Modified Gugging Swallowing Screen: A new evaluation tool for swallowing function in patients with partial laryngectomy before oral feeding. A single center retrospective study

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Abstract

Abstract Objectives: Dysphagia is a common complication after partial laryngectomy. Most of the evaluation tools are not suitable for swallowing assessment of patients after partial laryngectomy. Our aim was to introduce modified Gugging Swallowing Screen (GUSS) and evaluate the reliability and validity of it in patients with partial laryngectomy before oral feeding. Design: A single center retrospective study. Settings, participants and main outcome measures: From September 2018 to February 2020, 40 hospitalized patients with partial laryngectomy due to laryngeal carcinoma were included in this study. Modified GUSS and videofluorospic swallowing study (VFSS) were carried out to evaluate swallowing function respectively on the day before oral feeding. Two independent trained nurses evaluated all patients for interrater reliability of modified GUSS. The results of modified GUSS were compared with VFSS for predictive validity. The VFSS results of solid、semisolid and liquid food were compared for content validity. Spearman's rank correlation coefficient、Kappa statistics and Wilcoxon signed rank tests were used for analysis. Results: Modified GUSS had substantial to excellent interrater reliability for all classification categories (rs=0.961, P<0.01; $\varkappa$=0.600 to 1.000, P<0.01), and had excellent consistency and predictive validity compared with VFSS (rs=-0.931, P<0.01; $\varkappa$=0.800 to 1.000, P<0.01). The results of modified GUSS and the days from starting oral intake to removing gastric tube were demonstrated to have substantially negative correlation (rs= -0.664, P<0.01). The risk of aspiration of swallowing solid food was lower than that of swallowing semisolid food (P<0.01), and the risk of aspiration of swallowing semisolid food was lower than that of swallowing liquid food (P<0.01). Conclusions: We modified GUSS to make it suitable for patients with partial laryngectomy successfully. Moreover, the screen was proved as an evaluation tool that had good reliability and validity for assessment of swallowing function and risks of aspiration in patients with partial laryngectomy before oral feeding.

Key Points:

1. A convenient, bedside, reliable and validated screen for swallowing function evaluation of patients after partial laryngectomy.

2. Modified the sequence of food trails to minimize the risk of aspiration during the examination and to identify patients who could intake solid, semi-solid or liquid food respectively.

3. Both dysphagia and aspiration were evaluated at the same time.

4. Swallowing rehabilitations, food recommendations and long-term evaluation effectiveness were the next research directions.

Key Words

Assessment Scales; Swallowing Function; Dysphagia; Aspiration; Partial Laryngectomy

Introduction

Dysphagia is a common complication after partial laryngectomy. Persistent and severe dysphagia can lead to recurrent aspiration pneumonia, hyponutrition, and cachexia.[1-4] The solutions for those critical situations can be gastrostomies or total laryngectomies. Thus, it is very important to evaluate the swallowing function of patients with partial laryngectomy in early stage, especially before oral feeding.[5] Swallowing assessment before oral feeding has been a standard of care for years. However, most of the tools only include the test of liquid swallowing, which can not fully reflect the swallowing situation of various characters of food.[6] Therefore, most of the tools are not suitable for swallowing evaluation of patients after partial laryngectomy.

The main diagnostic tool recognized as the gold standard for identifying dysphagia is the videofluorospic swallowing study (VFSS).[7] And the fiberoptic endoscopic examination of swallowing (FEES) compares well with the results from VFSS.[8] However, they have several limitations respectively, such as radiation, complex processes.[9]Michaela Trapl developed a simple and convenient bedside evaluation tool of swallowing function (Gugging Swallowing Screen, GUSS) in stroke patients.[6] It was demonstarted as a quick and reliable method to identify stroke patients with dysphagia and aspiration risk. This new instrument allowed a graded assessment of the patient's swallowing abilities, measured the severity of dysphasia, and enabled dietary recommendations. The good reliability and validity of the Chinese version of the scale in stroke patients had also been demonstrated in China.[10] As far as we know, GUSS has not been used to assess swallowing function after partial laryngectomy. Based on the clinical practicability of the GUSS, we designed this study. Furthermore, we modified the GUSS to be more suitable for patients with partial laryngectomy, and analyzed the reliability and validity of modified GUSS to demonstrate whether the evaluation effect on swallowing function of patients with partial laryngectomy before oral feeding in early postoperative stage is definite.

Materials and methods

1. Study materials

Between September 2018 and February 2020, 120 patients underwent surgeries of laryngeal carcinoma at the Otorhinolaryngology, Head and Neck Surgery Department, ######. The research project was submitted and approved by the Ethics Committee of our hospital, and informed consents have been obtained from all patients according to the Ethics Committee.

Inclusion criteria for enrollment in the study were: (1) diagnosed as laryngeal carcinoma and classified according to the 8th Edition of the Union for International Cancer Control-American Joint Committee on Cancer (UICC-AJCC) TNM staging system;[11] (2) patients who underwent partial laryngectomy; (3) evaluation of swallowing function preoperatively was normal; (4) with good pulmonary function; (5) capable to follow the program, participated in the study voluntarily and signed informed consent. Exclusion criteria were: (1) patients had nearly total laryngectomy or transoral laser microsurgery; (2) with serious intraoperative or postoperative complications.

2. Study methods

Nasal feeding and tracheotomy status were lasting after the surgery. During the period, no swallowing rehabilitations were introduced to the patients. On the day before oral feeding, modified GUSS and VFSS were carried out to evaluate the swallowing function respectively. In addition, the performers of examinations were all different, and did not know the scores of other examinations.

2.1 Modified GUSS [6]

GUSS is divided into the indirect swallowing test and direct swallowing test that consists of semisolid、liquid and solid swallowing trials in sequence. These 4 subtests must be performed sequentially. Higher scores mean better performance, and the full score of each subtest is 5 points. Each subtest has several repetitions that must be completed successfully, and then the patient could reach the full score that must be attained to continue to the next subtest. Once the result of a subtest is less than 5 points, the examination must be stopped, and VFSS or FEES is recommended.

The sequence of the direct swallowing test was revised to solid、semisolid and liquid swallowing trials, and other evaluation measures remained invariant. The patient at beside swallowed solid food (dry bread) about 1cm × 1cm × 0.5cm, semisolid food manufactured by mixing water and Resource Espesante® (Nestle, Germany) according to International Dysphagia Diet Standardisation Initiative (IDDSI) level 4 (pureed/extremely thick),[12] and liquid food in sequence. During the examination, the possible compensatory position of the patient's body was selected in order to reduce the aspiration, and the testing was stopped if there was a severe aspiration. The procedures of all cases were executed and the data were evaluated by two trained ENT nurses independently.

2.2 VFSS

We improved VFSS properly (D2RS, STEPHANIX, France), using Iohexol Injection® (50ml: 17.5g, Yangtze River Pharmaceutical Co, China) instead of barium. The patient stood in an upright position, swallowed solid food (dry bread) about 1cm × 1cm × 0.5cm which injected Iohexol Injection, semisolid food manufactured by mixing Iohexol Injection and Resource Espesante®(Nestle, Germany) according to IDDSI level 4, and liquid food (Iohexol Injection) in sequence. During the examination, the possible compensatory position was chosen as same as modified GUSS. The procedures of all cases were executed by two trained ENT specialists and one experienced radiologist. Data were evaluated using a modified penetration aspiration scale (MPAS) (Table.1) for partial laryngectomy, already used and described in an earlier article, and the scores were assessed for all cases.[2, 3, 13] Higher scores mean worse performance. In addition, Solid and semisolid food trails were also both assessed in all cases, but once the score of Solid or semisolid food trails was more than or equal to 5, the liquid food trail would be forbidden.

3. Statistical considerations

According to the penetration aspiration scale (PAS), dysphagia was classified four degrees: no dysphagia (PAS score = 1 to 2), mild dysphagia (PAS score = 3 to 4), moderate dysphagia (PAS score = 5 to 6), and severe dysphagia (PAS score =7 to 8), corresponded to minimal、low、moderate and high risks of aspiration.[14]We compared the hierarchical entries of MAPS (Table.1) and PAS, and also classified MAPS to four degrees: no dysphagia (MPAS score = 1) with a minimal risk of aspiration, mild dysphagia (MPAS score = 2) with a low risk of aspiration, moderate dysphagia (MPAS score = 3 to 4) with a moderate risk of aspiration, and severe dysphagia (MPAS score = 5 to 6) with a high risk of aspiration. The highest score achieved in solid、semisolid or liquid swallowing trials was taken as the final score.

Dysphagia severity of modified GUSS was graded to four degrees that were the same as GUSS. 0 to 9 points were rated as severe dysphagia with a high risk of aspiration, 10 to 14 points as moderate dysphagia with a moderate risk of aspiration, 15 to 19 points as mild dysphagia with a low risk of aspiration, and 20 points as no dysphagia.[6] Reliability for modified GUSS was calculated by Spearman's rank correlation coefficient and Kappa statistics and the proportion of overall agreement (P0) as a raw agreement index. A r_s or $\varkappa$ coefficient between 0.4 and 0.8 was rated substantial, and values > 0.8 were considered excellent. Sensitivity and specificity, as well as positive and negative predictive values, were determined by comparing the results of modified GUSS with the results of VFSS. Spearman's rank correlation coefficient was also used to predict the correlation between results of modified GUSS and days from oral feeding to gastric tube extubation. Test validity of the values of r_s or $\varkappa$ coefficient was the same as above. Wilcoxon signed rank tests was used to distinguish the risks of aspiration caused by solid、semisolid、and liquid food. Statistical analyses were performed with SPSS 17.0, and descriptive analyses were performed according to data characteristics.

Results

1. Patient Characteristics

40 patients were included basing on the criteria, and all of them completed swallowing evaluation in the research (Table.2).

2. Interrater Reliability

The overall modified GUSS scores of two raters achieved high positive correlation (r_s=0.961, P<0.01), and the overall severity rating of two raters appeared high consistency (κ=0.849, P<0.01, P0=0.900). Both raters confirmed 16 (40.0%) patients having severe dysphagia in the sample (κ=1.000, P<0.01, P0=1.000). The first rater classified 19 (47.5%) patients as having severe and moderate dysphagia, where the second rater classified 18 (45.0%) patients (κ=0.950, P<0.01, P0=0.975). The first rater found 7 (17.5%) patients with no dysphagia, but the second rater found 4 (10.0%) patients with no dysphagia (κ=0.688, P<0.01, P0=0.925).

3. Predictive Validity

The overall scores of modified GUSS and VFSS illustrated high negative correlation (r_s=-0.931, P<0.01), and the overall severity rating of results of modified GUSS and VFSS achieved excellent agreement (κ=0.848, P<0.01, P0=0.900). The modified GUSS rater found 16 patients (40.0%) with severe dysphagia, but the VFSS rater found 19 (47.5%) patients with severe dysphagia. Predictive values of severe dysphagia by Modified GUSS: sensitivity 84.2%, specificity 100.0%, positive predictive value 100.0% and negative predictive value 87.5% when compared with VFSS (κ=0.848, P<0.01, P0=0.925). The modified GUSS rater classified 18 (45.0%) patients as having severe and moderate dysphagia, whereas the VFSS rater classified 20 (50.0%) patients. Predictive values of severe and moderate dysphagia by Modified GUSS: sensitivity 90.0%, specificity 100.0%, positive predictive value 100.0% and negative predictive value 90.9% when compared with VFSS (κ=0.900, P<0.01, P0=0.950). Both raters confirmed 7 (17.5%) patients having no dysphagia in the sample. Predictive values of dysphagia by Modified GUSS: sensitivity、specificity、positive predictive value and negative predictive value were all 100.0% when compared with VFSS (κ=1, P<0.01, P0=1.00) (Table. 3 and Table. 4). The results of modified GUSS and the days from starting oral intake to removing gastric tube were demonstrated to have substantially negative correlation (r_s= -0.664, P<0.01).

4. Content Validity

All 40 patients completed the solid and semisolid food trails of VFSS. Due to severe aspiration for stopping liquid food trails, just 22 patients finished the liquid food trail. We discovered 14、4、1 and 21 patients corresponding with high to minimal risks of aspiration in solid food trails, whereas 18、2、7 and 13 patients in semisolid food trails. We also found 2、7、13 corresponding with moderate to minimal risks of aspiration in semisolid food trails, whereas 1、1、 13 and 7 patients corresponding with high to minimal risks of aspiration liquid food trails. Overall median scores of solid food (1; interquartile range, 1 to 5) were lower than those of semisolid food (2.5; interquartile range, 1 to 5), thus indicating a higher aspiration risk or more severe dysphagia with semisolid food (n=40, P<0.01). Overall median scores of semisolid food (1; interquartile range, 1 to 2) were lower than those of liquid food (2; interquartile range, 1 to 2), thus indicating a higher aspiration risk or more severe dysphagia with liquid food (n=22, P< 0.01).

Discussion

With the incidence rate of laryngeal cancer increasing year by year in China,[15] more and more patients undergo partial laryngectomy.[5] After partial laryngectomy, the structure、local nerve、muscle and coordination function of larynx and pharynx are affected, resulting in dysphagia.[16] The most serious dysphagia occurs weeks after the surgery, and most patients could get different degrees of improvement through oral intake training, but the remaining problems of swallowing would affect the long-term life of patients, such as repeated pneumonias, change of eating habits and reducing or even refusing of social intercourse.[2]Therefore, it is imperative to evaluate and rehabilitate the swallowing abilities of the patients after partial laryngectomy, especially in early postoperatively period.[5]

VFSS is the gold standard for swallowing examinations.[4, 7, 17] Traditional VFSS usually uses barium as contrast agent that has some drawbacks. Once the barium is aspirated into the trachea and lung, it will be difficult to remove and absorb, and may cause damages of the lung function. Ioiohexol solution is a non-ionic contrast agent, which has the advantages of high-water solubility, low viscosity, low osmotic pressure and low toxicity.[18] Therefore, we improved VFSS using Iohexol Injection to instead of barium.

However, VFSS also has some disadvantages and it is necessary to develop new evaluation tools. So far,

almost all swallowing assessment tools require patients to swallow liquid food directly,[19]while ignoring the swallowing ability of food of other characteristics.[20, 21] GUSS chose three kinds of food to complete the test sequentially, but the evaluation sequence was not suitable for patients with partial laryngectomy. This was based on the following observation: the risk of aspiration of swallowing solid food was lower than that of swallowing semisolid food, and the risk of aspiration of swallowing semisolid food was lower than that of swallowing liquid food. Therefore, we modified the sequence of food trails to minimize the risk of aspiration during the examination and to identify patients who could intake solid, semi-solid or liquid food respectively. This point is important because it guides the rehabilitation.

In our research, we classified modified GUSS into 4 grades according to the severity rating of GUSS, and corresponded to 4 grades of risks of aspiration. The benefit was that both dysphagia and aspiration were evaluated at the same time. And we reported that the severity rating and grades of risks of aspiration assessed by modified GUSS were excellent consistent by comparing with VFSS. It indicated that modified GUSS could distinguish patients suffering from dysphagia with varying degrees of risks of aspiration and even recommend food of different characteristics. Although the recommendations were not drafted by us, they must be dissimilar to those of GUSS because of the modified sequence.

Moreover, we demonstrated that modified GUSS had substantial to excellent interrater reliability for all classification categories. The predictive values were also acceptable. For the chosen no dysphagia grade, it had 100.0% sensitivity and 100.0% specificity VFSS; for the chosen moderate and severe dysphagia grade, it had 90.0% sensitivity and 100.0% specificity; for the chosen severe dysphagia grade, it had 84.2% sensitivity and 100.0% specificity. The all 100.0% specificities meant extremely low misdiagnosis rates, and the high sensitivities meant very low missed diagnosis rates. However, the results revealed that some patients with severe or moderated dysphagia were graded with a lower severity degree, and also indicated that these patients were particularly difficult to swallow semi-solid food and liquid food, while relatively easy to swallowing solid food. In order to adjust this result and identify the false negative patients, daily evaluation by modified GUSS was recommended.

In addition, we revealed that the higher the modified GUSS scores, the less the days from oral feeding to gastric tube extubation. Although we did not set objective criteria for removing the gastric tube, just based on the subjective assessment of the patients by the doctors, we confirmed that the modified GUSS scores could predict the time to remove the gastric tube generally.

In summary, on the basis of GUSS, we introduced a bedside evaluation tool that had good reliability and validity for assessment of swallowing function and risks of aspiration before oral feeding in early period after partial laryngectomy. However, there is still a lot of work to be done according to modified GUSS, such as swallowing rehabilitations、food recommendations、long term evaluation effectiveness and standards for gastric tube extubation.

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