ON THE PARTICIPATION OF ARGYROPHYLLIC FIBERS IN REPARATIVE OSTEOGENESIS AFTER PARTIAL EXTIRPATION OF THE CEREBRAL CORTEX

M. B. Rappoport

From the Department of Pathological Anatomy (Head – Docent M. B. Rappoport)
of the Archangel Medical Institute (Director – Docent A. A. Kirov)
(Presented by Active Member of the AMN SSSR N. A. Kraevskii)
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 53, No. 2,
pp. 115-117, February, 1962
Original article submitted March 8, 1961

Inadequate attention has been devoted to the study of the influence of the central nervous system on the formation of bone callus. Only in the last decade have a few reports been devoted to this problem. Part of them have been concerned with the effect of brain injury [1, 2] on reparative osteogenesis, and the rest [3-7] to the effect of prolonged anesthesia on osteogenic processes.

In the aforementioned investigations there is no mention of the state or role of argyrophyllic axons in the healing of fractures of tubular bones.

To elucidate the role of the argyrophyllic axons in reparative osteogenesis when innervation had been destroyed we carried out 20 experiments on mature rabbits and performed a similar number of control experiments.

METHODS

The cortex of the parietal region and part of the frontal and temporal regions were removed in the experimental animals. Subsequently the ulnar bone was injured during the post-operative period. The ulnae were injured with a dentist's drill. This made it possible to obtain a singular defect in the bone with a length of 0.4 cm. The wounds were then sutured. In the control animals the cerebral cortex was not injured. Regeneration was followed by x-ray and by histology after 3, 5, 10, 15, 20, 35, 40, 60, 120, and 200 days after the injury. The sections were impregnated with silver nitrate by the method of Foot.

RESULTS

In three days after the injury to the ulnae in the controls and also in the experimental animals, no argyrophyllic fibers were seen in the region of the injury. In the periosteal and intermuscular connective tissue the fibers swelled. In the edematous sites of the intermuscular connective tissue the smallest fibers were fragmented.

In five days after injury to the ulnae in the control animals isolated, narrow, short, argyrophyllic fiber endings were seen in the region of the injury among the cells of the granulation tissue. In isolated bone spicules forming in the periosteum of the ulnar fragments were seen plexus of argyrophyllic fibers connecting the spicules. In the soft tissue of the forearm argyrophyllic fibers were slightly thickened. During the same period, in the experimental animals, there were significantly fewer argyrophyllic fibers than in the controls and they were shorter and narrower. In the soft tissue of the forearm in the experimental animals the plexus of fibers were considerably more coarse than in the control animals. They took the silver nitrate unevenly.

By the tenth day in the control animals the ulnar defects were replaced by granulating tissue and bone spicules. In the granulation tissue a large number of thick argyrophyllic fibers were evident. In the bone spicules they formed a fine plexus. A portion of the fibers formed a new plexus between the bone spicules. In the soft tissues of the forearm a fine interlacing network of fibers was found. In the experimental animals there were significantly less argyrophyllic fibers in the region of the defect in the ulna and callus formation was delayed. In the newly formed osteoid tissue extremely thick, coarse, interlacing argyrophyllic fibers were found. In the regions between these osteoid struts the plexus were made up of the thickest argyrophyllic fibers. The plexiform fibers in the walls of the blood vessels were fragmented to a greater degree in the experimental animals than in the control animals and the fibers were coarsened in the soft tissue of the forearm.

The differences between the argyrophyllic fibers in the experimental and control groups became even more clear after 15 to 20 days. In the control animals the defect was almost completely replaced by osteoid tissue and a large number of plexus of argyrrophyllic fibers were evident. During this same period in the experimental animals only a portion of the defect was replaced by osteoid and the rest still contained remnants of granulation tissue, cartilage and fibrous cartilage which contained fewer argyrophyllic fibers. The plexiform fibers of the soft tissue were collagenized significantly sooner or later than in the control animals.

In 35 to 40 days, in the control animals, the majority of argyrophyllic fibers and of osteoid tissue is converted into collagen fibers forming a basic material for bone formation. Several spicules acquire a lamellar character. In place of the plexus of thick fibers in the bone spicules there are isolated, thick, argyrophyllic fiber end separating the network of argyrophyllic fibers situated between the spicules, and the reticular fibers of the soft tissue of the forearm acquire their usual appearance and structure. During this same period the experimental animals have preserved their thick fibered spicules and subsequently a large number of plexiform fibers. In the space between the struts there is less evident destruction of the plexus than in the control animals. A portion of the fibers of the soft tissue of the forearm have degenerated into clumps.

After 60 to 120 days in the control animals the callus of the ulnar bone consists primarily of lamellar osteoid which in many areas forms compact bone. In the lamellar osteoid isolated, thick, argyrophyllic fiber ends are seen arranged in radial fashion in relation to the Haversian canals. The space between the osteoid is very narrow and argyrophyllic fibers are not found. During this same period in the experimental animal the coarse fibrous struts persist with plexus of thick, argyrophyllic fibers. In the central portion of the callus among the bundles of collagen fibers isolated argyrophyllic fiber ends are observed. In the soft tissues a significant portion of argyrophyllic fibers do not have clear outlines. Several of them are degenerating into clumps.

In 200 days after the injury, when the callus is finally formed in the control animals, argyrophyllic fibers are rarely observed in the form of fine threads. In the soft tissue of the forearm, close to the callus and at a significant distance from it, there is the usual form and structure. In the experimental animals after this same period of time there is frequent formation of false articulations. In the articular ends of the false joint isolated bone spicules are seen with a coarse fibrous structure and a large number of thick, argyrophyllic fibers. In the fibrous-cartilaginous tissue thick, plexiform fibers appear. In the soft tissue of the forearm of the experimental animals the argyrophyllic fibers are unevenly impregnated with the silver nitrate. A portion of the fibers without clear outlines degenerate into clumps and a portion are collagenized.

Thus injury of the cortex of the cerbrum has a significant effect on the formation and condition of argyrophyllic fibers and their role in reparative osteogenesis.

SUMMARY

In rabbits with partial decortication considerable delay and disturbance of the osteogenic process are seen 15-20 days after the injury in the tissue replacing the ulnar bone defects. In the latter the tissues are characterized by the following abnormalities: there is a smaller quantity of argyrophil fibers than in control rabbits, they are more coarse, ununiformly impregnated with silver and a part of them is subjected to early or late collagenization. In 35-40 days, when in control animals a considerable part of the reticular fibers has transformed into collagenous fibers, the former are still retained for a long time in the experimental animals. In connection with disturbed osteogenesis the callus tissue often consists of the fibrous-cartilaginous tissue. In the latter coarse, thick reticular fibers are detected at the late periods. In the articular ends of the false joints, which are often formed after injury of the cerebral cortex, coarse fibrous trabeculae with argyrophil framework are often retained for 200 days.

LITERATURE CITED

1. Z. Kh. Bashirov, In: The Collection of Scientific Papers of the Bashkir Medical Institute. Ufa, Vol. 11, p. 281 (1959).
2. G. B. Bochorishvili, Report of the AN of Georgia, SSR, No. 9, p. 835 (1956).
3. R. Ya. Vepkhvadze, Papers of the Tbilisi Institute of Post Graduate Medicine, Vol. 5, p. 223 (1958).
4. G. L. Emets, In: The Collection of Papers of the Ukrainian Central Research Institute of Orthopedics and Traumatology. Kiev, Vol. 6, p. 15 (1955).
5. P. M. Kovalevskii, In: The Collection of Essays on Scientific Investigation of the Stavropol Medical Institute, Vol. 1, p. 94 (1955).
6. V. T. Leonov, Sov. med., No. 3, p. 15 (1952).
7. G. I. Tregubov, In: Problems of Practical Medicine. Rostov-on-Don, p. 72 (1959).