Yonago Acta Medica 2021;64(1):12–17 doi: 10.33160/yam.2021.02.003 *Original Article*

Application of an Immobilization Device for the Modified Killian's Method

Kazunori Fujiwara,* Satoshi Koyama,* Ryohei Donishi,* Tsuyoshi Morisaki,* Takahiro Fukuhara* and Hiromi Takeuchi*
**Division of Otolaryngology, Head and Neck Surgery, Department of Sensory and Motor Organs, School of Medicine, Faculty of Medicine, Tottori University, Yonago 683-8504, Japan*

ABSTRACT

Background The hypopharynx is a closed space that is difficult to observe. The modified Killian's (MK) method was introduced to obtain wider exposure. However, this method requires keeping the head forward during the examination. Postural maintenance might be problematic. To use the MK method safely for a thorough endoscopic examination, we introduced a new body immobilization device. The aim of this study was to evaluate the effectiveness of this body immobilization device.

Methods Twenty-five patients underwent transnasal laryngoscopy using the MK method with the immobilization device. This device consists of a board to place the chest and a shaft. We classified hypopharynx visualization using a 5-point scale, in various combinations of head torsion, Valsalva maneuver, and MK position. Furthermore, we classified the feasibility of the MK method for 54 patients. Age, BMI, and performance status were evaluated by MK position feasibility class.

Results The MK method with the body immobilization device was completed in all patients. It was significantly associated with higher hypopharyngeal visibility score. BMI and performance status were significantly associated with MK method feasibility. There were no significant differences in hypopharynx visualization scores with versus without this device for the patients that could maintain the MK position on their own.

Conclusion For patients with poor nutrition or poor ability to perform activities of daily living, it was difficult to maintain the MK position. Thus, this immobilization device might be useful to complete the MK method and provide accurate detection of hypopharyngeal lesions in these patients.

Key words body immobilization device; hypopharynx; modified Killian's method; visualization

Corresponding author: Kazunori Fujiwara, MD, PhD
kfujiwa@tottori-u.ac.jp
Received 2020 November 6
Accepted 2020 November 26
Online published 2020 December 25
Abbreviations: BMI, body mass index; MK, modified Killian's; NBI, narrow-band imaging; Ph, phonation; PS, performance status; Va, valsalva

Flexible laryngoscopy has become one of the most important modalities for assessing oropharyngeal and hypopharyngeal cancer.[1] Early detection of these cancers offers the best prognosis.[2] Recently, remarkable progress in endoscopic technology, such as narrow-band imaging (NBI) and increased resolution, has enabled the detection of superficial cancers that were previously undetectable.[3, 4]

The entire hypopharynx is difficult to observe because it is a closed space except during swallowing. Thus, it is important to expand the hypopharynx to improve visualization. Lesions have been detected using various techniques such as head torsion,[5] Valsalva maneuver,[6] anterior neck skin traction,[7] and Killian's method. Based on these methods, the modified Killian's (MK) method has been reported.[8–10]

The MK method enables observation of the entire circumference of the hypopharyngeal space and the proximal cervical esophagus. The modified Killian's method may become an indispensable technique for observing the hypopharynx and detecting hypopharyngeal cancers. However, this method requires maintenance of a head forward posture during the examination. It is problematic that some patients have difficulty in maintaining the head in a forward position and move during the examination.

To use the modified Killian's method safely for a thorough endoscopic examination, we introduced a new body immobilization device. The aim of this study was to evaluate the effectiveness of the new body immobilization device.

MATERIALS AND METHODS

MK method feasibility

Between April 2019 and March 2020, 54 outpatients who had been followed and underwent screening for pharynx participated in this clinical trial. They had no lesions in the larynx or pharynx at the time of examination. General parameters such as age and body mass index (BMI) were evaluated. Eastern Cooperative Oncology Group (ECOG) performance status (PS) was confirmed and divided into two groups: PS 0–1 and PS 2–3.

We evaluated the feasibility of using the MK method, which consisted of the following steps:

Fig. 1. Modified Killian's method with the body immobilization device. This device consists of a board to place the chest and a shaft to hold. (White arrow; board to place the chest, Black arrow; shaft to hold) (**a**). The height of the board is adjusted to the level of the subject's knees. The subject places the chest on the board and holds the handlebar. The subject has the head down and chin tucked down (**b**).

1. Insert the endoscope via the nasal route.
2. Bend the patient forward, with the neck bent forward and the chin sufficiently depressed.
3. Turn the patient's head and have the patient perform the Valsalva maneuver while in the MK position.

We classified the feasibility of MK method based on whether the patient could maintain MK position as instructed (class 1), maintain the MK position with the support of a nurse (class 2), or could not maintain the MK position (class 3). Age, BMI, and PS were evaluated for patients in each category.

MK method with the body immobilization device

Between April 2019 and March 2020, 25 outpatients underwent transnasal laryngoscopy using the MK method. They had no lesions in the larynx or pharynx at the time of examination.

The Rakusukesan® immobilization device (Idea System, Nagano, Japan) consists of a board to place the chest made of urethane foam and a shaft made of stainless steel. This device is registered as a welfare apparatus (01239-000009). This device is used to maintain a forward seated position for those who have difficulty in maintaining this position on their own in other situations, for example during defecation. The angle of the board to place the chest could be adjusted to 0, 15, 30, or 45 degrees. This device weighs 4.2 kg and is 630 mm in length, 480 mm in width, and 610 mm in height (Fig. 1). The maximum allowable load is 100 kg. The height of the board is adjusted on the subject's knee. This device can be easily installed in front of an examination chair by the examiner. The subject is asked to place the chest on the board and grab the shaft. The subject places the head down and tucks the chin down. After positioning, the MK method was performed as described above.

In this study, observation of the hypopharynx was performed in seven positions and maneuvers as reported by Murono et al. First, the patient was asked to phonate "e" in the normal position (normal-Ph). Second, the patient's head was rotated laterally and the patient was asked to phonate "e" (torsion-Ph). Third, the Valsalva maneuver was performed after resuming a normal head position (normal-Va). Fourth, the Valsalva maneuver was performed with head torsion (torsion-Va). Fifth, the patient was asked to phonate "e" in the MK position (MK-normal-Ph). Sixth, the patient's head was rotated laterally and the patient was asked to phonate "e" (MK-torsion-Ph). Seventh, the Valsalva maneuver was performed in the MK position with head torsion (MK-torsion-Va).

During the endoscopic procedure, we evaluated how well the hypopharynx was visualized using the 5-point scale reported by Murono et al: 1 point, only the pyriform sinuses were observed; 2 points, part of the postcricoid area was observed; 3 points, the entire postcricoid area was observed; 4 points, more than the entire postcricoid area was observed; 5 points, the upper esophageal sphincter was observed.

To evaluate visualization with the MK method with versus without the immobilization device, 10 patients underwent transnasal laryngoscopy using the MK method without this immobilization device. Views of the pyriform sinus, post-cricoid area, and upper esophageal sphincter were scored according to previous reports by Williams et al as follows: 0, not observed; 1, partially observed; 2, and well observed.[7, 11] Scores for visualization of the pyriform sinus, post-cricoid area, and upper esophageal sphincter with versus without the immobilization device were compared.

Ethics considerations

All patients gave informed consent. This study was approved by our institutional review board (approval number 20A057).

Statistical analysis

Data are expressed as means ± SE. Age and BMI were compared by MK method feasibility using the Kruskal-Wallis test. PS was evaluated by MK method feasibility using Fisher's exact test. Regarding the MK method with the body immobilization device, visualization scores were compared with the Friedman test. In addition, the Mann-Whitey *U* test to compare visualization scores with versus without the immobilization device. All analyses were performed with Prism (GraphPad Software, San Diego, CA).

RESULTS

MK method feasibility

Of the 54 study participants, mean age was 67 ± 1.5 years and BMI was 21.4 ± 0.4 kg/m^2. 30 out of 54 patients had a history of radiotherapy. Forty patients who underwent the MK method without support were classified as class 1, 8 patients who underwent the MK method with support were classified as class 2, and 6 patients who could not undergo the MK method was classified as class 3. The primary diseases of patients are shown in Table 1. By class, mean age was 64 ± 1.5 years in class 1, 74 ± 5.9 years in class 2, and 73 ± 3.5 years in class 3. There were no significant differences in age among the groups. Mean BMI was 22.0 ± 0.4 kg/m^2 in class 1, 20.6 ± 1.0 kg/m^2 in class 2, and 18.4 ± 1.2 kg/m^2 in class 3. Patients in class 3 had significantly lower BMI than patients in class 1. None of the 40 patients in class 1 had PS 2–3, 3 of 8 patients in class 2 had PS 2–3, and 6 of 6 patients in class 3 had PS 2–3. PS was significantly associated with class (Fig. 2).

Table 1. Primary disease and history of radiotherapy

Disease	*n*
Hypopharyngeal cancer	18
Oropharyngeal cancer	6
Throat dysesthesia	6
Oral cancer	5
NPC	4
Thyroid Ca	4
Dysphasia	2
LC	2
Unknown cancer	3
VCP	1
ML	1
MC	1
EC	1
Sinisitis	1
Chronic thyroiditis	1

EC, esophageal cancer; LC, laryngeal cancer; MC, maxillary cancer; ML, malignant lymphoma; NPC, nasopharyngeal cancer; VCP, vocal cord paralysis.

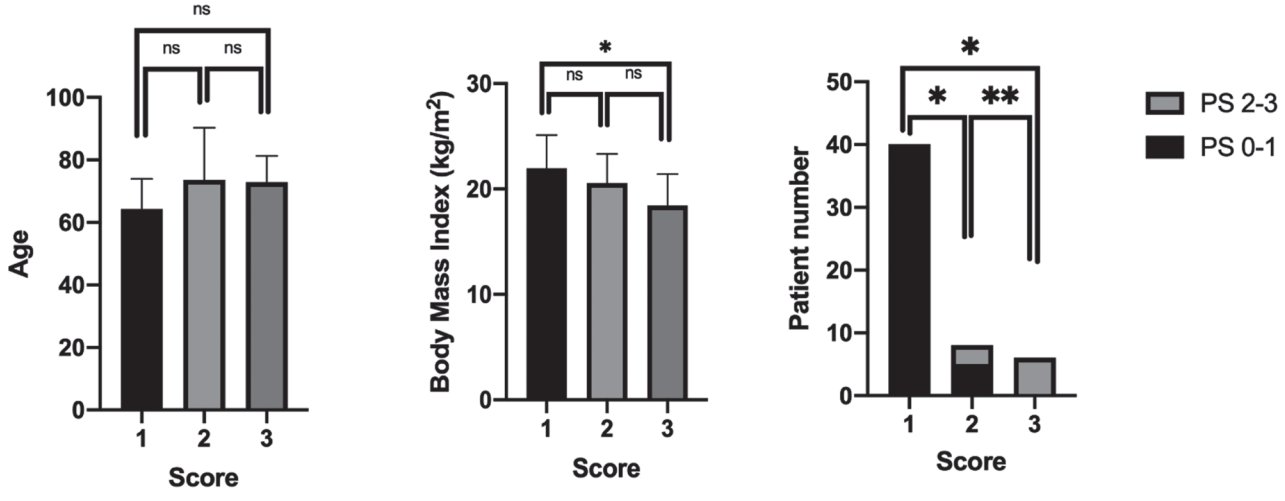

Fig. 2. Feasibility of the modified Killian's method. By class, mean age was 64 ± 1.5 years in class 1, 74 ± 5.9 years in class 2, and 73 ± 3.5 years in class 3. There were no significant differences in age among the groups. Mean body mass index was 22.0 ± 0.4 kg/m^2 for class 1, 20.6 ± 1.0 kg/m^2 for class 2, and 18.4 ± 1.2 kg/m^2 for class 3. Class 3 had significantly lower body mass index than class 1. None of the 40 patients in class 1 had performance status (PS) 2–3, 3 of 8 patients in class 2 had PS 2–3, and 6 of 6 patients in class 3 had PS 2–3. PS was significantly associated with MK method feasibility class. *P < 0.001, **P = 0.03. ns, not significant.

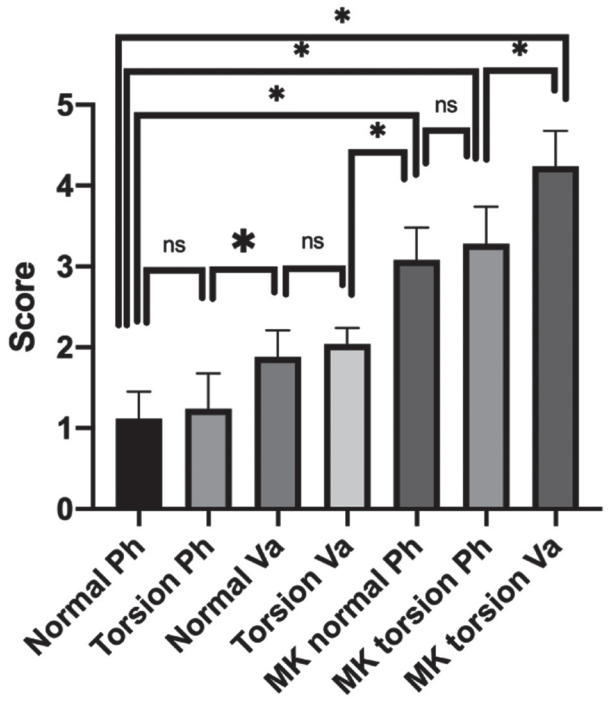

Fig. 3. Hypopharyngeal visibility score by position and maneuver. There were significant differences in score by position and maneuver with the following exceptions: normal Ph versus torsion Ph, normal Va versus Torsion Va, and MK normal Ph versus MK torsion Ph. *$P < 0.001$. ns, not significant.

MK method with the body fixation holder

Of the 25 study participants, mean age of the enrolled patients was 70.6 ± 2.1 years, with a range of 56–90 years. The mean height and weight were 159.1 ± 1.5 and 52.3 ± 1.8. 6 out of 25 enrolled patients had a history of radiotherapy. The MK method could be performed with the body immobilization device in all patients. No adverse events occurred during or after transnasal laryngoscopy. Visualization scores with normal-Ph, torsion-Ph, normal-Va, and torsion-Va were 1.1 ± 0.1, 1.2 ± 0.1, 1.9 ± 0.1, and 2.0 ± 0.0, respectively. Scores with MK-normal-Ph, MK-torsion-Ph, and MK-torsion-Va were 3.1 ± 0.1, 3.3 ± 0.1, and 4.2 ± 0.1, respectively. In 7 positions or maneuvers, there were significant differences in score, except between normal-Ph versus torsion-Ph, normal-Va versus torsion-Va, and MK-normal-Ph versus MK-torsion-Ph (Fig. 3).

In the comparison of visualization scores with versus without the immobilization device, there were no significant differences in scores for the pyriform sinus, post-cricoid area, and upper esophageal sphincter, respectively (Table 2).

Table 2. Visualization scores with versus without the immobilization device

	+	–	*P*
PS	2.0 ± 0.0	2.0 ± 0.0	> 0.99
PC	2.0 ± 0.0	2.0 ± 0.0	> 0.99
UES	1.24 ± 0.2	1.0 ± 0.1	0.29

There were no significant differences in scores for the pyriform sinus, post-cricoid area, and upper esophageal sphincter. PC, post-cricoid; PS, pyriform sinus; UES, upper esophageal sphincter.

DISCUSSION

Advances in endoscopy such as NBI improve the efficacy of screening or surveillance for lesions in the head and neck, especially the oropharynx and hypopharynx. Clinically, early detection is one of the most important strategies for improving survival and quality of life for patients with head and neck cancer.[3] Clarification of the extent of cancer based on a sufficient view of the hypopharynx is indispensable for surgical planning. However, the hypopharynx is a closed space that is difficult to observe in normal clinical practice. Wide exposure of the hypopharynx is considered necessary to not miss superficial cancers.

The MK position was first introduced in 2014 to obtain wider exposure of the hypopharynx.[10] A previous study has reported that a wide-field view of the hypopharynx can be achieved with the MK position by combining torsion and the Valsalva maneuver.[10] The patient bends even more forward than with the original Killian position to add torsion and vocalization. The hypopharyngeal space can be more easily opened with the Valsalva maneuver while the patient is in the MK position than with only the conventional Valsalva maneuver alone. However, a desirable field of view cannot be obtained if the patient is insufficiently bent forward or if the patient's chin is raised.

The patient's general condition might make it hard to maintain these positions. If a patient cannot keep the head bent forward, an assistant should hold the patient's body in the correct position.

In this study, transnasal endoscopy with the MK position was significantly less feasible in patients with low BMI or high PS. Performing the procedure required support by another staff member. Patients with low BMI might have poor nutrition. Patients with high PS may have muscle weakness and physical deconditioning. Patients with these conditions might have difficulty keeping their body steady. If the patient could not keep the body steady, an accurate endoscopic examination is not possible. Patients who are malnourished or have less

ability to perform daily living might require support to keep the body steady.

We introduced this immobilization device to help patients stay in the MK position. This immobilization device is composed of a board to hold the body and a shaft to hold up the board. Patients can lie on the board, which helps them maintain the MK position comfortably. Thus, this immobilization device can prevent body movements or tremors. In addition, installation of the device does not require much time or support from other medical staff.

In this study, the effect of performing the MK method using this immobilization device on hypopharyngeal visibility during transnasal endoscopy was evaluated. The MK method provided an effective view of the hypopharyngeal space. The MK position was associated with superior visibility of the hypopharyngeal space compared with the normal seated position, with head torsion compared with no head torsion, and with the Valsalva maneuver compared with phonation. The MK method with head torsion, MK position, and Valsalva maneuver might provide an excellent view of the hypopharyngeal space. The findings of this study were consistent with the findings of a previous study.[8]

Visualization using the MK method with versus without the immobilization device was evaluated. There were no significant differences in scores for visualization of the pyriform sinus, post-cricoid area, and upper esophageal sphincter, respectively. Differences in visualization with the MK method were not observed by immobilization device use in patients who could hold the MK position on their own.

In this study, all patients could complete the transnasal endoscopy examination, including patients with low BMI or high PS, with this immobilization device. In this feasibility study, the patients in class 1 who could maintain the MK position as instructed could complete the MK method without the immobilization device. Thus, these patients do not seem to require the device. On the other hand, 8 of 54 patients in class 2 required assistance with maintaining the posture needed to complete the MK method from other medical staff when the immobilization device was not used. Furthermore, 6 out of 54 patients in class 3 could not complete the MK method. However, these patients could complete the MK method using the immobilization device. In transnasal endoscopy with the MK method using this immobilization device, no assistance from other medical staff was required, which might be helpful for reducing the workload. In addition, the immobilization device decreased examinee discomfort in those with difficulty maintaining the necessary posture. Furthermore, this device was thought to increase endoscope operability and prevent inadequate examinations, resulting in more accurate endoscopic examinations. This device is expected to not only improve the feasibility and accuracy of examinations but also lead to workload reduction for other medical staff.

This study has several limitations. This was a retrospective study. This study showed that the immobilization device had a significant effect on maintaining the MK position. The patients who could not maintain the MK position could complete the MK method with the immobilization device. Thus, this device is considered useful for patients with difficulty in maintaining the necessary posture. However, we did not compare the effect of the MK position on examination time and degree of pain during the examination with versus without the immobilization device in the same patient. Thus, further studies should be performed to show the effectiveness of this device in patients who can maintain the MK position on their own.

This device was useful for patients who could not maintain the MK position on their own. Since patients with head and neck cancer might have poor nutrition and poor ability to perform activities of daily living, these patients might not be able to maintain the MK position and this immobilization device was thought to be useful for them. This might lead to earlier detection of hypopharyngeal cancer, higher examination accuracy, and lower workload for staff.

The authors declare no conflict of interest.

REFERENCES

1 Tsikoudas A, Mochloulis G. Role of transnasal oesophagoscopy in diagnosis of early malignancy in the area of the oesophagus and hypopharynx. A review of the literature. Eur Arch Otorhinolaryngol. 2014;271:203-4. DOI: 10.1007/s00405-013-2560-7, PMID: 23665747

2 Parkin DM, Bray F, Ferlay J, Pisani P. Global cancer statistics, 2002. CA Cancer J Clin. 2005;55:74-108. DOI: 10.3322/canjclin.55.2.74, PMID: 15761078

3 Muto M, Nakane M, Katada C, Sano Y, Ohtsu A, Esumi H, et al. Squamous cell carcinoma in situ at oropharyngeal and hypopharyngeal mucosal sites. Cancer. 2004;101:1375-81. DOI: 10.1002/cncr.20482, PMID: 15368325

4 Watanabe A, Taniguchi M, Tsujie H, Hosokawa M, Fujita M, Sasaki S. The value of narrow band imaging endoscope for early head and neck cancers. Otolaryngol Head Neck Surg. 2008;138:446-51. DOI: 10.1016/j.otohns.2007.12.034, PMID: 18359352

5 Tsunoda A, Ishihara A, Kishimoto S, Tsunoda R, Tsunoda K. Head torsion technique for detailed observation of larynx and hypopharynx. J Laryngol Otol. 2007;121:489-90. DOI: 10.1017/S0022215106005251, PMID: 17164027

6 Spraggs PDR, Harries ML. The modified Valsalva manoeuvre to improve visualization of the hypopharynx during flexible nasopharyngoscopy. J Laryngol Otol. 1995;109:863-4. DOI: 10.1017/S0022215100131512, PMID: 7494121
7 Purser S, Antippa P. Maneuver to assist examination of the hypopharynx. Head Neck. 1995;17:389-93. DOI: 10.1002/hed.2880170505, PMID: 8522439
8 Murono S, Tsuji A, Endo K, Kondo S, Wakisaka N, Yoshizaki T. Evaluation of modified Killian's method: A technique to expose the hypopharyngeal space. Laryngoscope. 2014;124:2526-30. DOI: 10.1002/lary.24760, PMID: 24913849
9 Sakai A, Okami K, Ebisumoto K, Sugimoto R, Maki D, Iida M. New techniques to detect unknown primaries in cervical lymph node metastasis. Laryngoscope. 2010;120:1779-83. DOI: 10.1002/lary.21030, PMID: 20717942
10 Sakai A, Okami K, Sugimoto R, Ebisumoto K, Yamamoto H, Maki D, et al. A new technique to expose the hypopharyngeal space: The Modified Killian's method. Auris Nasus Larynx. 2014;41:207-10. DOI: 10.1016/j.anl.2013.10.012, PMID: 24183396
11 Sakai A, Okami K, Ebisumoto K, Yamamoto H, Saito K, Maki D, et al. How to improve the endoscopic view of the hypopharynx: validation of our novel modified Killian's Method to expose the hypopharynx in 20 subjects. Clin Otolaryngol. 2018;43:1407-10. DOI: 10.1111/coa.13172, PMID: 29920948