ACOUSTIC EMISSION DETECTION ON SKIN SURFACE INFLUENCED BY VARIATIONS IN SOFT TISSUE THICKNESS AND SENSOR POSITION

Jin Luo
University of Roehampton, London, United Kingdom

Introduction

Acoustic emission (AE) can be used to monitor the mechanical properties of biological tissue such as bone [Kohn, 1995]. For example, it can potentially be used as a simple and non-invasive clinical tool for the diagnosis of osteoporosis of the spine [Lentle et al., 2000]. However, the transmission of AE signal to the skin surface could be influenced by individual variations in the quantity and quality of intervening soft tissue and also by the location of the AE sensor which is often chosen without the knowledge of the exact location of AE source. These variations in AE transmission could affect the results and influence the accuracy of diagnosis. The aim of this study was to investigate how variations in individual's soft tissue and sensor position influence the AE signal detected on skin surface.

Methods

Three porcine loins (spinal level L1 to L4) were obtained from local butcher for this study. One AE sensor (R15UG, Mistras, UK) used as an AE pulse generator was attached to the soft tissue adjacent to the vertebral body (L2), while another AE sensor (R15UG, Mistras, UK) as receiving transducer was attached to the skin surface on two different positions: position 1 - the AE sensor was at the same spinal level as the pulse generator; position 2 - the AE sensor was at one spinal level down from the pulse generator. The distance between the two sensors in position 1 was measured as soft tissue thickness. To establish the no soft tissue reference AE signals were first measured for five times with the pulse generator and the receiving transducer in direct contact. AE signal was then measured in each of the two positions for five times. The raw data were analyzed to obtain the following parameters: peak amplitude, total energy, and AE counts. All parameters were normalized to the average of the no soft tissue reference values. Repeated-measure ANOVA was used to compare measurements between two different locations (within-subject factor) and among three specimens (between-subjects factor).

Results

The thickness of soft tissue was 84 mm, 90 mm, and 97 mm in specimen 1, 2, and 3, respectively. There were significant differences in amplitude and energy between the two positions and among the three specimens ($P<0.05$) (Table 1). Amplitude and energy were significantly higher in position one than in position two ($P<0.05$). However, there was no significant difference in counts between the two positions and among the three specimens ($P>0.05$).

	Amplitude		Energy		Counts	
Position	**1**	**2**	**1**	**2**	**1**	**2**
Specimen 1	48.1	19.3	27.3	13.1	55.8	53.7
Specimen 2	20.8	8.6	16.6	6.8	54.4	48.1
Specimen 3	12.5	7.5	9.4	7.8	47.3	50.8

Table 1: Mean values of normalised AE parameters

Discussion

Previous studies found that AE parameters (amplitude, energy, and counts) decreased exponentially with the increase of soft tissue thickness [Wright et al., 1983]. However, the attenuation coefficient was higher for amplitude and energy than for counts, meaning that amplitude and energy are more sensitive to variations in transmission distance than counts. This can explain our results that different soft tissue thickness and sensor positions could induce significant change in AE amplitude and energy, but not in AE counts. Our results suggest that AE counts could be a more reliable AE parameter than AE amplitude and energy to monitor AE from bone structures on the skin surface.

References

Kohn DH, Crit Rev Biomed Eng, 23:221-306, 1995.
Lentel BC. *et al*, Patent no 6,024,711, 2000.
Wright TM. *et al*, J Biomech Eng, 105:20-23, 1983.