

# COMPARING NORMAL AND PATHOLOGICAL ARTICULATION BY MEANS OF ELECTROPALATOGRAPHY

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## ABSTRACT

In the present study a comparison is made between pathological and normal speech by means of electropalatography (EPG). EPG was used to document articulation in two subjects with oral motor dysfunctions, primarily affecting specific speech sounds. The subjects had normal intelligence and were presently enrolled in the public school system. The subjects' speech was recorded acoustically and dynamic EPG records of tongue-palate contacts were gathered during the production of Swedish stops and fricatives. An analysis of these patients' speech production patterns was compared to data on normal patterns of articulation for these Swedish sounds. Differences were found between normal speech and subjects regarding constriction place and constriction width for fricative sounds. The clinical evaluation regarding severity of the articulatory deviation was confirmed by a t-test between subjects,  $p = .0001$ .

## 1. INTRODUCTION

Several studies have recently pointed out the need for systematic investigations of therapy outcome and efficacy in the field of speech and language pathology and swallowing disorders [1], [2], [3]. Regarding outcome evaluation studies of therapy for teenagers and young adults with persisting articulatory difficulties the literature is limited. The reason for this may be twofold. First, according to theories on acquisition of motor skills the most receptive period is before adolescence, thus making this patient group difficult to treat. Second, the group is very heterogeneous making general conclusions tentative.

Palatography has historically been used to analyze tongue and palate contact of single speech sounds [4]. With modern electro-palatography (EPG) it has been possible also to analyze running speech. This has widely extended the possible applications of this experimental technique. Three main areas can be identified. 1. Experimental phonetics [5], [6]. 2. Studies to describe the speech disorders resulting from different pathological conditions [7]; [8], [9]. 3. Studies where EPG has been used as a therapeutic treatment application giving the patient visual feedback [10], [11], [12].

The present study is a first step in the evaluation of a therapeutic method for the treatment of articulatory disorders. The treatment is based on the orofacial regulation therapy described by dr Castillo Morales [13]. It includes intra-oral stimulation of specific articulatory targets by means of individually designed palatal-plates [14]. The treatment evaluation involves the establishment of a baseline for normal articulatory behavior in terms of EPG data. In this paper some normal and pathological data are compared in order to find usable

measurements to describe differences between normal and deviant articulation.

## 2. METHODS

### 2.1. Subjects

Included in this study were two patients who had been referred to the department of Speech Pathology at Danderyd Hospital for an assessment of articulatory difficulties. The two subjects were 16 and 17 years old at the onset of therapy. Two additional subjects had been clinically evaluated and had custom made epg-plates made but had not yet been recorded at the time of writing this paper. All subjects were native Swedish speakers.

### 2.2. Clinical evaluation and epg-recording

Each subject was recorded in a studio at the time of the first visit to the clinic. They read a standardized text and a short list of words with increasing articulatory difficulty. The speech assessment also included an oral motor examination. This included observations of breathing patterns and simple non speech oro-facial movements. Range and precision in movements, voice and articulation was documented. A simple examination of sensory ability by means of a two-point discrimination test around the mouth and on the tip of the tongue was also performed [15].

Each patient had a dental examination including dental molds that were used to construct the individual epg plates.

The epg recording was conducted in a sound treated booth at the University of Stockholm, Dept of Linguistics and Phonetics. Each patient wore the palatal plate at least 30 minutes before the recordings were made. The words were spoken in a carrier phrase.

The epg system was the Reading system EPG2 [16]. The electrodes are arranged according to anatomical and phonetic criteria to permit comparisons between speaker's [17].

Three epg measures were chosen based on previous studies. They were constriction place (CP), constriction width (CW) and total number of activated electrodes for each speech sound. The speech sounds examined were the Swedish voiceless fricatives [s], [ʃ], [ç] and [h] as well as the stop [t].

Subjects AM and OE were both normal native Swedish speakers. Their epg-data served as comparison.

## 3. RESULTS

The clinical assessment of speech and oral motor function resulted in the diagnosis dyspraxia for three subjects (KM, KP and LS) and ankyloglossia with compensatory articulatory behavior for one subject. Two subjects also had habitual mouth-

breathing and a deviant bite. In this paper results from two subjects KM and KP will be presented.

The clinical evaluation showed that KM had a more deviant articulation and less volitional control of simple oral movements than subject KP. This was also confirmed by a t-test of epg data on CP, constriction place,  $p = .0001$ . In Figure 1 the mean values of both subjects are compared to the data for two normal controls. The mean values of CP for subjects KM are concentrated to row 8 showing a marked posterior preference of articulation.

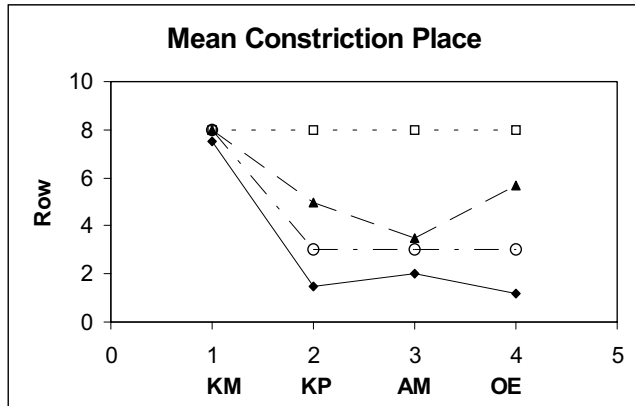


Figure 1. Mean constriction place for each subject and the fricative sounds [s] (filled diamonds), [ʃ] (unfilled circles), [ç] (filled triangles) and [h] (unfilled squares).

Regarding subject KP no clear deviation could be observed for the mean values of CP. However, both subjects were somewhat less consistent as compared to the normal speakers (AM, OE) regarding CP. This was shown in an analysis of variance, see Tab.1.

	[t]			[s]		
	Var tot	Var CP	N	Var tot	Var CW	N
KM	2,8	0,3	10	0,5	0,5	6
KP	14	0,7	10	8	2	6
AMA	2,3	0	10	0	0	6

Table 1. Analysis of variance for each subjects epg data regarding the stop [t] and the fricative [s]. Variance tot in the second column is the variance of total number of activated electrodes. Variance CP is the variance of constriction place and variance CW is the variance in constriction width. N = number of samples.

The normal subject had no variance at all for the parameters CP and CW. It is also evident that subject KP was somewhat less consistent than subject KM in this respect.

In Figure 2 a comparison is made between the two subjects and the two controls. The constriction width (CW) has a considerably greater spread for the controls than for the subjects.

CW varies between approximately one and 3,8 for the controls but only between one and two free electrodes for the subjects.

t-test	P-value	N for each subject	N tot
[s]	0,146	6	24
[ʃ]	0,092	6	24
[ç]	0,401	2	8
[h]	0,048*	2	8

Table 2 shows the results from a t-test comparing the mean constriction width in fricative sounds of the two subjects to that of the two controls. N tot stand for the total number of compared samples. Considering the small number of subjects it is notable that one sound has a p value of .048 indicating a systematic deviation of the subject's articulation. \*  $p \leq .05$ .

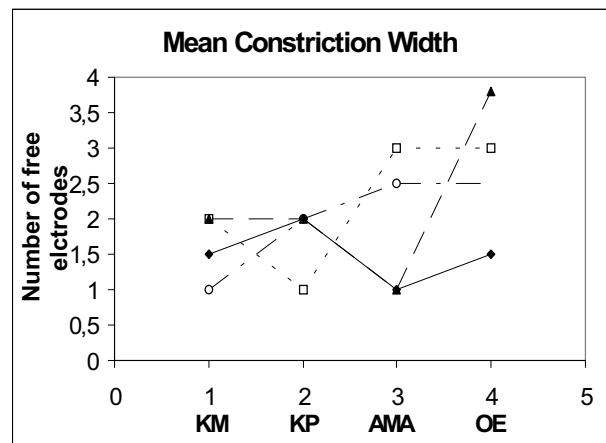


Figure 2. Mean constriction width for each subject and the fricative sounds [s] (filled diamonds), [ʃ] (unfilled circles), [ç] (filled triangles) and [h] (unfilled squares).

#### 4. DISCUSSION

This is a preliminary study reporting on the first results from only two subjects. The study is part of an ongoing project investigating articulatory deviations in adult patients by means of EPG. This work is meant to serve as a baseline for further analysis of observable intra-subject improvement as measured by perceptual evaluations of articulatory performance and intelligibility and EPG before and after therapy.

Despite the small number of subjects deviations from normal could be observed. The EPG records indicated that the subject, KM, clinically evaluated as having a more deviant articulation also displayed a greater departure from normal articulation. However, both subjects deviated from normal but in different respects. One subjects (KM) was consistent in her deviant behavior. The second subject (KP) was close to normal with respect to mean constriction place for [s] but had a variance of

8 regarding total number of activated electrodes for this sound. The normal subjects had 0 and subject KM had 0,5 showing a more consistent articulatory behaviour.

Regarding CW the subjects had less articulatory variation between the studied fricative sounds than the controls. This lack of difference may contribute to the clinical evaluation of deviation, thus obscuring the listeners' comprehension.

We also found considerable variability between the normal speakers with regard to constriction width for the fricative sound [ç] with a mean value of one free electrode for subject AM and almost four for subject OE. This shows that more normal EPG data is clearly needed to establish a base for evaluation and comparison of articulation and articulation disorders. No general conclusions can be made based on this study but the results indicate that EPG may serve as a useful tool both in the initial assessment and in the post therapy outcome evaluation.

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