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Clinical Study

# Positional change of hyoid bone after anesthesia in anterior surgery of upper cervical spine

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**Abstract**

**BACKGROUND CONTEXT:** The hyoid bone is used as a landmark in anterior upper cervical spine operations and is supposed to represent the level of C3 body. However, this correspondence between hyoid bone position and cervical level is not static and changes during surgery (extension after anesthesia).

**PURPOSE:** To find the cervical level corresponding to the position of hyoid bone before and after anesthesia and to evaluate the adequacy of its usage as a surgical landmark.

**STUDY DESIGN:** A retrospective study.

**PATIENT SAMPLE:** One hundred twenty-eight patients with degenerative cervical diseases who had undergone anterior cervical discectomy and fusion.

**OUTCOME MEASURE:** Radiologic measure.

**METHODS:** For each patient, preanesthesia neutral, preanesthesia extension, and postanesthesia induction extension C-spine lateral image were obtained. The level of cervical vertebra that midline of hyoid bone indicated was measured by radiological method. A cervical vertebra was divided into three segments, consisting of upper half, lower half, and disc space, and each of these segments was considered as one level. The differences between pre- and postanesthesia induction hyoid positions were classified as minimal change (one level or less) and significant change (two levels or greater). Relationship between positional change of hyoid bone to gender, obesity, and age were respectively investigated.

**RESULTS:** There were 20 cases of one-level distal displacement of the hyoid bone, 40 cases of two-level distal displacement, 34 cases of three-level distal displacement, 16 cases of 4-level distal displacement, and two cases of five-level distal displacement. In eight cases, there was no level change, and in the remaining 8 cases, the hyoid bone had been displaced proximally. There were 34 cases of minimal change. The remaining 94 cases (73.4%) had significant changes. No respective relationship was found between sex, obesity, age and pre-and postanesthesia induction positional change of hyoid bone.

**CONCLUSIONS:** Among the 128 cases studied, 73.4% hyoid bone positions had changed by more than one cervical vertebra body between the pre- to postanesthesia induction X-ray images. Sex, age, and body mass index were not associated with statistically significant differences in these positions. The hyoid bone should not be trusted as a landmark for upper cervical operations, and the cervical level to be operated should be confirmed by a radiological method before a skin incision is made. 

*Keywords:* Hyoid bone; Post-anesthesia induction; Landmark; Positional change; Upper cervical spine; Radiological measure

FDA device/drug status: Not applicable.

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## Introduction

Adequate skin incision in anterior cervical spine is essential for proper surgical-site exposure for cervical decompression and fusion, metal insertion, and artificial disc insertion and is also essential for safe retraction of neurovascular and visceral structures. Although an inadequate skin incision can be extended, large postoperative scars are significant cosmetic problems in the anterior neck. If the length of skin incision is inadequate in the lower (fourth to seventh cervical vertebrae) neck, surgical exposure can be compensated to some extent, whereas inadequate incisions in the upper neck (second and third cervical vertebrae) cannot easily be extended. Inadequate skin incisions increase the risk of esophageal injury, inappropriate cervical decompression, difficulty in proper positioning of metal and artificial disc, and dysphagia caused by excessive and prolonged retraction [1,2]. Presently, hyoid bone (C3), thyroid cartilage (C4–C5), cricoids cartilage (C6), and carotid tubercle (C6) are most commonly used as superficial landmarks in anterior cervical operations [3]. Among these, the hyoid bone is the only landmark for upper cervical surgeries. In the experience of the authors, these landmarks did not accurate predict cervical spinal levels, especially in patients with short neck, bulky muscle, and/or obesity. We intended to identify positional change of these landmarks because they did not coincide with the cervical levels traditionally associated, especially after endotracheal intubation in the operating table. The purpose of this study is to find the cervical level corresponding to the position of hyoid bone before and after anesthesia, and to evaluate the adequacy of its usage as a surgical landmark.

## Materials and methods

### *Patients and study design*

This study was performed by the approval of the Institutional Review Board of Chonbuk National University Research Council (IRB-2010-22). A retrospective study was performed on 128 patients (74 male, 54 female) who were undergoing anterior cervical discectomy and fusion for degenerative cervical disease from January 2010 to January 2012. The mean age was 55 years (range, 43~81 years). Patients with traumatic disc herniation, cervical kyphosis, revision surgery, and congenital vertebral deformity (ie, Klippel-Feil syndrome) were excluded from this study.

### *Methods*

Lateral cervical spine X-ray images were obtained for preanesthesia induction neutral, preanesthesia induction extension, and postanesthesia induction extension positions. Preanesthesia induction neutral and preanesthesia induction extension images were obtained in the outpatient department as standing C-spine lateral images. Postanesthesia induction extension images were obtained in actual supine surgical position after endotracheal intubation. The surgical position used was natural cervical lordosis with posterior cervical bolster with each patient's head fixed on the operating table, and both upper extremities were secured with 2-inch-plaster to maintain traction for clear vision of the lower cervical spine. These images were obtained without Gardner Wells or Mayfield tongs application. To determine the location of hyoid bone in the radiologic images, the midline of upper and lower ends of hyoid bone were indicated against the respective level of cervical vertebra and intervertebral body. Two spine fellows repeated the measurement three times each to minimize measuring bias.

For localization of hyoid bone, each vertebral body was bisected. Proximal and distal half vertebral bodies by bisecting line and disc space were defined as a level. Thus, each level was classified as disc space of C2–C3, upper 1/2 and lower 1/2 of C3 body, disc space of C3–C4, upper 1/2 and lower 1/2 of C4 body, disc space of C4–C5, upper 1/2 and lower 1/2 of C5 body (Fig. 1).

The pre/postpositional change of hyoid bone was classified as follows: minimal change, for one level or less; and significant change, for two levels or greater. Sex, body mass index (BMI), and age were investigated in relationship to the positional changes of hyoid bone.

For statistical analysis, pre- and postanesthesia induction positional change of hyoid bone was described in percentages. The comparison of sex, BMI, and age were performed with $\chi^2$ test with a significance level of .05.

## Results

### *Interobserver and intraobserver reliability*

Interobserver and intraobserver reliability were 0.91 and 0.93 of the kappa value.

### *Pre- and postanesthetic position of hyoid bone (Fig. 2)*

In comparing the pre- and postanesthesia induction positions of 128 patients, there were 20 cases in which the hyoid bone had been displaced distally by one level. Distal displacements of two, three, and four levels consisted of 40, 34, and 16 cases, respectively. There were two cases of distal displacement of five levels. In eight cases, the hyoid bone did not change positions from pre- to postanesthesia induction images. In the remaining eight cases, the hyoid bone had been displaced proximally.

When these cases were divided into the groups defined previously, 34 cases were considered to have minimal change (change of one level or less), and 94 cases were considered to have significant changes (more than two levels).

### *Positional change of hyoid bone according to sex*

Among the male patients (n=74), there were 10 cases of one-level distal displacement of hyoid bone, 18 cases of two-level distal displacement, 20 cases of three-level distal