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Histological Changes of Dorsal Nerve Roots and Ganglia Induced by Spinal Fusion in Immature Rabbit Model

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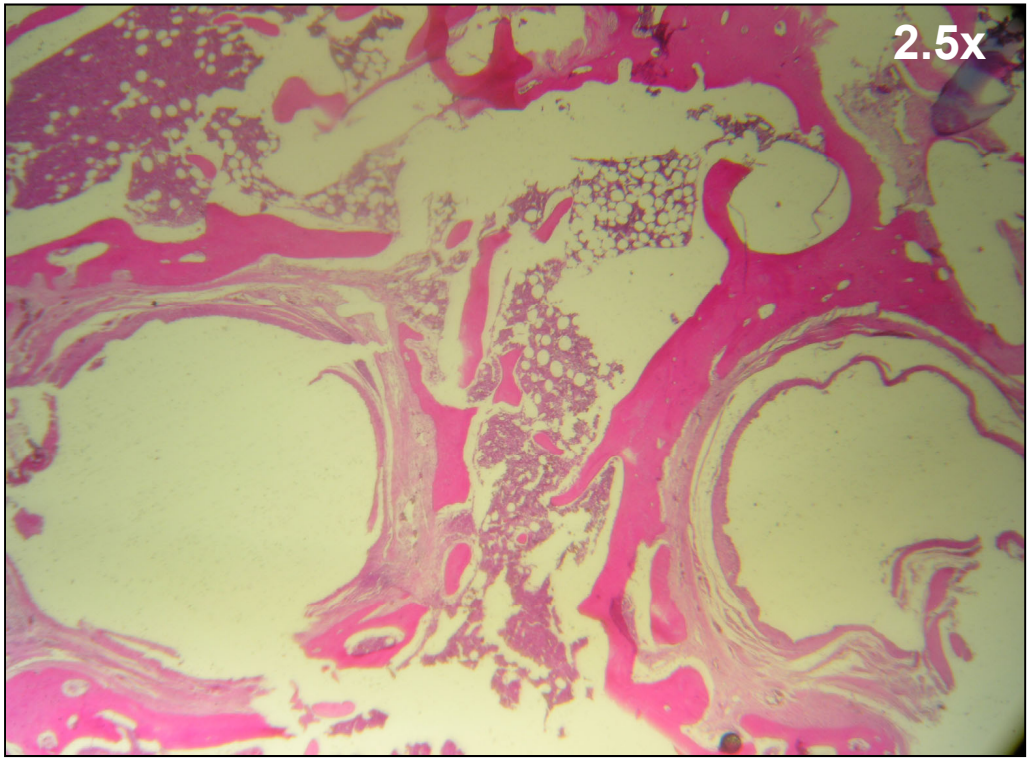
Introduction

- The structural changes of neural elements induced by dorsal arthrodesis performed in immature spines are not completely understood

- The aim of this study is to describe how an early partial dorsal arthrodesis (T1-T6) may affect the shape and structure of nerve roots and ganglia, spinal cord and intervertebral discs

Material and Methods

- 16 skeletally immature *New Zealand White rabbits*$^{(NZW)}$
  - 13 NZW : extracanal dorsal vertebral arthrodesis
  - 3 NZW : sham operation
  - At skeletal maturity (8 months) the rabbits were sacrificed
- Fusion in operated rabbits was confirmed by CT scan and Histology



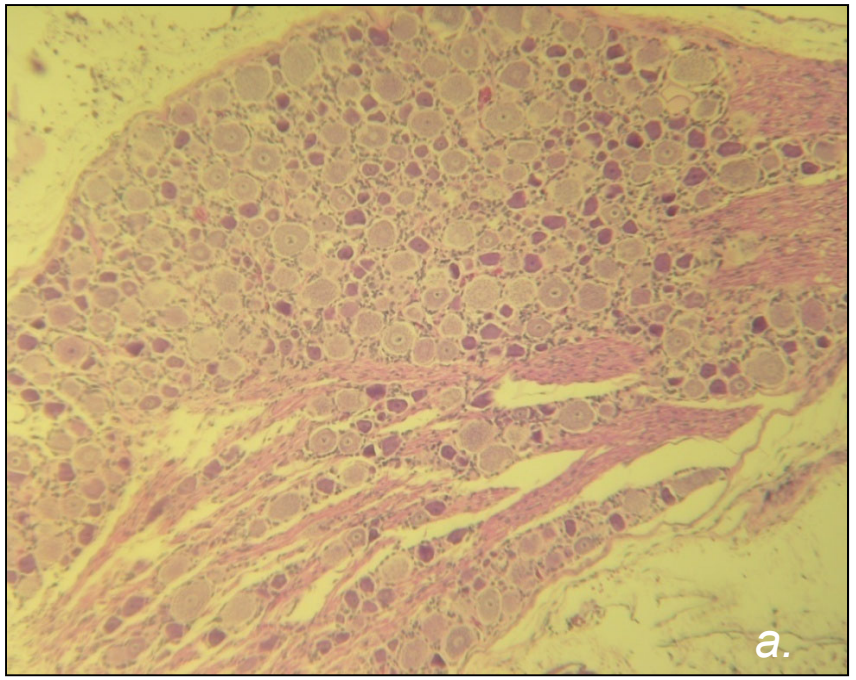
Material and Methods

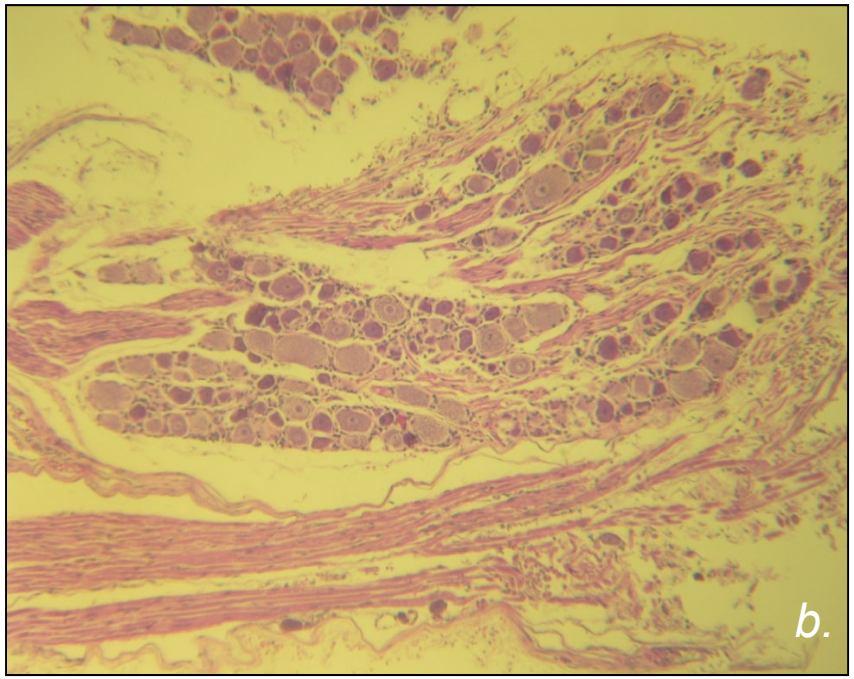
- In 12 cases, spinal cord, nerve roots and ganglia were harvested, fixed in formaldeide and prepared for histology
- In 4 cases coronal and sagittal segments of the thoracic spine were obtained, fixed in formaldeide, decalcified and prepared for histology
- 8-10 μm paraffin sections were obtained, stained with H&E and toluidine blue and analyzed

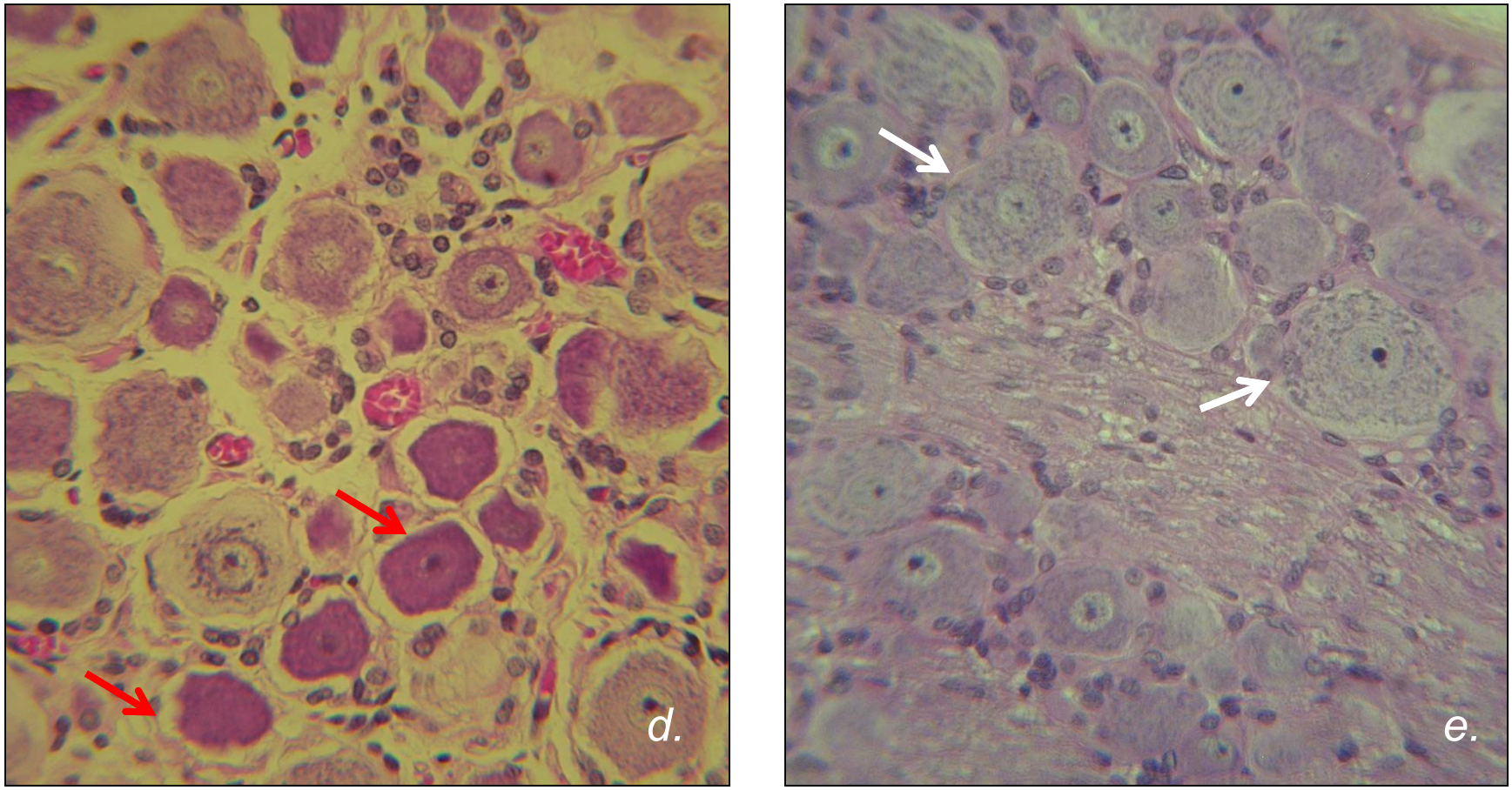
- 51 dorsal root ganglia from operated (n=42) and sham operated (n=9) rabbits were available for analysis

Results

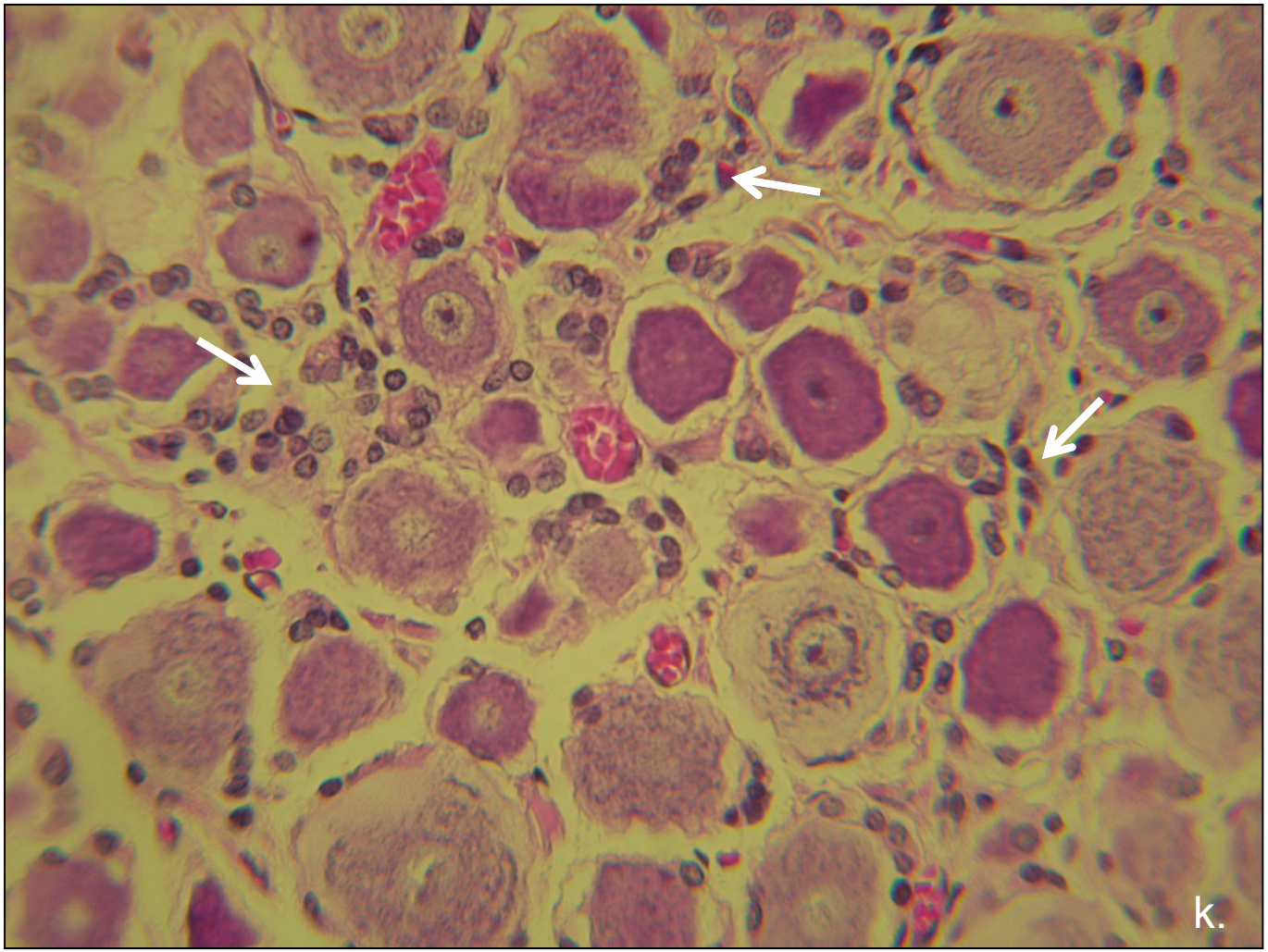
- **Dorsal root ganglia of three operated rabbits.** T1-T6 segment. Sagittal sections *[a-c]*.
- Two different populations of pseudo-unipolar neurons (*T neurons*) are identified:
  - Homogeneous coloration, regular shape
  - Hypercromic, condensed, irregular shape
- H & E stains; L.M., low magnification (10x)



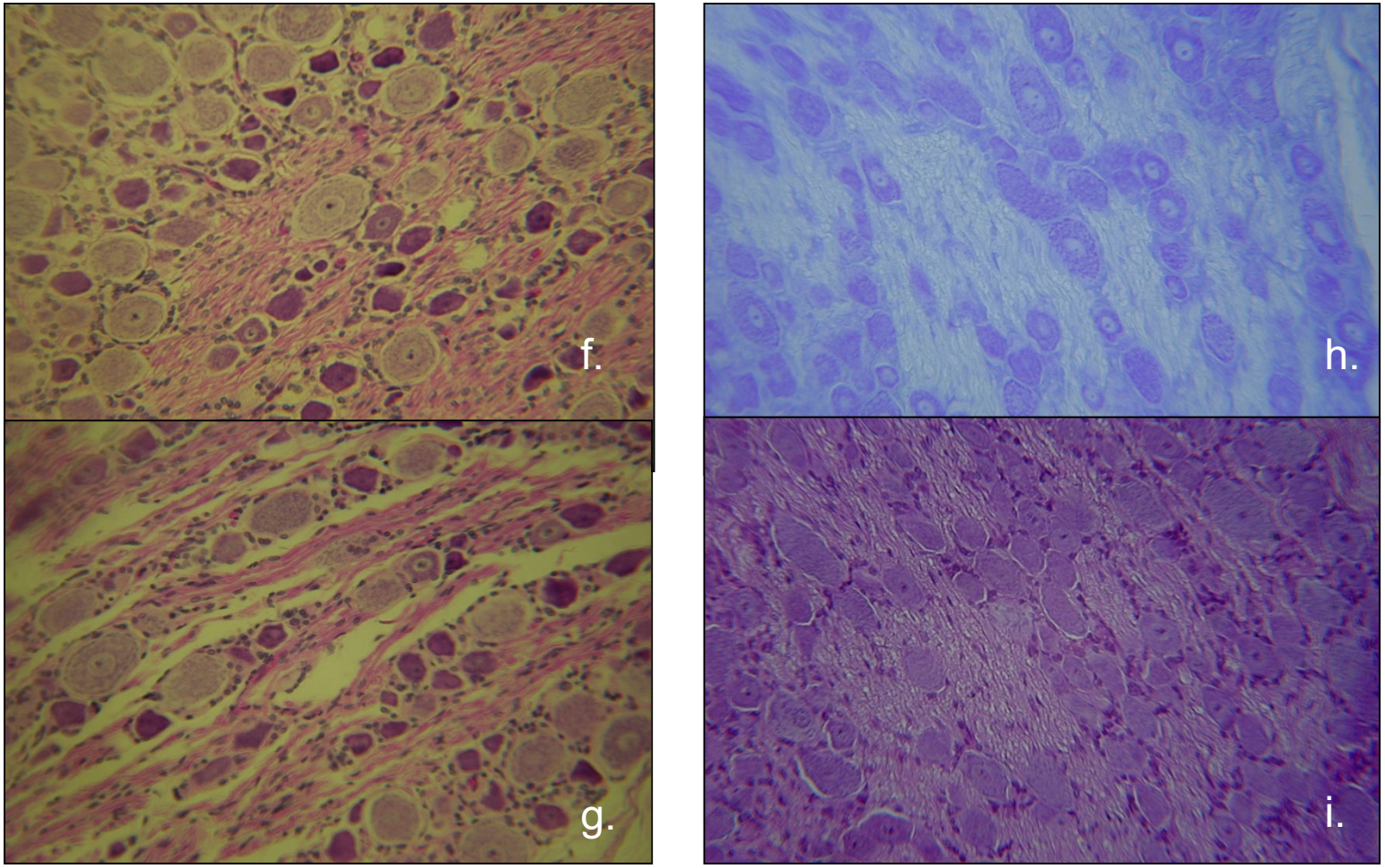




- **Comparison of dorsal root ganglia** of operated rabbit *[d]* with sham control *[e].* Sagittal section. T1-T6 segment.
- Abnormal neurons with irregular contour, acidofilic cytoplasm, Nissl granules and picnotic nucleus poorly identifiable (*red arrow*).
- Normal neurons with circular and regular contour, clear nucleus and round, ipercromic nucleulus. Nissl granules with typical “dust-like” appearance (*white arrow*)
- H & E stains; L.M. intermediate magnification (25x)



- **Dorsal root ganglia of operated rabbit.**T1-T6 segment. Sagittal sections *[k]*.
- *Satellitosis* around abnormal neurons (*white arrow*)
- H & E stains; L.M., intermediate magnification (25x)



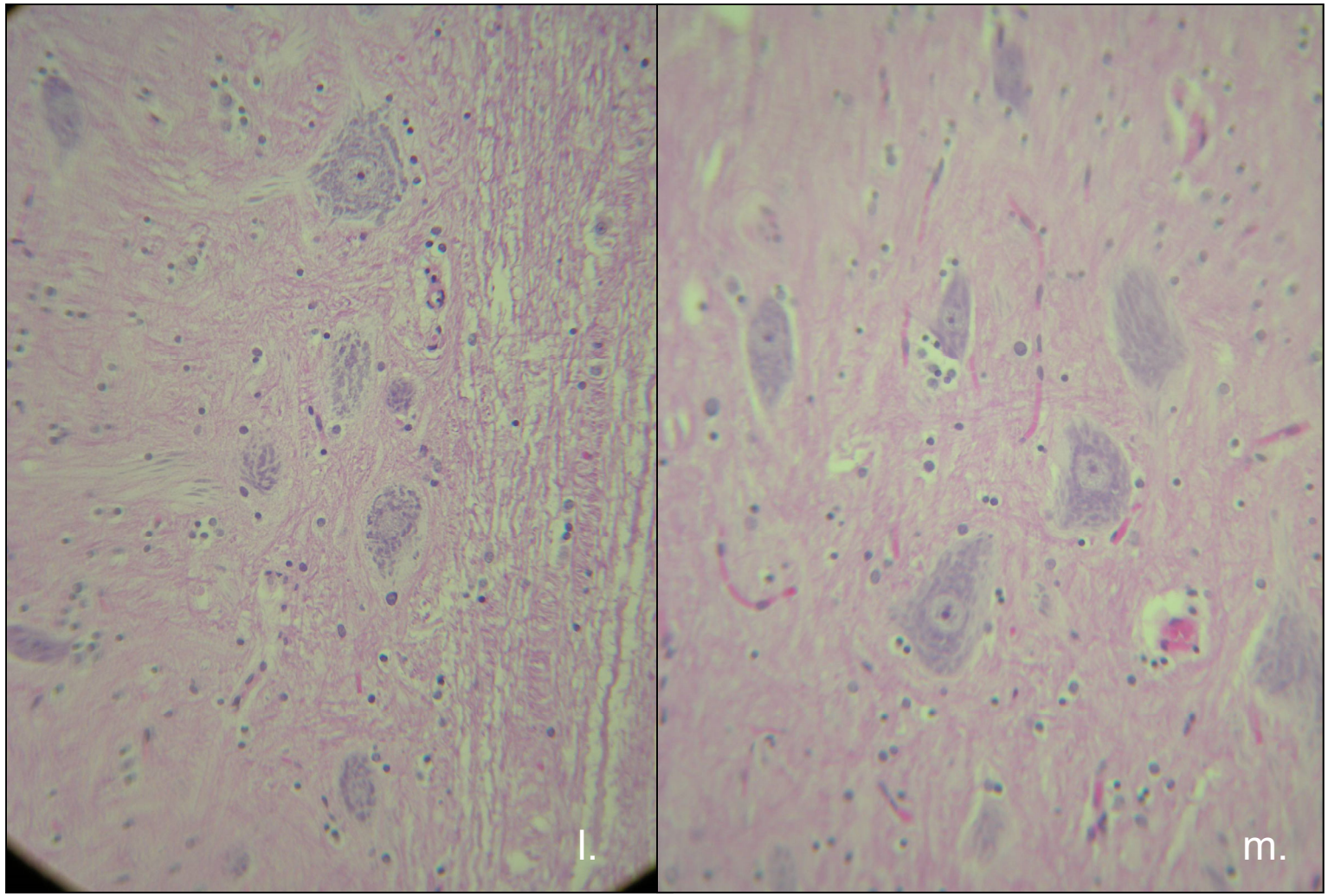
- **Comparison of dorsal root ganglia** of operated rabbit *[f,g]* with sham control *[h,i].* Sagittal section. T1-T6 segment.
- H & E *[f-i]* and Toluidine bleu *[h]* stains; L.M., low magnification (10x)

Percentages of Normal/Abnormal neurons in dorsal root ganglia[º] of operated and sham-control rabbits

[°N=51]

Operated Rabbits (T1-T6)		Sham-control (T1-T6)	
Normal Neurons	Abnormal Neurons	Normal Neurons	Abnormal Neurons
56.8% (50-66.7)	***43.2% (33.3-50)***	**96.5% (93.2-100)**	***3.5% (0-6.8)***
Operated Rabbits (T7-T12)		**Sham-control (T7-T12)**	
Normal Neurons	Abnormal Neurons	Normal Neurons	Abnormal Neurons
57.6% (43.5-56.4)	***42.4% (43.6-56.5)***	**98.5% (94.3-100)**	***1.5% (0-5.7)***

$p<0.05$



- **Comparison of spinal motor neurons** (ventral horns, gray substance) of operated rabbit *[l]* with sham control *[m].* Sagittal section. T1-T6 segment.
- *No evident atypical features in both pictures [l,m]. Nissl granules* ++
- H & E *[l,m]* stains; L.M., intermediate magnification (25x)

Discussion

- Two populations of neurons were identified in the root ganglia of arthrodesed rabbits: one normal and one with pathological changes
- The alterations resembled those that follows axonal resection and were found only in operated rabbits

Discussion

- Early thoracic spinal arthrodesis negatively affects as thoracic growth seems to have a negative effect on nerve roots and dorsal spinal ganglia as well
- The progressive pathological changes of the satellite cell sheaths and the “neuronal disorganization” may be influencing factors to reduced chest growth and thoracic dystrophy