

VISUALISING SPEECH: USING ULTRASOUND VISUAL BIOFEEDBACK TO DIAGNOSE AND TREAT SPEECH DISORDERS IN CHILDREN WITH CLEFT PALATE

Joanne Cleland¹, Lisa Crampin², Natalia Zharkova³, Alan Wrench³, Susie Lloyd¹ & Pertti Palo¹

¹University of Strathclyde, UK, ²NHS Greater Glasgow & Clyde ³Queen Margaret University, UK
joanne.cleland@strath.ac.uk
[@DrJoanneCleland](https://twitter.com/DrJoanneCleland)

BACKGROUND

Problems with producing clear, intelligible speech can occur in cleft lip and palate (CLP), even after successful surgery to repair the palate.

Current methods of assessment:

- Perception-based phonetic transcription
 - unreliable in CLP due to range and type of errors¹
- Electropalatography (EPG)
 - recommended by Royal College of Speech and Language Therapists
 - can reveal covert contrasts and errors
 - requires custom-made artificial palate
 - images only tongue-palate contact from the alveolar region to the boundary of the hard and soft palate
- Advantages of Ultrasound Tongue Imaging (UTI) over EPG:
 - cheaper
 - images from near the tongue tip to the root
 - pharyngeal articulations, common in CLP, are visible
 - does not require individualised equipment
 - can continue to be used as child grows or following surgery

Therapy

Ultrasound can be used as a visual biofeedback tool (U-VBF), to provide children with real-time feedback on their articulations. This can lead to quick remediation of deeply engrained articulatory patterns demonstrated by a growing evidence base (~30 small studies, e.g.^{2, 3, 4}). However, only one small study has focussed on the CLP population, with just two children with sub-mucous cleft².



AIMS

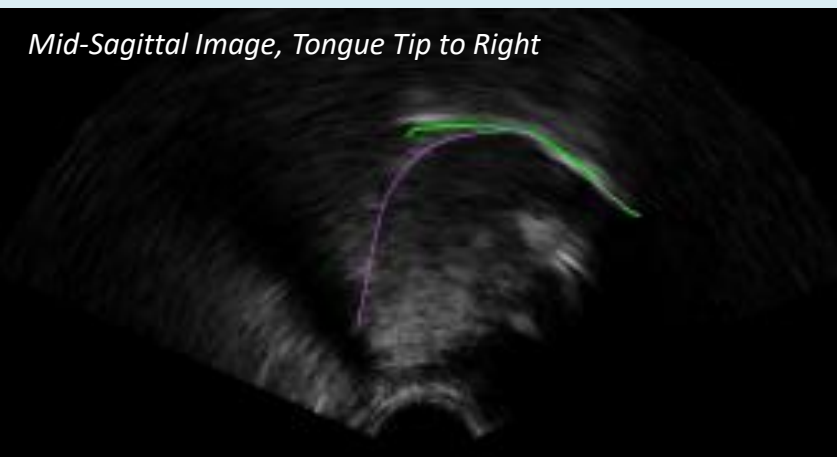
STUDY 1: Assessment

To develop an ultrasound-based diagnostic assessment for identifying imperceptible speech errors in children with cleft palate which will be a viable tool for clinical practice and circumvent the practical problems associated with EPG.

STUDY 2: Intervention

To evaluate the effectiveness of U-VBF in remediating speech disorders in CLP

ERROR TYPES REVEALED BY ULTRASOUND: *Examples form Children with Speech Sound Disorders.*



Increased contact



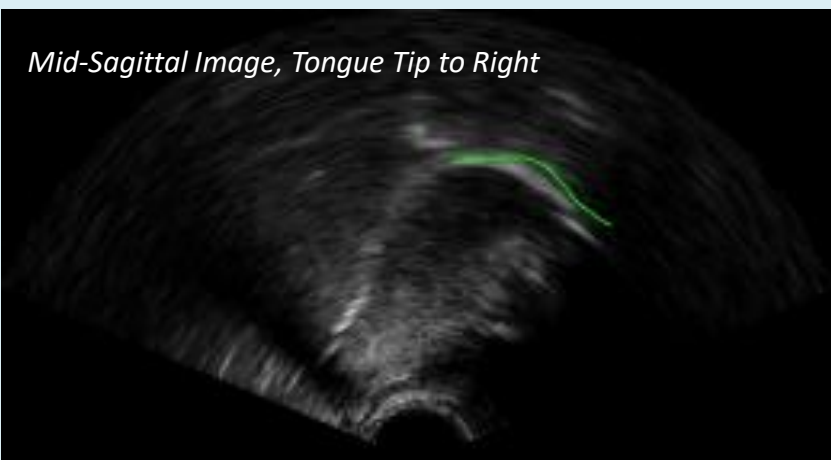
No contact/undershoot



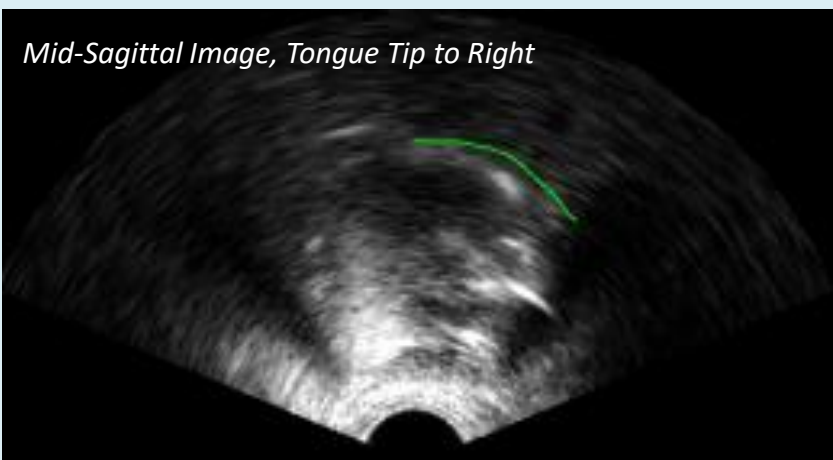
Fronted placement



Complete closure
(Loss of groove - coronal)





Retraction to velar or
palatal placement



Double articulations



Probe stabilising headset for children

	PARTICIPANTS	DESIGN	ANALYSES
Study 1 Assessment	<p>~48 children Aged 3-15 Non-syndromic or syndromic CLP</p> 	<ul style="list-style-type: none">• Head set stabilises probe under chin• Micro high-speed cineloop system at 100fps over a 150 degree field of view• Data collected:<ul style="list-style-type: none">• spontaneous counting• all consonants in /aCa/• minimal sets contrasting common substitutions• Sentences from the CleftNet Protocol	<ul style="list-style-type: none">• Perceptual analysis - phonetic transcriptions• Visual analysis of ultrasound – documented live• Quantitative analysis of ultrasound using Articulate Assistant Advanced software⁵ and a range of measures:<ul style="list-style-type: none">• Dorsum Excursion Index• LOC_{a-i}• Modified Curvature Index• Nearest Neighbour Distances
Study 2 Intervention	<p>~ 8 children from study 1 with lingual speech errors</p> 	<ul style="list-style-type: none">• Single subject multiple baseline across participants• 10x 45 minute weekly therapy sessions• Target specific untreated probes: 3 baseline, mid-therapy, post-therapy, 3 month post-therapy	<ul style="list-style-type: none">• Probes, wordlists and DEAP transcribed by SLT blind to the intervention time point and scored for % segment on target• Celeration lines and 2SD band methods to determine progress statistically within speakers

References

- ¹S. Howard, "Phonetic Transcription for Speech Related to Cleft Palate.," in *Cleft Palate Speech: Assessment and Intervention*, Chichester, Wiley-Blackwell, 2011, pp. 127-144.
- ²Z. Roxburgh, J. M. Scobbie and J. Cleland, "Articulation therapy for children with cleft palate using visual articulatory models and ultrasound biofeedback.," in *Proceedings of the 18th ICPHS.(0858).*, Glasgow, 2015
- ³J. L. Preston, N. Brick and N. Landi, "Ultrasound biofeedback treatment for persisting childhood apraxia of speech.," *American Journal of Speech-Language Pathology*, vol. 22, no. 4, pp. 627-643, 2013.
- ⁴J. Cleland, J. Scobbie and A. Wrench, "Using ultrasound visual biofeedback to treat persistent primary speech sound disorders.," *Clinical linguistics & phonetics*, vol. 29, no. 8-10, pp. 575-597, 2015.
- ⁵Articulate Instruments Ltd, Articulate Assistant Advanced User Guide: Version 2.14., Edinburgh: Articulate Instruments Ltd., 2012.