European Cells and Materials Vol. 16. Suppl. 2, 2008 (page 25) ISSN 1473-2262

Morphological changes of intervertebral disc cells in the porcine and human injured cervical spine following trauma.

I. Sitte[1], A. Kathrein[1], K. Pfaller[2], F. Pedross[3], S. Roberts[4].

[1]*Department of Traumatology and Sports medicine,* [2]*Division of Histology and Embryology,* [3]*Department for Medical Statistics, Informatics und Health Economics, Med. Univ. of Innsbruck, Austria;* [4]*Centre for Spinal Studies, RJAH Orthopaedic Hospital, Oswestry, Shropshire and ISTM, Keele University, UK*

INTRODUCTION: The intervertebral discs are vital to the functioning of the spine in terms of its movement, load bearing and protection of the spinal cord. However, little is known about what influences the vitality and causes death of disc cells, or by what mechanism they may die. Trauma has been demonstrated to lead to apoptosis (so called programmed cell death) in articular cartilage and human thoracolumbar intervertebral discs.[1, 2] We have studied in detail the cell viability and manner of cell death in human cervical discs from patients who have undergone traumatic injuries to the spine with subsequent surgical stabilization.

METHODS: The anterior portion of intervertebral discs (annulus fibrosus (AF) and nucleus pulposus (NP)) and endplates from 44 patients with traumatic injuries to the cervical spine. They were examined histologically, using trypan blue exclusion and TUNEL staining, to assess cell viability and apoptosis, respectively. In addition, electron microscopy was used to study the ultrastructural morphology of the disc cells. Fractures were classified according to Magerl et al[3], depending whether they were mainly compressive, flexion or rotation injuries. Similar studies of disc and endplate were undertaken on porcine cervical spines, 0-24 hours post mortem.

RESULTS: Electron and light microscopy showed that up to 75% of human disc cells die within the first 24 hours of trauma, mainly by necrosis. Similar results were seen in pig discs post mortem. Two morphologies, previously not reported in the disc, were also seen, particularly in human discs with compressive fractures (A-, B1+2-fractures). These were: (i) chondroptosis, where cells have patchy, condensed chromatin and vacuoles but no true apoptotic bodies and (ii) 'ballooned cells', with poorly visualized, homogenous chromatin, in large cells often containing much glycogen (Fig.1a+b).

Fig.1a Chondroptotic cell (iAF) A3.3. Fracture

Fig.1b Balloon cell (iAF) A3.3. Fracture

Porcine samples revealed comparable rates of apoptosis and chondroptosis as fractures with less compression, but no ballooned cells.

DISCUSSION & CONCLUSION: Traumatic injuries of the human cervical spine lead to rapid changes in disc cell morphology and cell death, particularly via necrosis. The type of fracture and load appears to influence the type of cell death. This study describes for the first time an alternative form of cell death in discs, chondroptosis, in addition to a novel morphology for disc cells, 'balloon cells'. Balloon cells have been described previously in articular cartilage.[4] Interestingly tumour cells, such as in multiple myeloma, present a similar homogeneous nucleus and are known to be very active with a high rate of RNA synthesis, mitosis and enhanced protein synthesis. Whether balloon cells in the disc would be as active as such tumour cells, must be considered and investigated. Similarly, how altered disc cell morphology might influence the survival or degeneration of the disc and whether disc cells and disc matrix will partially recover following trauma remains to be investigated.

REFERENCES: [1]Tew SR, Kwan APL, Hahn A, Thomson BM, Archer CW. (2000) Arthritis& Rheumatism 43(1):215-25.

[2]Heyde C-E, Tschoeke S, Hellmuth M et al. (2006) BMC Clinical Pathology 6: 5-14.

[3] Magerl F, Aebi M, Gertzbein SD et al. (1994) Eur Spine J 3:184-201.

[4]Ghadially FN. (1997) Ultrastructural Pathology of Cell and Matrix. Butterworth-Heinemann.

ACKNOWLEDGEMENTS: Supported by ÖNB (Projectnumbers: ÖNB 8590; ÖNB 10032; Ethics commission: UN 1052; UN 1653)