論　文　内　容　要　旨

Videofluorographic study of effortful swallowing and K-method swallowing
(努力嚥下とKメソッドによる嚥下法に関するVideofluorographyを用いた研究)

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Introduction: Videofluorographic examination (VF) is the most commonly used instrumental procedure for the examination of swallowing function, followed by fiberoptic endoscopy. Using the former procedure, we can obtain temporal and spacing information. Although we can measure distances and angles using this method, the rates of mechanical distortion and enlargement, and some other factors, make it unreliable. However, temporal measurements are more reliable. In this study, I focused on the timing of bolus movement, hyoid bone movement, and laryngeal movement.

There are many rehabilitation techniques for swallowing disturbance. Of these, effortful swallowing is one of the most popular techniques. It represents a volitional attempt by the patient to increase the force applied to the bolus from structures within the swallowing mechanism. The K-method is a newly proposed method by speech therapist Chieko Kojima. It is a slightly complicated method, in that before starting to swallow, the patient must make a tongue posture to produce a “ki” sound while keeping the bolus on the tongue surface, and then swallow. As the swallow is not seen on the outside, it is difficult to know when the rehabilitation training is achieved. Therefore, VF is sometimes used for evaluation during training of dysphagia patients.

Aim: The purpose of this study was to clarify the relationship among the bolus movement, laryngeal movement, and hyoid bone movement in daily (control), effortful, and K-method swallowing using VF.

Subjects: Nine volunteers, comprising seven females and two males aged 25–59 years (mean±SD: 39.4±13.5 years), were recruited.

Methods: During a VF lateral examination, each volunteer was asked to swallow 3 ml of test food (thickened barium sulfate solution) three times using three swallowing methods: 1) daily swallowing as a control; 2) effortful swallowing; and 3) K-method swallowing as a rehabilitation method. Eighteen events were defined, and time measurements were performed for each series of 27 swallowing videos.

The time measurements were based on the frame where the bolus first passed through the posterior margin of the mandible as 0 s. Events occurring earlier than that point were recorded as minus, and those occurring after that point were recorded as plus.

Results: The start of anterior quick movement of the hyoid bone occurred at 0.02±0.22 s (mean±SD) in control swallows, 0.08±0.24 s in effortful swallows, and 0.19±0.40 s in K-method swallows. The start of continuous elevation of the larynx occurred at 0.02±0.27 s in control swallows, 0.11±0.0.26 s in effortful swallows, and 0.24±0.039 s in K-method swallows. There was no significant difference in anterior hyoid bone movement among the three groups, but a significant difference between the

control and K-method in laryngeal elevation ($p=0.0286$, Tukey–Kramer HSD test). The correlation coefficients between the two events were 0.958, 0.936, and 0.986 in control, effortful, and K-method swallowing, respectively ($p<0.0001$). The relative relationship between most anterior position of the hyoid bone and maximum elevation of the larynx was 0.989 in control swallows, but 0.995 and 0.986 in effortful and K-method swallows, respectively ($p<0.0001$).

The durations of the oral transit time (OTT), pharyngeal transit time (PTT), and pharyngeal delay time were calculated according to the following definitions. For OTT, the duration was the time taken for the bolus to move through the oral cavity from the first frame showing backward movement of food until the bolus head passed a landmark in the posterior oral cavity. For PTT, the duration was the time taken for the bolus to move through the pharynx from the point at which the bolus head passed the back of the mandible until the bolus tail passed through the pharyngeal region. For PDT, the duration was the time from the bolus head arrival at the point where the shadow of the lower edge of the mandible crossed the tongue base until the pharyngeal swallow was triggered. In this study, the start of quick anterior movement of the hyoid bone was used as the trigger point. The mean OTT was 1.29±0.49 s in control swallows, 1.23±0.48 s in effortful swallows, and 2.13±1.28 s in K-method swallows. A significant difference was observed between control and K-method ($p=0.0012$), and between effortful and K-method ($p=0.0005$). The mean PTT was 0.67±0.24 s in control swallows, 0.74±0.23 s in effortful swallows, and 0.88±0.38 s in K-method swallows. A significant difference was observed between control and K-method ($p=0.0288$). The mean PDT was −0.02±0.22 s in control swallows, −0.08±0.24 s in effortful swallows, and −0.19±0.40 s in K-method swallows. A significant difference was observed between control and K-method ($p=0.0288$).

The intra-subject occurrence orders of swallowing events were not the same in all swallowings. No same patterns were observed.

Discussion: In control swallowing, both events in all three methods were very close to 0. This means that the events occur at almost the same time as the bolus movement. These events can be representative of the start of the pharyngeal phase. However, this timing is slightly elongated in effortful and K-method swallowing, especially K-method swallowing. Laryngeal movement appeared to be longer than hyoid bone movement. This means that laryngeal movement can be changed by intention. There is a possibility that pharyngeal structures may be trained by rehabilitation.

Conclusion: Time analysis clarified the differences in the swallowing methods.