Quantification of the pressures generated during insertion of an epidural needle in labouring women of varying body mass indices

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Background

Epidurals can result in serious complications. Incidence of permanent harm from obstetric epidurals range from 0.2 in 100,000 to 1.24 in 100,000 and include spinal infections and direct nerve injury. [1] The primary aim of this study is to quantify pressures generated during epidural needle insertion in parturients of increasing body mass indices (BMI). We believe this to be a necessary step in creating a novel epidural simulator because feedback from current simulators highlights the unrealistic sensation of needle advancement [2]. A secondary aim is to incorporate the measured epidural pressures, MRI and US scans into a high fidelity epidural simulator for training and assessment.

Methods

Pressure measurement using a 16G Tuohy needle (Smiths Medical plc) by two anaesthetists with more than 250 successful epidurals experience required use of a three-way tap, a pressure transducer (Kimal plc) and a custom designed wireless transmitter and receiver, which allowed remote recording of epidural pressures. [3] Following full informed consent, the clinical trial involved measurement of epidural pressures in 4 groups of labouring women (5 per group) with BMIs between <25 to >45. Inclusion criteria included women of ASA 1 or 2 aged 18-40 years, nulliparous or multiparous in early labour with singleton pregnancies. Exclusion criteria included contraindications to epidural anaesthesia, known spinal abnormalities, previous back surgery, history of connective tissue disorder, women who needed their epidural re-siting or had more than

three attempts and where full informed consent could not be obtained. Ultrasound images of the lumbar region were undertaken before the pressure measurements and MRI images of the lumbar region were done within 72hrs post-delivery.

Results

The mean epidural pressures of labouring women decreases with increasing BMIs (Table 1 and Fig. 1) and characteristic epidural traces using the intermittent, mixed and constant pressure techniques are shown in Fig. 2. Analysis of the MRI intensity of the ligamentum flavum revealed that with increasing BMIs, the MRI intensity decreases (Table 2 and Fig. 3).

BMI Group	Highest mean pressure (mmHg)	Lowest mean pressure (mmHg)	Mean (mmHg)	Standard deviation
18.5 – 24.9	530	385	461	46.94
25 – 34.9	520	320	430	79.68
35 – 44.9	510	285	415	101.19
>45	450	280	376	71.33

Table 1. Epidural pressures measured in the four BMI groups

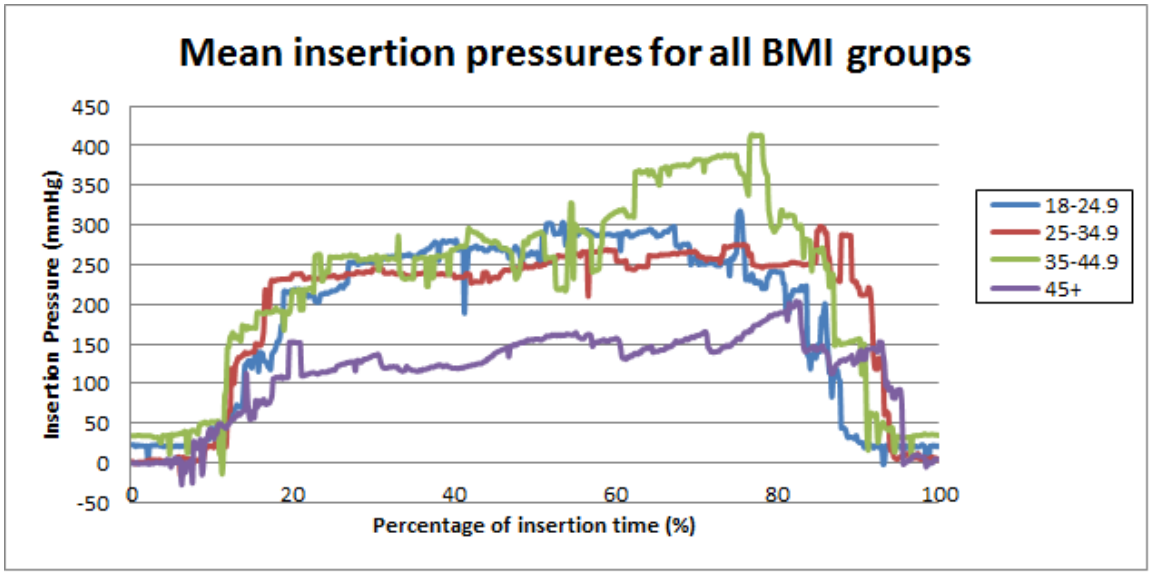

Fig.1. Graphs of mean insertion pressures over time during the epidural procedure

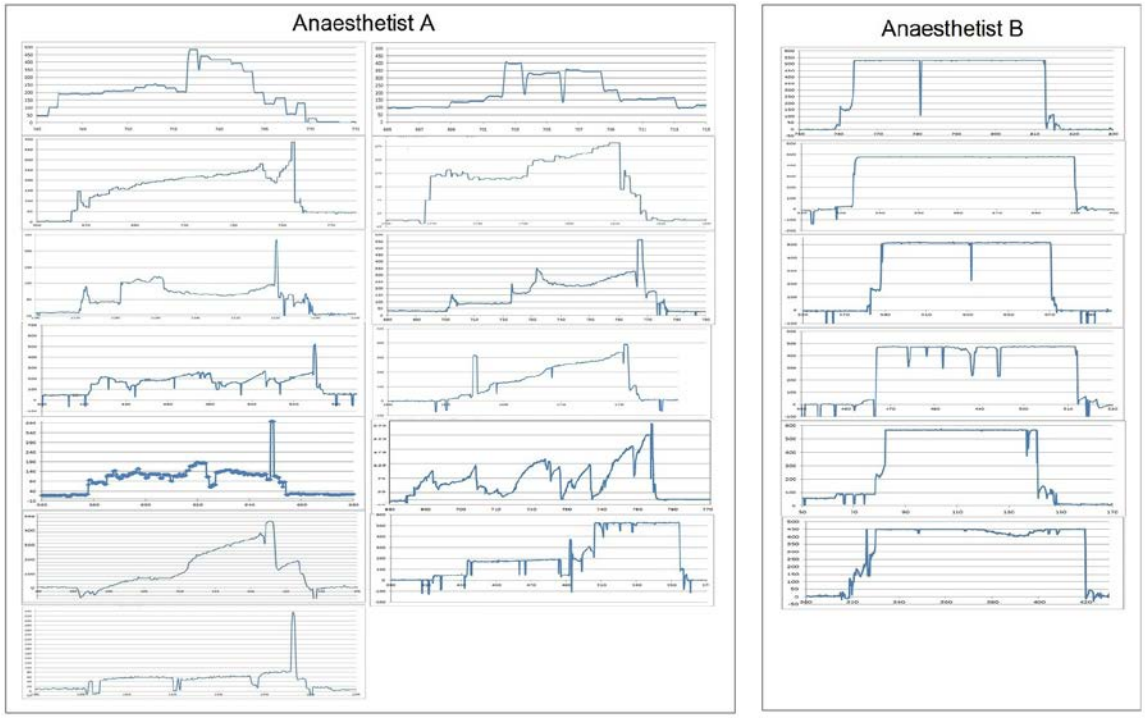

Fig. 2. Epidural pressure traces of the two trial anaesthetists showing two different techniques of epidural insertion.

BMI Category	Study ID	Epidural interspace	Pixel Count	Min Intensity	Max Intensity	Mean	Standard Deviation
18.5 – 24.9	13	L3/4	20	1.58	185.17	51.91	48.22
"	16	L3/4	17	7.98	218.56	71.04	56.36
"	21	L3/4	25	14.64	197.64	81.75	52.14
"	32	L2/3	16	13.8	299.1	79.18	73.46
"	40	L2/3	22	0	109.41	28.71	28.27
25 – 34.9	14	L2/3	11	19.12	245.67	73.29	69.99
"	17	L3/4	24	41.41	152.9	91.11	26.27
"	19	L2/3	18	18.79	148.88	71.55	38.48
"	29	L3/4	29	3.54	214.28	62.53	49.11
"	34	L3/4	23	40.69	200.46	114.48	41.07
35 – 44.9	12	L3/4	15	0	196.66	59.78	50.18
"	15	L3/4	26	42.66	194.77	103.73	37.14
"	24	L3/4	43	0	154.28	47.76	39.47
"	33	L3/4	24	7.31	222.3	105.67	53.36
>45	46	L3/4	25	16.46	126.75	49.32	25.83

Table 2. MRI intensity of ligamentum flavum versus BMI category

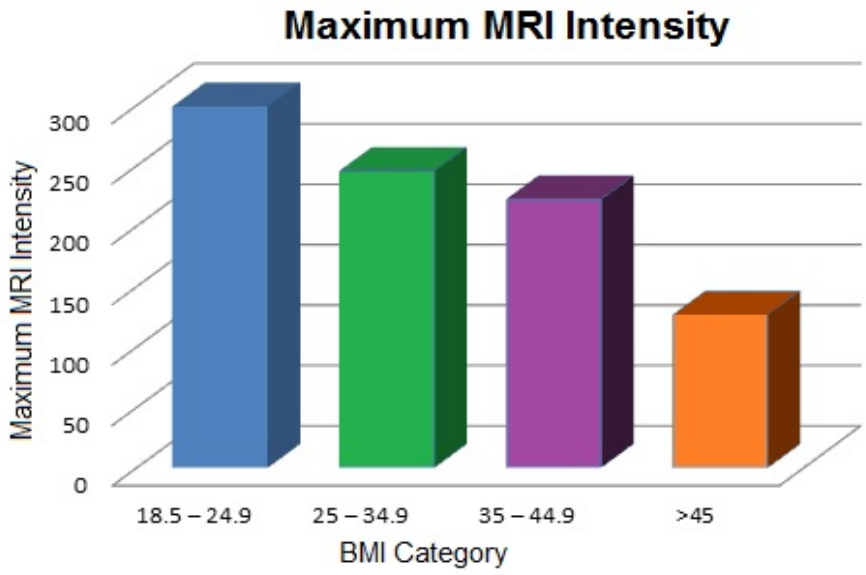

Fig. 3. Maximum MRI intensity versus BMI category

Discussion and conclusions

There was a trend of reduced epidural pressure with increasing BMI and MRI intensity of the ligamentum flavum decreased with higher BMI parturients. This is probably due to increased adiposity of tissues. Epidural pressure tracings by different operators demonstrated individual properties dependent on technique and could be used to hone skills in a high fidelity simulator, which should be created and tested from the information derived from this study.

References

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2. Vaughan N, Dubey VN, Wee MYK, Isaacs R. A review of epidural simulators: where are we today? Medical Engineering and Physics Journal; 2013a, **35**(9), 1235-50.
3. Vaughan N, Dubey V, Wee MYK, Isaacs R. Towards a realistic in vitro experience of epidural Tuohy needle insertion. Proc IMech E Part H: J Engineering in Medicine 2013; 227(7), 767-777.