

Factors affecting physiology of intraosseous pressure measurement

OARSI ABSTRACT

HOLLAND

2016

Purpose

Intraosseous pressure (IOP) has been studied for 50 or more years and is of interest in diseases such as osteoarthritis and osteonecrosis and in bone pain. IOP in cancellous bone has usually been thought to have a static value due to venous back pressure or tissue turgor. We measured IOP in patients before surgery but the results varied. We therefore set out to assess factors which might influence the physiology of IOP at rest in healthy subchondral cancellous bone in a standardized animal model.

Method

With ethical approval IOP was studied in 21 anaesthetised rabbits. Intraosseous pressure was measured through needles inserted directly into the subchondral bone of the femoral head, femoral condyle or upper tibia. Pressure was also measured in the left femoral artery in 5 animals. A heparinized saline filled line was connected from the intraosseous needle to pressure transducers (Bell and Howell or Druck PDCR75) and to a four channel chart recorder (Lectromed MX4P- 31). The transducers were calibrated on a 0-60 mmHg scale. Needle clearance was occasionally required using a 0.5ml saline bolus.

Results

Basal intraosseous pressure (IOP) was measured in 21 individuals at 51 sites and varied considerably between different subjects and also at different sites in the same subject. The average IOP (n=51) was 23.8mmHg (SD 13.6mmHg) with a pulse pressure (PP) of 4.0mmHg (SD 4.2mmHg).

Gender (female n=14, male n=7) had no effect on IOP (t test=0.58). Weight (2,920g – 5,560g) had no effect on IOP (Pearson correlation p=0.248). Needle size (23G n=33 or 21G n=18) had no effect on IOP (t test=0.141). Needle site (femoral head n=6, femoral condyle n=7, upper tibia n=32) had no influence on IOP (analysis of variance p=0.188).

The majority of recordings showed a pulsatile wave form. At a recording speed of 12.5mm/sec the wave was seen to be synchronous with the arterial pulse.

At a 1/60th slower recording speed of 12.5mm/min the arterial pulse was obliterated but an underlying wave synchronous with respiration was seen.

After bolus drug administration a third or 'circulation time wave' was seen. This wave lasted some 90 seconds and could be followed for one or two passes.

After a saline clearance bolus injection the IOP and PP fell. Recovery took up to 15 minutes. After aspiration to clear the needle recovery was within 30 seconds.

There was a correlation between the IOP and the mean blood pressure (Pearson p<0.001)

There was a close correlation between IOP and its associated pulse pressure ($p < 0.0001$).

Conclusions

These results show that IOP is not a static venous back pressure but is closely related to the arterial supply circulation. The variability in IOP is a manifestation of the size of vessel encountered by the needle tip or pool in the microcirculation in which the pressure is being measured. A single IOP measurement in isolation is meaningless. The physiology of the subchondral microcirculation may be important in understanding blood supply to the cartilage in health and in osteoarthritis.