Abstracts

These summaries are of projects awarded grants from the Chartered Society of Physiotherapy Charitable Trust.

A New Method to Quantify Manual Paediatric Chest Physiotherapy Techniques

R K Gregson, G W Petley, M Browne, R M Pickering, J O Warner
Southampton General Hospital

Background Descriptions of techniques which involve applying a force to the chest wall in the treatment of respiratory conditions were documented as early as 1915. However, little is known of the characteristics of the forces applied. Preliminary laboratory investigations and a review of reported data suggested that an appropriate sensing system should measure a force range from 0 to 160 newtons with an accuracy within 10% full scale. Analysis of the frequency composition revealed that a bandwidth of 30 Hz is needed to characterise the signal adequately. The Novel™ Pliance (Novel GMBH, Munich) capacitance sensing system was reported to fulfil these criteria and was purchased under a joint development agreement.

Aim The aim of this study was to develop a direct and real-time measurement technique to quantify the forces applied to a child's chest wall during the three different chest physiotherapy procedures of hand percussion, mask percussion and vibrations.

Methods The Novel™ Pliance capacitance sensing system was calibrated and validated. Pilot data of manual chest physiotherapy techniques were collected from six paediatric physiotherapists performing techniques on seven healthy babies and four healthy older children. Three paediatric physiotherapists each treated two young babies (aged two and three months respectively) with both mask percussion and hand percussion.

Results The Novel™ Pliance system (fig 1) was found to be linear in response, accurate to within 5% full scale, with a frequency response of 0 to 35 Hz. The system was found to be capable of adequately quantifying the pilot data.

Characteristic force profiles were produced for the three different techniques. The highest forces and variability were displayed during chest vibration.

The mean (standard deviation) peak force delivered during vibration by a therapist to a ten-week-old infant of 45 (11) newtons was approximately half that delivered by the same therapist to a nine-year-old child of 93 (13) newtons (fig 2).

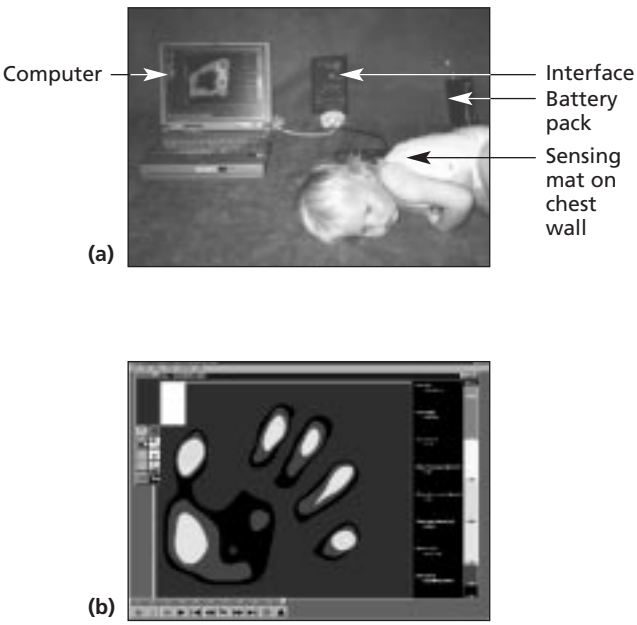

Fig 1: (a) The Novel™ Pliance System with sensor mat applied over child's chest wall; (b) spatial distribution of right hand

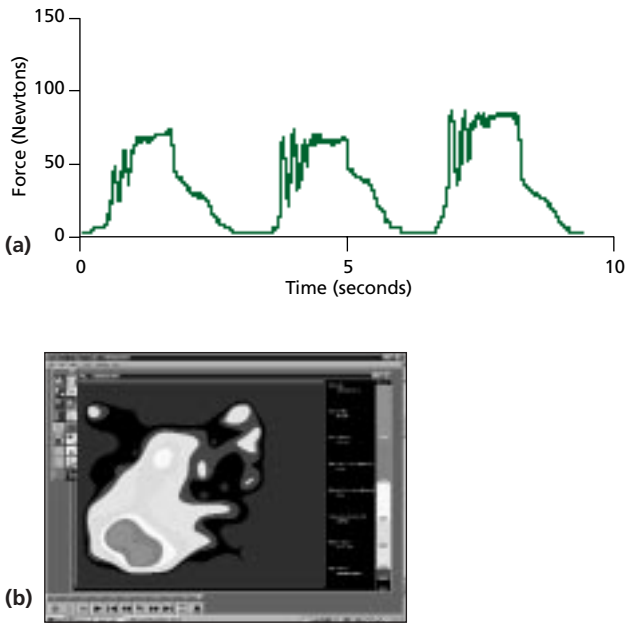

Fig 2: (a) Vibration force-time trace; (b) spatial distribution from treatment of a nine-year-old (single-handed)

Maximum peak force (SD) in newtons during percussion applied over 15 seconds on two babies by three paediatric physiotherapists

Age	*Therapist*	*Mask percussion*			*Hand percussion*		
		Peak force	*(SD)*	*Range*	*Peak force*	*(SD)*	*Range*
3 months	1	2.8	(0.5)	1.9-4.1	3.6	(0.9)	1.8-5.6
(13.6kg)	2	3.2	(0.6)	2.1-5.1	3.7	(1.3)	1.7-6.1
	3	3.3	(0.5)	1.8-4.1	†		†
Mean		3.1	(0.5*)		3.6	(1.1*)	
2 months	1	2.4	(0.5)	1.5-3.1	3.3	(0.8)	1.5-4.8
(12.2kg)	2	2.9	(0.5)	2.3-3.9	2.2	(0.6)	1.6-3.6
	3	2.0	(0.3)	1.6-2.8	2.0	(0.2)	1.5-2.4
Mean		2.4	(0.4*)		2.5	(0.6*)	

* Calculated as square root of the average variance
† Data unavailable due to excessive movement of the baby

Percussion data from the three physiotherapists' treatment of the two babies (see table) showed similar forces for the two babies, ranging from 1.5 to 6.1 newtons. There is some suggestion that forces were lower for the smaller baby. However, the range of values over the 15-second data collection period for the two babies does not seem greatly different.

Conclusions Laboratory investigations suggest the Novel™ Pliance system is appropriate for quantifying the spatial distribution and magnitude of forces applied during chest physiotherapy in children up to 18 months of age, both for static and dynamic loading. In addition, single-handed techniques can be quantified in older children. The preliminary data studies need replication on larger numbers of children where manual chest physiotherapy is clinically indicated.

The system is being developed further to quantify the force profiles being delivered during manual chest physiotherapy in children aged between 18 months and 16 years. Repeatability and further validation studies have been planned, and a clinical study in the paediatric intensive care units of Southampton General Hospital and Great Ormond Street Hospital for Children will assess the range of manual chest physiotherapy techniques being delivered to children requiring mechanical ventilation. Simultaneous assessment of the children's respiratory response to manual chest physiotherapy will be made. The authors believe that this will be the first time in which any attempt to quantify paediatric manual chest physiotherapy and simultaneous respiratory response has been undertaken.

Acknowledgements

The authors are grateful to the Physiotherapy Research Foundation and the NHS Executive – South East Research and Development Directorate for supporting this research.

Thanks are also expressed to Southampton Hospital's paediatric physiotherapy department and the volunteer children and their families who participated in this work.

This next stage of research is funded by SPARKS (Sport Aiding Medical Research in Kids) and Great Ormond Street Hospital for Children through a research Fellowship.

Contact Address

R K Gregson BSc MCSP, University Child Health (803), Level G, Centre Block, Southampton General Hospital, Southampton, Hants SO16 6YD.