seen. Approximately $\times 34,000$ (reduced to $\frac{1}{10}$)

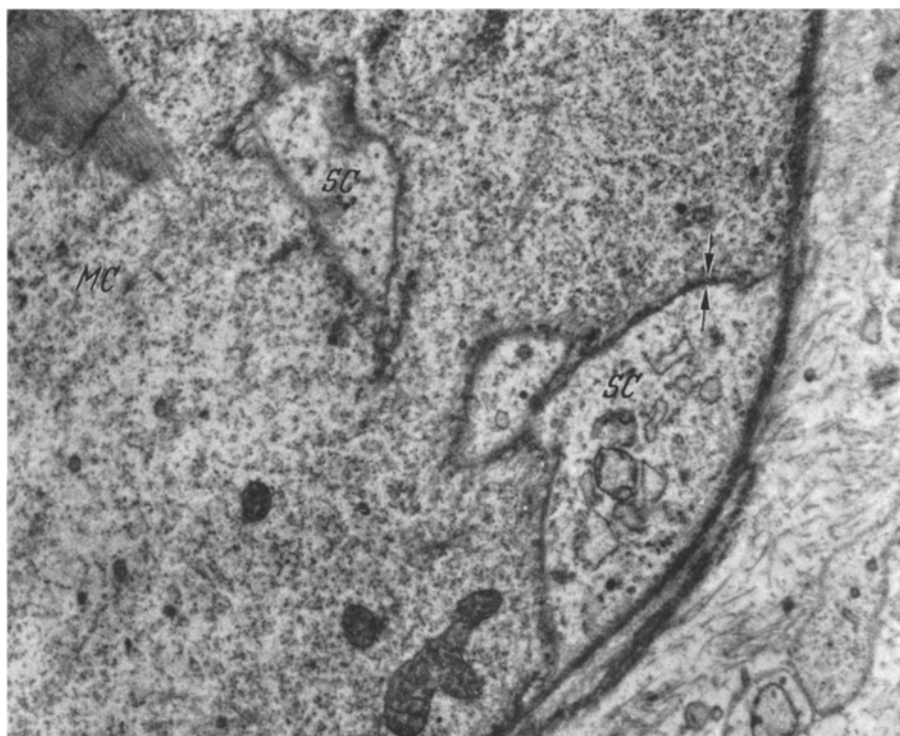


Fig. 4. A satellite cell getting deeply into the muscle fiber. At the arrows both plasma membranes can be seen. The muscle fiber is thought to be a regenerating one. Approximately $\times 14,000$

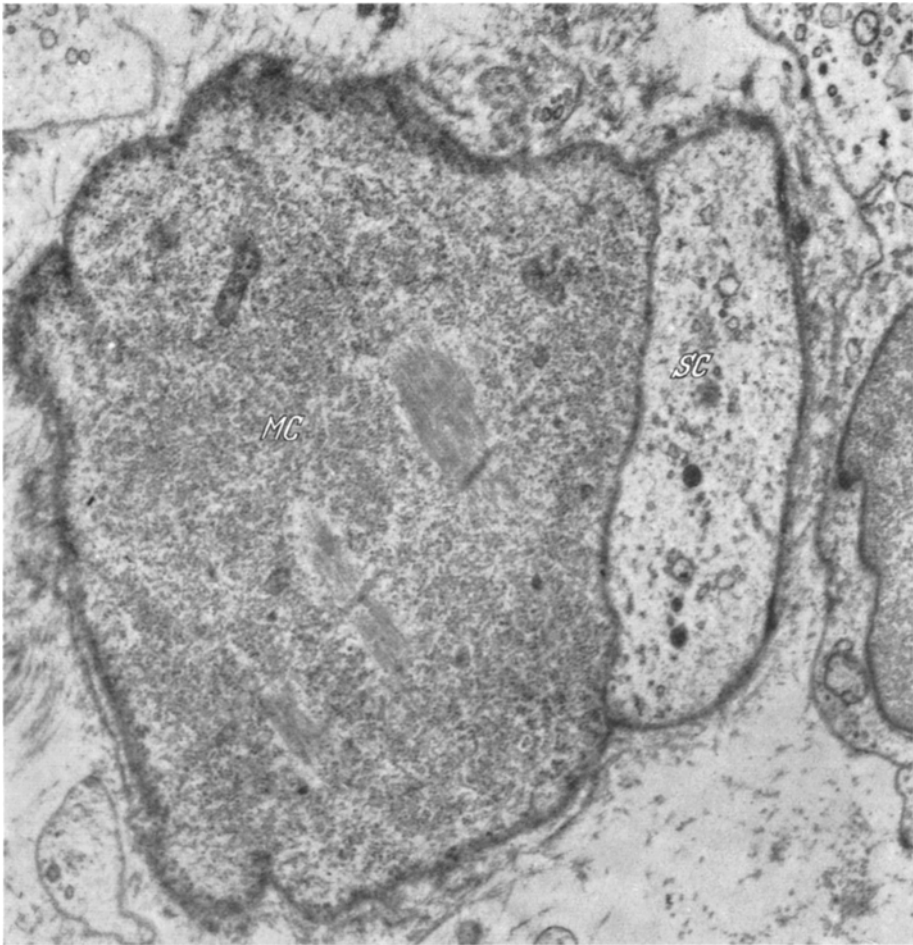


Fig. 5. Low magnification of a small muscle fiber interpreted as a regenerating one and a satellite cell with hypertrophied cytoplasm. Approximately $\times 5,500$

and especially when it is regenerating, it is suggested that they might perform a trophic function, acting as an intermediate cell between the tissue space and the muscle fiber.

Satellitenzellen an Skelettmuskelfasern bei der progressiven Muskeldystrophie des Menschen

Zusammenfassung

Auf Grund elektronenmikroskopischer Untersuchungen von Muskelbiopsien von fünf Fällen menschlicher progressiver Muskeldystrophie wird eine besondere Zellart beschrieben, die zwischen den beiden Lagern des oberflächlichen Membrankomplexes der Muskelfasern gelegen ist. Da diese Zellen hypertrophieren, wenn die Muskelfaser geschädigt ist, besonders aber, wenn sie regeneriert, wird angenommen, daß sie eine trophische Funktion besitzen und als celluläre Vermittler zwischen Gewebsraum und Muskelfaser dienen.

References

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