

Symposium sponsored by The Anatomical Society of Great Britain and Ireland

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'Intervertebral disc pain, degeneration and regeneration.'

Centre for Comparative and Clinical Anatomy, University of Bristol, 6th October 2010

Background

The symposium brought together academics from various disciplines to discuss intervertebral disc research. Its purpose was to focus attention on discogenic back pain, which provides a major motivation for disc research. If some consensus could be reached on important issues, it would assist British research efforts in this relatively underfunded area. The Symposium also marked the re-organisation of the previous Department of Anatomy at the University of Bristol. Research in the newly-formed Centre for Comparative and Clinical Anatomy will be more focused in the areas of musculoskeletal science, and neuroendocrinology.

An informal discussion format was adopted. Invited participants are listed below.

Summary of discussions

Discussions were vigorous, but no clear consensus could be reached on many important topics, highlighting the need for further research. It was apparent that much less is known about intervertebral discs than about articular cartilage, for example, even though back pain is just as great a medical and socio-economic problem as osteoarthritis. There was general support for the following summary statements, which are grouped under the headings used to structure the discussions.

Back pain and intervertebral discs

- Most back pain of short duration probably originates in muscles and tendons rather than discs.
- Disability may be a more important clinical outcome than pain for many patients.
- Pain provocation studies indicate that discs and apophyseal joints are the major sources of chronic back pain; however it is difficult to diagnose discogenic pain with certainty.
- There are strong epidemiological *associations* between chronic back pain and disc degeneration, as visualised by MRI. Nevertheless, many degenerated discs are not painful.
- Innervation capable of nociception is probably confined to the outer few mm of the annulus, and close to the endplates. Nerves in the nucleus are rare, even in “painful” discs removed at surgery; however locating nerves in disc tissues is technically difficult, and many may be overlooked.

Characteristics of painful discs

- Common gross features of painful discs are: radial fissures in the annulus, loss of annulus height, inwards collapse of the annulus, disc prolapse, defects in the endplate, and inflammatory-like (“Modic”) changes in the adjacent vertebral body. None of these features can be used to define a painful disc, and some can be difficult to detect.
- Loss of disc signal on MRI is not strongly associated with pain, but may precede disc narrowing.
- Disc degeneration and pain are most often associated with L4-5 and L5-S1 discs.
- Back pain is most common in middle age, even though disc degeneration increases into old age. Evidently, pain does not increase simply as degeneration progresses.
- There are no means of predicting which discs will become painful in the future.
- Disc tissues become more prone to injury in middle age because a) collagen changes make them more vulnerable to impact loading, and b) GAG/water loss allows stress concentrations to develop within them. Reduced mechanical loading in old age may reduce injury risk.

- There is a strong genetic influence in disc degeneration, probably due to 100's of genes.

Pain sensitisation and inflammation

- Pain-provocation experiments on patients with back pain confirm that disc tissues can become acutely sensitive to mechanical stimulation.
- Inflammatory cytokines are produced by nucleus and annulus cells in degenerated discs; animal experiments suggest that these can sensitise nerves and nerve roots, causing back pain and sciatica.
- Inflammatory changes can involve blood-derived cells, especially if the disc is prolapsed.

Disc injury and healing

- Disc degeneration is more common in those who undertake heavy manual labour or sports, although these environmental influences are weaker than genetic influences.
- Disc inflammation and catabolic factors can be induced by tissue injury. Disc trauma is probably rare, but fatigue failure is hard to detect and may be common, especially in those with weak tissues.
- Typical annulus fissures, and disc prolapse, can be caused by excessive or repetitive mechanical loading in cadaveric spines. Prior cell-mediated degenerative changes are not essential.
- Outer annulus tissue (only) can heal in (young) animal experiments, by means of granulation tissue and scar, but the healing potential of human discs is largely unknown.
- Analogies with tendon healing suggest how annulus healing might be promoted in human patients, although there is no direct supporting evidence.

Treating discogenic pain and restoring function to disc and spine

- Two treatments introduced in 2010 hold promise for the future: a polyurethane artificial disc with variable materials properties and no moving parts; and the injection of methylene blue to deactivate nerves within the disc space. However, early results require confirmation, and explanation.
- Severe disc degeneration disturbs spinal mechanics, and probably contributes to apophyseal joint osteoarthritis and vertebral wedge fractures. Disc prostheses must therefore restore normal spine mechanics, as well as replace or repair the painful disc tissue.
- Tissue engineering techniques such as a “cell bandage” may not work in the hostile environment of a severely degenerated disc, and they may be too invasive to treat mild disc degeneration.

Future research priorities regarding discogenic back pain

- Improve clinical methods to identify a painful intervertebral disc.
- Characterise innervation (and nerve density) throughout normal and painful human discs.
- Investigate if the in-growth of nerves and blood vessels precedes or follows the development of annulus fissures, endplate defects, focal loss of proteoglycans, and reduced mechanical pressure.
- Identify which disc cells initiate inflammatory responses, and why.
- Characterise the role of injury and fatigue (“wear and tear”) damage in disc inflammation.
- Explore methods to boost disc cell metabolism in-situ in order to slow the degeneration process.
- Fundamental problems concerning tissue engineering solutions suggest that tissue engineering should not dominate resource allocation for disc research.

Participants

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Apologies

Professor Tony Freemont and Professor Judith Hoyland (Manchester), Professor Vic Duance (Cardiff), Professor Anthony Hollander and Dr John Tarlton (Bristol).