A review of mechanical nociceptive threshold data in eight mammalian species

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Background

Mechanical nociceptive threshold testing (MNT) is widely used in studies of clinical and experimental pain in a range of species. An enormous variety of probe styles and tip diameters have been used, making it very difficult to compare data between studies. Nociceptive thresholds are also reported in numerous units of pressure and force, making interpretation and comparison even more difficult.

This investigation aimed to review data from published literature in order (1) to establish normal mechanical thresholds in a number of different species and (2) to examine the effects of different probe styles, sizes and their application. This should enable guidance to be established on the best methodology for MNT.

Hand held testing in the horse

Fixed actuator on dog limb for mechanical threshold testing

Testing for wound sensitivity after ovarohysterectomy in a cat

Methods

Published peer reviewed papers reporting MNT in normal subjects were reviewed. Data were taken from human, basic science and veterinary publications. Data from approximately 100 reports were examined and 70 reports containing sufficient information for analysis were included. Papers omitting probe dimensions or those reporting only changes from normal baselines could not be used.

The following data were derived: MNT (force N), probe tip area and rate of application of the stimulus, (Ns^{-1}). MNT was plotted against tip area and their relationship examined. The relationship between MNT, tip area and rate of application was also examined.

Human pain thresholds measured with a fixed actuator

The MouseMet electronic von Frey system

von Frey filaments are often used to measure mechanical thresholds in rats and mice as well as for identification of allodynia in larger species

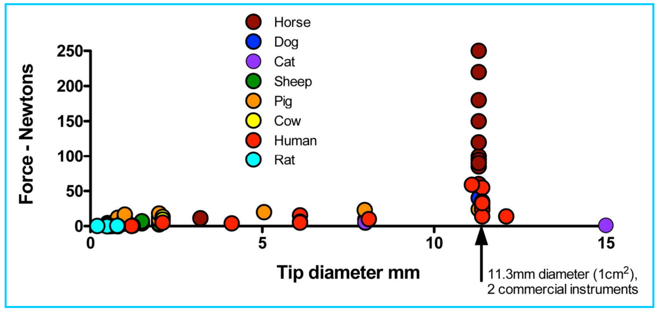
Data were collected from reports of hand-held algometers and for actuators attached to the animal. Hand held equipment included traditional force transducers, pneumatic actuators, von Frey filaments and electronic von Frey systems. Commercially available equipment as well as purpose-built was considered. Tip diameter ranged from 0.2 to 15 mm diameter, and the majority were round, with either flat or semi hemispherical tips. Rate of force application ranged from 0.08 - $5Ns^{-1}$, except for one commercial algometer (Wagner Instruments, tip diameter 11.3mm) which was $50\text{-}100Ns^{-1}$.

Results

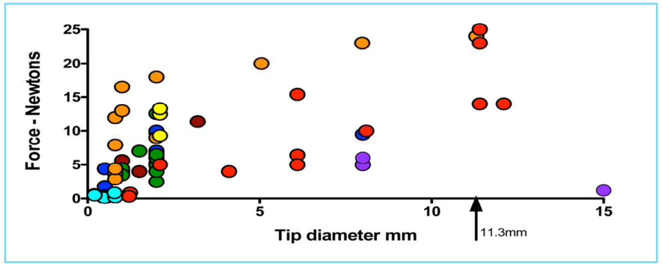
MNT in 8 species (measurement of force)

Species	Tip diameter (TD) mm	Threshold (MNT) N
Horse	1 - 11.3	4 - 250
Dog	0.5 - 8	1.8 - 10
Cat	1 - 15	1.2 - 5.5
Sheep	1 - 2	2.5 - 12.6
Pig	0.8 - 11.3	3.7 - 24
Cow	2	9.3 - 12.5
Human	0.4 - 11.3	0.3 - 59
Rat	0.5	0.1 - 0.3

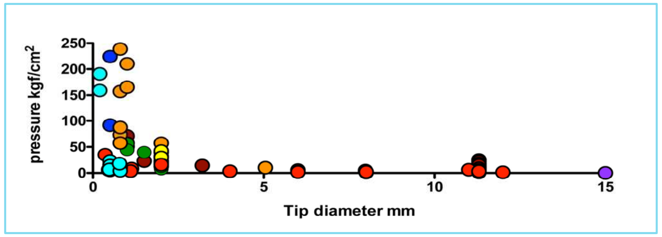
Relationship between MNT and tip diameter, showing that 11.3mm tips have produced a large data range.



MNT versus tip diameter, expanded force axis to remove high force values from 11.3mm tip, showing that MNT generally increases with tip diameter.



Tip pressure, calculated as MNT/Area, showing that theoretical pressure is very high at small tip diameters.



Conclusions

MNT increases with tip diameter and large tip diameters appear to produce a huge data range. We question whether forces above 30N can be applied manually in a consistent and progressive manner and whether they elicit MNT or simply displace the limb or animal. We surmise that high force application rates ($50\text{-}100Ns^{-1}$) are sometimes used because of the physical difficulties of applying these high forces manually.

Small tip diameters produce high theoretical tissue pressures. We suggest that local tissue distortion spreads the force over a greater area than that calculated from the tip diameter.