Invest Clín 17(3): 115-121, 1976

EXPERIMENTAL TRAUMATIC EFFECTS ABOUT MYELINATED FIBERS IN THE SPINAL CORD

J. Vaquero Crespo, S. Oya, M.J. Ramiro*

SUMMARY

The authors report the histopathological alterations that take place in the nervous fibers of the contused spinal cord, particularly during the following 8 days of the experimental trauma.

The axonal degeneration process can be quickly detected in the electronic and optic microscope. Particularly, the images of the axonal denudation and demyelinization which appear between the 4th and 8th day, with an important and persistent tissulary oedema.

INTRODUCCION

After Albin (1) proposed a group of rules in the way to stop the injurious evolution in the zones of the experimental contusion, the histopathological study of the traumatic spinal cord is actual once more. The liberation of some biogenic amines of effector vasculary action in the physiopathology in this kind of lesion is considered from Osterholm and cols. work (4). According to these appreciations, the knowledge of the histopatholo-

* *Department of Histology. Section of Neurohistology. School of Medicine. Complutensis University. Madrid, Spain.*
Reprints: Dr. J. Vaquero Crespo. Villaamil 31. Madrid 29. Spain
This paper was in part presented on the scientific session of the 27th Meeting of the Spanish Society of Neurology. Barcelona, Spain. December, 1975.

gical sequential alterations are of considerable interest as they let us know the right moment to work therapeutically through a pharmacological action blockading the supposed accumulated amines.

Dohrmann and cols. (2) and Wagner's group (6) recently studied the primary axonal alterations in the experimental spinal cord injury.

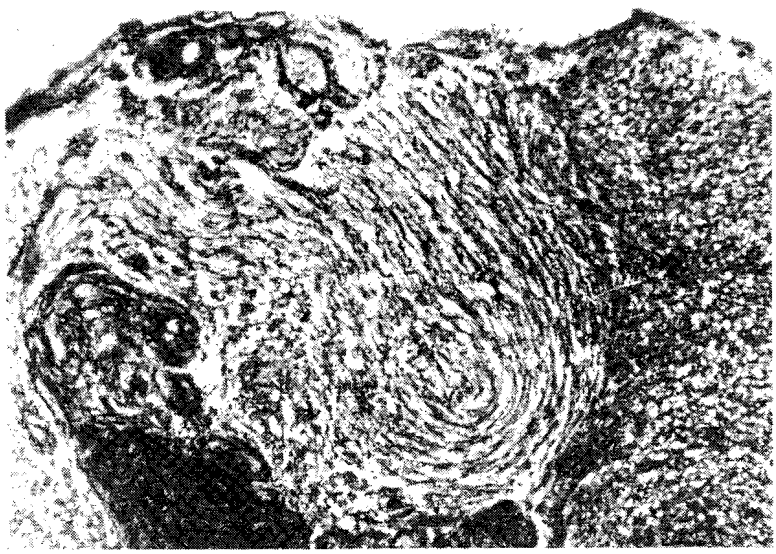

Fig. 1.– Aspect of the dorsal spinal cord region 90 minutes after an injury of 75 grm-cm. Silver carbonate technique.

Our purpose has been to study those lesions during the following 8 days of the trauma.

MATERIAL AND METHODS

We used twelve rabbits of 1500 grm weight. Previous to an anaesthesia with intraperitoneal (30 mgrm/Kgrm. weight), laminectomies were performed in the D4-D6 level up to expose the dorsal medullar face. In two rabbits, used as control, we closed the surgical lesion without any traumatic alteration. In the other rabbits, we contused the spinal cord dropping a steel bar of 25 grm. weight and 12.56 mm^2 section between 2 and 4 cms. height, depending on the case. We proved an immediate paraplegia after the trauma in all the cases, with the exception of the control animals.

After 90 minutes of the contusion 2 animals were sacrifised and four hours later the other two, the obtained pieces being destined to their study under argentic technics by means of the optic microscopy. The other 6

animals were sacrifised, some after 48 hours, others on the fourth day, and the last ones on the 8th day after the experimental injury, obtaining spinal cord fragments in diverse levels, that were fixed in 3% glutaraldehyde in buffer phosphate 0.1M, and pH 7.4; postfixed in osmic acid 1% in buffer

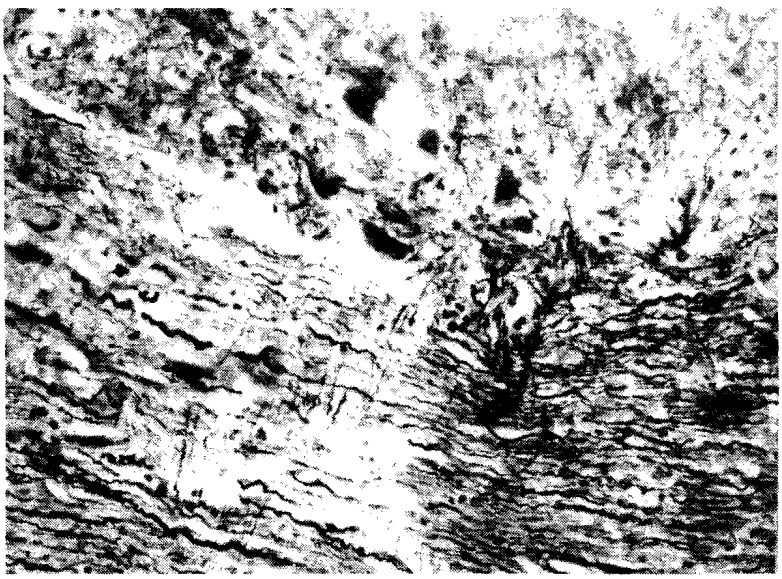

Fig. 2.– Oblique cut showing the fibers of the anterolateral cord, 4 hours after an injury of 100 grm-cm. Silver carbonate.

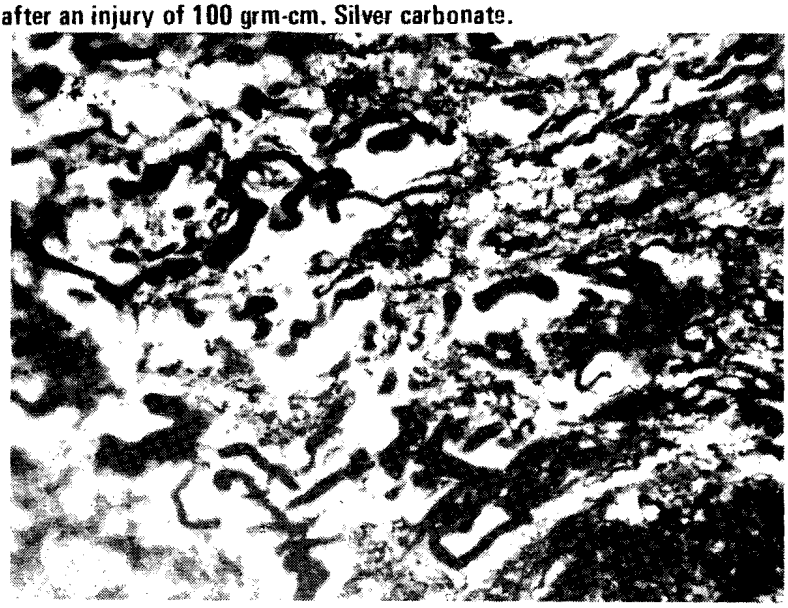

Fig. 3.– Detail of the fibers of the dorsal spinal cord, 90 minutes after an injury of 75 grm-cm. Silver carbonate.

with similar characteristics and dehydrated in acetones in increasing gradation. Afterwards they were included in Vestopal W, being cut with an ultramicrotome L.K.B. They were contrasted following the Reynolds technique (5) and examined with a Philips EM-200 electronic microscope.

Fig. 4.– Picture of walterian degeneration at lumbar level, 48 hours after an injury of 50 grm-cm on the spinal cord.

RESULTS AND DISCUSSION

We see one primary axonal degeneration in the contused zones through the silver technique in the animals that belong to the group of acute lesions. Mononucleary cells and clear spaces appear in between the nervous fibers. After 90 minutes of the lesion, the silver carbonate shows segmentary axonic enlargements that lets us think of a primary degenerative process in the anterolateral cord. The axonic degeneration is clearer 4 hours after the trauma and in the longitudinal cuts excrescences and tortuosities appear in the nervous fibers. Those images are in agreement with Wagner and cols. observations (6) about the phenomenon of the axonal degeneration primary established in the contused spinal cord zones.

The electronic microscopy lets us find the augmentation of the periaxonal space in a great number of myelinic fibers in the lateral cord, after 48 hours of a traumatism of 50 grm-cm, just like the Dohrmann and col. (2) description of the very primary periods of the traumatism. Notwithstanding, we observe zones with normal aspects of the fibers and discrete homogeneization of the myelinic structure and little irregular mass formation in relation to the axonal myelinic cover. At this time, we appreciate

wallerian degeneration images on lumbary level.

After four days of traumatism, in the peritraumatic level, we observed a very important enlargement of the lesions with a tissular oedema image, fringes formations in the myelinic capsule and their normal structure disappear. At the same time, there are a lot of irregular masses of myelinic material showing zones with greater electronic density which have granular aspect, that makes us think of the reported images by Lampert and Cressman (3) after an experimental myeletomy in the rat.

After 8 days of the traumatism there is a predomination of denuded and fragmented axons in the surrounding zones of the lesion. Then we can observe myelinic lamellaes leaving the periaxonic normal trajectory and remaining in the surrounding zones. At the same time, there is a persistent tissullary oedema which is responsible for its characteristic grills in many of the examined zones. As a consequence, we observe a progressive demyelinization in the lesioned zones the following days of the trauma, particularly between the 4th and 8th days. But the axonal degeneration appears very soon, being detectable after 90 minutes of the hit.

Undoubtedly, there must be the influence of its pathogenesis, strict mechanic phenomenon, because of the structural distortion formed in the posterior cords (Fig. 1). At the same time, there is a noxious contribution of the ischemic phenomenon improved in the zones of the lesion.

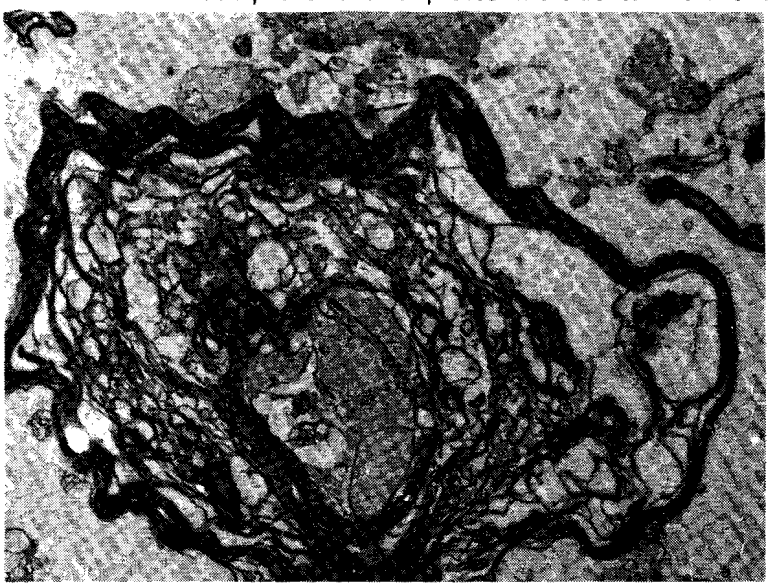

Fig. 5.– Marked alterations on the myelinated fibers, 4 days after an injury of 30 grm-cm. Important tissular oedema.

Furthermore, we consider a therapeutic action in the demyelinization process, much more than on the axonal degeneration. At the same time, we can work during the next days of the trauma because of the demyelinization phenomenon that is developed later. On the 8th day of the lesion, there is a vasogenic oedema which could be a very important thing in the separation process of the myelinic lamellaes and as a consequence, the axonal denudation.

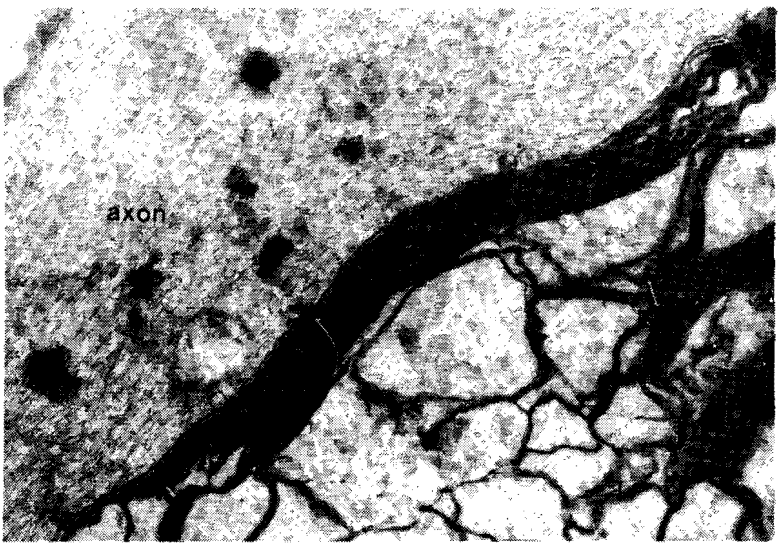

Fig. 6.– Picture of axonal denudation with unpacking of myelin lamellaes, 50 grm-cm. Eight days of evolution.

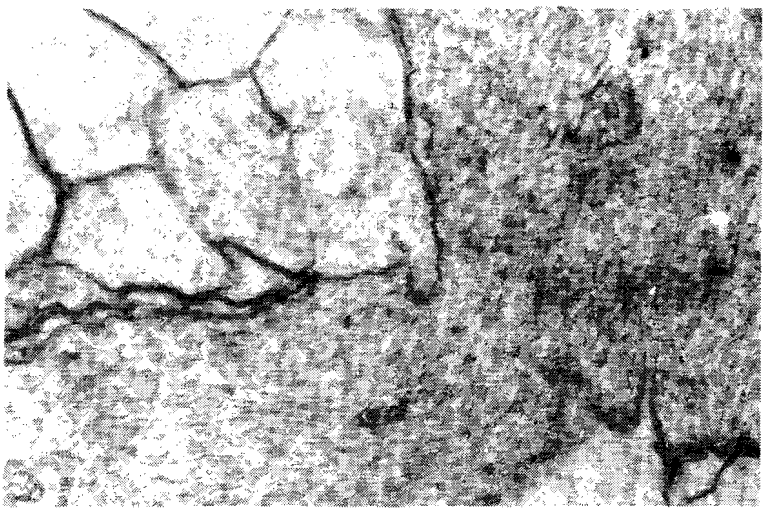

Fig. 7.– Axonal denudation with myelin lamellaes unfastened offering a railing aspect. Eight days of evolution after an injury of 50 grm-cm.

RESUMEN

Efectos traumáticos experimentales en las fibras mielínicas de la médula espinal. *Vaquero-Crespo J. (Villaamil 31, Madrid 29, España), Oya S., Ramiro M.J.* **Invest Clín.** *17(3): 115-121, 1976.*- Se describen las alteraciones histopatológicas que se suceden en las fibras nerviosas de la médula espinal contusionada, particularmente durante los 8 días que siguen al trauma experimental. El proceso de degeneración axonal puede ser detectado muy temprano en el microscopio óptico y en el electrónico. Particularmente, las imágenes de denudación axonal y demielinización aparecen entre el cuarto y el octavo día, con un importante y persistente edema tisular.

REFERENCES

1 -- ALBIN MS, WHITE RJ, LOCKE GE and col.: Localized spinal cord hypothermia; anesthetic effects and application to traumatic injury. Anesth Analg 46: 8-16, 1967.

2-- DOHRMANN GJ, WAGNER FC and BUCY PC: Transitory traumatic paraplegia: electron microscopy of early alterations in myelinated nerve fibers. J Neurosurg 36: 407-415, 1972.

3-- LAMPERT RW and CRESSMANN M: Fine structural changes of myelin sheaths after axonal degeneration in the spinal cord. Amer J Pathol 49: 1139-1155, 1966.

4-- OSTERHOLM JL, MATHEWS CJ: Altered norepinephrine metabolism following experimental spinal cord injury. Part I. Relationship to hemorragic necrosis. J Neurosurg 36: 386-394, 1972.

5-- REYNOLDS ES: The use of lead citrate at high pH as an electron microscopy. J Cell Biol 17: 208-212, 1963.

6-- WAGNER FC, Jr. DOHRMANN GJ: Alterations in nerve cells myelinated fibers in spinal cord injury. Surg Neurol 3: 125-131, 1975.