

# Long-term outcomes of supracricoid partial laryngectomy with cricothyroidopexy and its modified version

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## ABSTRACT

**الأهداف:** التحقق من النتائج بعيدة المدى لاستئصال الخنجرية المصابة بالسرطان عن طريق تثبيت المزمار الحلقي الالمني والطريقة المعدلة لتثبيت المزمار الحلقي الالمني والتي عن طريقها تمكنا من الاحتفاظ بالحدود الخلفية والسفلية لكلا من الصفائح الغضروفية للغدة الدرقية لحماية وظيفة البلع.

**الطريقة:** قمنا بمراجعة 86 مريض لمدة 3 أعوام خضع 46 مريض بتثبيت المزمار الحلقي الالمني و40 مريض للعملية المعدلة لتثبيت المزمار الحلقي الالمني. قمنا كذلك بقياس معدل البقاء ومراجعة بيانات إزالة الأنوب. تم قياس جودة الحياة باستخدام استبيان جودة الحياة في 53 من أصل 65 شخص في نهاية فترة المراجعة عام 2011م. كما خضع 24 شخص من أصل 53 مريض لعملية تثبيت المزمار الحلقي الالمني وخضع الباقي لطريقة تثبيت المزمار الحلقي الالمني المعدلة.

**النتائج:** لم تظهر هنالك أي اختلافات مهمة في البقاء لدى المجموعتين  $p=0.92$ ، كان معدل إزالة الأنوب 93.5% في المجموعة التي تم تثبيت المزمار الحلقي الالمني و100% في المجموعة المعدلة. أظهر معدل وقت إزالة الأنوب نتائج إحصائية مهمة  $19.0 \pm 4.6$  يوم في المجموعة التي تم تثبيت المزمار الحلقي الالمني و  $14.0 \pm 2.3$  يوم في المجموعة الخاضعة لتثبيت المزمار الحلقي الالمني بالطريقة المعدلة  $p=0.000$ . كما أظهر تحليل الأنوفا أحادي الاتجاه أثر إحصائي متعدد المتغيرات للمجموعات ونتائج مهمة إحصائية أحادية المتغيرات في 5 مقاييس من أصل 11 مما يشير إلى جودة البلع والحياة لدى المجموعة الخاضعة لطريقة تثبيت المزمار الحلقي الالمني المعدلة ( $p < 0.05$ ).

**خاتمة:** ليس هنالك أي اختلاف إحصائي في معدل البقاء بين المجموعتين. تفوقت المجموعة الخاضعة لتثبيت المزمار الحلقي الالمني بالطريقة المعدلة في إزالة الأنوب بمدة أقل وجودة البلع بشكل أفضل واستخدمها هذه الطريقة مجزية كما أظهرت مؤشرات الدراسة.

**Objectives:** To investigate the long-term outcomes of supracricoid partial laryngectomy with cricothyroidopexy (CHEP) and its modified version, in which we reserve the poster inferior borders of both thyroid cartilage laminae to protect swallowing function.

**Methods:** This retrospective survival analysis was performed in 86 patients, wherein 46 undergoing CHEP and 40 undergoing modified CHEP. Their decannulation data were reviewed. We used swallowing quality-of-life questionnaire to measure the quality-of-life in 53 of the 65 survivals at the end of the follow-up period in 2011. Of the 53 patients, 24 underwent CHEP, while the remaining by modified CHEP.

**Results:** The log rank test showed no significant difference in survival distributions of the two groups ( $p=0.92$ ). The decannulation rate was 93.5% in CHEP and 100% in modified CHEP, showing no significant difference. The time span of decannulation in CHEP was  $19.0 \pm 4.6$  days, significantly longer than ( $14.0 \pm 2.3$  days) the modified CHEP ( $p=0.000$ ). As to quality-of-life data, one-way multivariate analysis of variance, revealed a significant multivariate main effect for groups ( $p=0.001$ ), and significant univariate main effects in 5 scales out of 11 ( $p < 0.05$ ), which showed a better swallowing life quality in modified CHEP.

**Conclusion:** There was no significant difference in survival rate between the 2 surgeries. The modified CHEP succeeded in earlier decannulation and better long-term swallowing life quality. Thus, modified CHEP is worth promoting, as long as indications were strictly conformed.

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The surgical concept of supracricoid partial laryngectomy with cricohyoidoepiglottopexy (CHED) was first introduced in 1959 by Majer and Rieder.<sup>1</sup> The CHEP technique was originally applied to 1) the early tumors of the glottis in an attempt to increase the local control rate when compared with the conventional modality of vertical partial laryngectomy or radiation therapy, and 2) advanced tumors of the glottis to avoid permanent tracheostomy which is required in total laryngectomy or near-total laryngectomy. In the latest decade and many areas of the world, as radiotherapy and carbon dioxide laser therapy became the primary treatments for early glottis cancer, CHEP became an important surgical salvage treatment in patients with radiation/laser therapy failure.<sup>2,3</sup> Since our adoption of this technique in 1998, we used it in patients without preoperative radiotherapy, but some received postoperative radiotherapy as a supplementary therapy. Generally, satisfactory curative effect has been achieved. However, the postoperative patients often suffered from deglutition disorders, for instance, severe aspiration. In order to ameliorate patients' swallowing function, we made further study to modify the technique of CHEP, and developed a so called "modified CHEP" in 2000. Both 2 techniques have a common use in our department since then. After a long-term follow-up, we noticed that those who underwent modified CHEP had much less complaints on swallowing than those who underwent CHEP. Therefore, this clinical study aimed to comprehensively understand the long-term outcomes of these 2 surgeries. Since the data proved the advantage of modified CHEP, we probed into anatomic and technical reasons and called for a wilder, but appropriate usage of this surgical technique.

**Methods.** *Clinical materials.* A retrospective survival analysis was performed. Participants in this study were patients with histopathological diagnosis of squamous cell carcinoma, locating at the glottis, staged from T2N0M0 to T4N1M0, and submitted to either CHEP or modified CHEP between January 2000 and September 2008, in the Department of Otorhinolaryngology, the first affiliated hospital of

Wenzhou Medical College, Wenzhou, China. Patients who received extra radiotherapy and chemical therapy were included in the study. We excluded those who had any disorder that probably influence swallowing function, such as esophageal, oral, neurological diseases, and those who experienced any other head and neck surgery before or during the research. During questionnaire survey, to ensure the quality of survey, those with communication disorders such as dementia, deafness, and illiteracy were excluded.

The questionnaire survey was carried out on October and November in 2011. Respondents were volunteers of the survivals, recruited by the inclusive and exclusive criteria mentioned above. Information on participants are summarized in Table 1. Each subject signed an agreement of participation in this study that was approved by the Research Ethics Committee, Wenzhou Medical College.

*Surgical techniques.* 1) Traditional CHEP: Both vocal cords, laryngeal ventricles, false vocal cords, part of aryepiglottic fold, and the whole thyroid cartilage or most of it were routinely removed, while the epiglottic cartilage and at least one arytenoid cartilage were preserved. The cricoid was lifted and fixed to hyoid and epiglottis directly (Figure 1a). 2) Modified CHEP: In the ill side, true and false vocal cord, immobile or mobility-limited arytenoid cartilage and anterior 2/3 laminae of thyroid cartilage are removed. In the other side, true and false vocal cord along with approximately 1/3 to 2/3 laminae of thyroid cartilage were removed, while the healthy cricoarytenoid joint was reserved. To emphasize the key point, the poster inferior borders of laminae of thyroid cartilage in both sides were reserved. The cricoid was also lifted and fixed to hyoid and epiglottis directly (Figure 1b). 3. Tools and methods: The swallowing quality-of-life questionnaire (SWAL-QOL) was applied to measure the long-term postoperative quality-of-life. This questionnaire, created by Mchorney et al<sup>4,6</sup> is a specific tool to assess the impact of swallowing alterations on life quality. The Chinese version of SWAL-QOL (CSWAL-QOL) was translated in 2010 and proved to be clinically valid and reliable in Chinese community.<sup>7</sup> It consists of 44 items distributed in 11 scales: burden, eating duration, symptom frequency, eating desire, food selection, communication, mental health, social function, fear, fatigue, and sleep. Each item is a question with 5 answers that converted into scores that vary between 0 and 100 (worse and best scoring).<sup>5</sup>

Statistical analysis was performed using the Statistical Package for Social Sciences Version 12.0 (SPSS Inc., Chicago, IL, USA). Values were expressed

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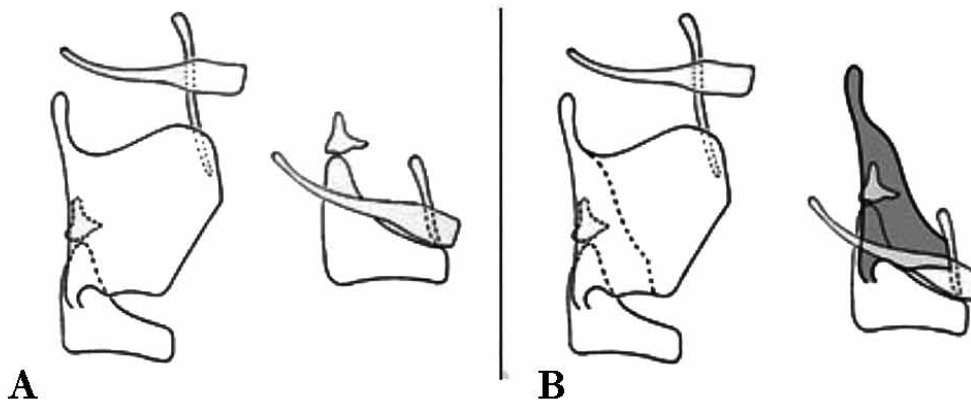
**Table 1** - Demographic, clinical, and treatment characteristics of participants.

Demographic/category	Survival analysis (N=86)			QOL survey (N=53)		
	CHEP (n=46)	Modified CHEP (n=40)	P-value	CHEP (n=24)	Modified CHEP (n=29)	P-value
<i>Age (years)</i>						
Min - Max	44-82	42-79	-	48-78	45-77	-
Median	61	59.5	0.488	63	64	0.151
<i>Gender</i>						
Males	46	39	0.465	24	28	0.547
Females	0	1		0	1	
<i>Stage</i>						
-	-	-	0.730	-	-	1.000
T2N0M0	14	14	-	8	9	-
T2N1M0	6	7	-	2	4	-
T3N0M0	13	5	-	8	8	-
T3N1M0	10	14	-	5	8	-
T4N1M0	3	0	-	1	0	-
<i>Postoperative radiotherapy</i>						
Yes	19	20	0.419	9	13	0.590
No	27	20		15	16	
<i>Chemotherapy</i>						
Yes	18	19	0.434	9	12	0.773
No	28	21		15	17	
<i>Arytenoid removed</i>						
One	27	29	0.180	14	17	0.983
None	19	11		10	12	
<i>Neck dissection</i>						
Yes	19	21	0.299	7	10	0.680
No	27	19		17	19	
<i>Follow-up time (months)</i>						
Min - Max	12-92 <sup>a</sup>	18-96 <sup>a</sup>	-	36-92	36-88	-
Median	58	59.5	0.390	58.5	61	0.251

Min - minimum, Max - maximum. <sup>a</sup>Every patient was supposed to be followed-up for more than 36 months.

The numbers less than 36 represented the follow-up time of those who did not survive to 36 months.

CHEP - cricothyroidopiglottopey, QOL - quality of life

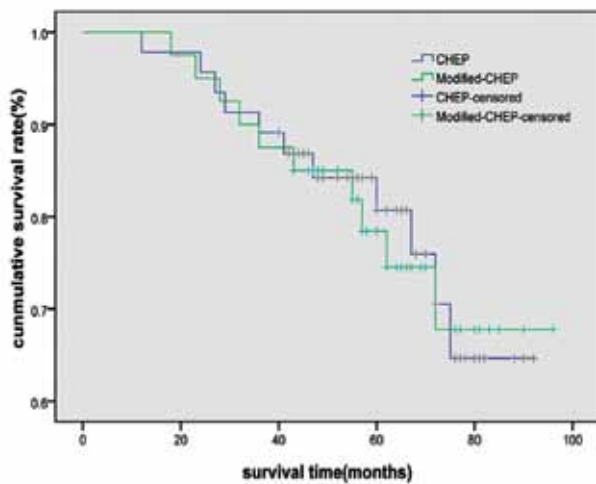


**Figure 1** - Excision range. A) Represents the procedure of cricothyroidopiglottopey (CHEP) and B) modified CHEP. The CHEP removed the whole thyroid cartilage while modified CHEP reserves the posteroinferior borders of laminae of thyroid cartilage on both sides.

as Means±SD or as percentages. Means were compared by the Student's t-test or Analysis of Variance Test. The percentages were calculated in the presence and absence group by Pearson's Chi-square test. Kaplan-Meier analysis<sup>8</sup> was used to calculate the survival rates, and the log rank test was applied to compare the survival distribution of the 2 groups. The limit for statistical significance was set at  $p < 0.05$ .

**Results.** We followed up 86 postoperative patients for survival analysis, and recruited 53 of the 65 survived patients to take part in the questionnaire survey held in 2011. The demographic, clinical, and treatment characteristics of the 2 groups are well matched (Table 1).

According to the Kaplan-Meier survival curve, we observed that the survival rates in the 2 groups at different time varied mildly (Figure 2). The log rank test



**Figure 2** - Kaplan-Meier survival curve of cricohyoidoepiglottopexy (CHED) and modified CHEP.

**Table 2** - Score distribution regarding each scale of SWAL-QOL.

Score distribution	CHEP (n=24) Mean±SD	Modified CHEP (n=29) Mean±SD	P-value of univariate main effects
Burden	76.04±31.69	86.64±14.91	0.115
Eating desire	90.28±18.33	95.40±8.21	0.182
Eating duration	66.15±35.64	88.79±19.29	0.005
Symptom frequency	82.05±13.15	86.67±10.89	0.168
Food selection	88.02±18.61	98.28±4.39	0.006
Communication	55.73±24.99	62.93±30.52	0.358
Fear	71.61±27.71	86.64±16.26	0.017
Mental health	83.13±25.83	95.86±10.70	0.019
Social function	62.29±32.40	77.76±21.78	0.044
Fatigue	87.50±15.15	92.82±9.38	0.124
Sleep	82.81±16.82	79.31±23.21	0.540

CHED - cricohyoidoepiglottopexy,  
SWAL-QOL – swallowing quality of life questionnaire

showed no significant difference in survival distributions of the groups ( $\chi^2=0.008$ ,  $p=0.92$ ). The Kaplan-Meier survival analysis also revealed that the 3-year cumulative survival rate in the CHEP group was 89.1% and in the modified CHEP group was 87.5% while the 5-year cumulative survival rate was 80.7% in the CHEP group and 78.4% in the modified CHEP group. Within the CHEP and modified CHEP groups, the decannulation rate was 93.5% (43/46) and 100% (40/40) showing no significant difference (Fisher's exact test,  $p=0.148$ ). The time span of decannulation in the CHEP group was  $19.0 \pm 4.6$  days, significantly longer than  $14.0 \pm 2.3$  days in the modified CHEP group ( $t=6.27$ ,  $p=0.000$ ).

As to the swallowing quality-of-life survey, the score distribution regarding each scale was summarized in Table 2. It provides an intuitive impression that modified CHEP group gained higher scores than CHEP group in most scales. A one-way MANOVA was introduced to analyze the quality-of-life data, which revealed a significant multivariate main effect for groups (Wilks'  $\lambda=0.509$ ,  $F=3.596$ ,  $p=0.001$ ). Significant univariate main effects were obtained for groups in 5 scales out of 11 (eating duration,  $p=0.005$ ; food selection,  $p=0.006$ ; fear,  $p=0.017$ ; mental health,  $p=0.019$ ; social function,  $p=0.044$ ). These results demonstrated that patients after using the modified CHEP earned a better swallowing quality-of-life than those who underwent regular CHEP.

**Discussion.** With the updating knowledge of the characteristic of embryogenesis, anatomic structure and lymphatic drainage of larynx, plenty of innovations in technique of laryngectomy to preserve laryngeal function have been successfully achieved. The technique of CHEP is an innovation in the field of modern laryngeal functional surgery.<sup>9</sup> Satisfying life quality and long-term survival rate has been proved after wide adoption.<sup>10,11</sup> Swallowing disorder is frequent and regarded as the main defect of CHEP, displayed as aspiration, which can cause respiratory complications such as broncho-pulmonary infections.<sup>12,13</sup> Aiming to improve the postoperative life quality further, we modified the original technique of CHEP in 2000, called modified CHEP. Henceforth, both techniques were adopted in our department. Results demonstrated that modified group indeed excelled at long-term swallowing function recovery, and related quality of life. Survival analysis proved no difference in survival rate between groups.

Swallowing is a daily experience, which affects the most basic of sociobiological functions: the ability to eat and drink.<sup>5</sup> Most patients after CHEP can back to

an oral diet; however, swallowing disorder more or less remains with different severity. For example, choke on liquids is the most common experience in patients. What this brings to patients is much more than physiology discomfort. Patients with persistent aspiration, especially the serious cases, often suffer from anxiety and depression, and then become self-contemptuous and self-reclusive. Life quality will change for the worse over time. During the SWAL-QOL survey, not a few patients in CHEP group agreed with statements listed in social function scale of SWAL-QOL: my swallowing problem makes it hard to have a social life; my role with family and friends has changed because of my swallowing problem, and so forth. Nevertheless, patients in modified CHEP group seldom complained of severe swallowing discomfort that burdened their life. However, many of them also told that mild aspiration still exists. Social function was also somewhat affected in modified group but much better than CHEP group. Generally, modified CHEP had a milder impact on postoperative swallowing life quality than CHEP.

The supposed technical reasons for better swallowing function in modified CHEP are listed as follows: 1) to enter the laryngeal cavity, frontal longitudinal incision on thyroid cartilage is performed, leaning to the none-tumor bearing side. There is no need to transect the superior and inferior cornua of thyroid cartilage on the tumor-affected side, and no need to disarticulate cricothyroid joint. Therefore, the possibility of injury to laryngeal nerves is minimized. Moreover, this entrance to laryngeal cavity provides a convenient and appropriate view for operative manipulation. 2) The preservation of posterior-inferior of thyroid lamina makes the aditus of neo-larynx in a relatively high position during eating. Additionally, dissection of pyriform fossae and inner thyroid cartilage perichondrium from the inner surface of the thyroid lamina is not needed; hence, the pyriform fossae after surgery remain in a relatively natural condition, and the postoperative reposition of them is accelerated, compared to traditional CHEP. Naudo et al<sup>14</sup> noted that pyriform fossae reposition is the only variable that statistically reduces the risk of aspiration. Patients managed with traditional CHEP usually feel irritated by spontaneous choke/cough due to aspiration of secretion, which leads to consequent dread of eating or drinking. The modified CHEP can help to reduce the discomfort of choke/cough, and the fear of feeding, which will be tremendously helpful for further feeding training. In the procedure of modified CHEP, the range of resection is similar to the common used "extended vertical partial laryngectomy" but then comes the difference. No flap pleriosis is needed during operation,

instead by fixing cricoid to hyoid and epiglottis directly. Thus, there will barely be complications such as failure of decannulation as a result of stenosis of neo-larynx. Benefiting from the preservation of posterior parts of thyroid lamina and arytenoid cartilages as a suitable frame for reconstruction of lateral wall, early decannulation will be obtained after modified CHEP. Early decannulation training and appropriate vocal training can be smoothly performed for laryngeal functional recovery. It was suggested that early decannulation could stimulate a promptly recovery of swallowing and vocal function.<sup>15</sup> Furthermore, risk of nosocomial infection is lessened and length of hospital stay is shortened, as a result of reduction of pulmonary infection rate related to oral secretion aspiration.

Considering the preservation of such sizable thyroid lamina during the procedure of modified CHEP, we strongly recommend that it should be indicated for 1) tumors of glottis classified as T2 with mobility limitation of vocal cord and laryngeal ventricle invasion, or with a subglottic invasion less than 1 cm, 2) tumors of glottis classified as T3 with paraglottic space invasion, especially when the contralateral vocal cord is invaded, but the cricoarytenoid joint remains unaffected. Traditional CHEP has a wider range of indication. Except the above-mentioned, it indicates for T4 glottic tumors with localized invasion of thyroid cartilage, without outer perichondrium of thyroid cartilage involved.

Contraindication of traditional CHEP includes 1) tumors of glottis with immobility of both arytenoid cartilages or invasion of posterior commissure. 2) extended invasion of subglottis, 3) tumors of the glottis invading the outer perichondrium of the thyroid cartilage or presenting with extralaryngeal spread. Modified CHEP is recommended with a stricter contraindication. Along with those mentioned above, T4 glottic tumors with localized invasion of thyroid cartilage (with or without invasion of the outer perichondrium) should also be the contraindication.

In summary, provided that indications and contra-indications are strictly complied, theoretically, all kinds of partial laryngectomies can achieve a satisfying local control rate and surviving rate. Under the premise of guarantee of local control, we should consider cautiously to ameliorate patients' life quality when making treatment plan. Admittedly, owing to the development of techniques, carbon dioxide laser and radiotherapy are now playing important roles in head and neck field. But surgery treatment is still the ultimate weapon against cancers. It either acts the role as a remedial operation after a failure radiotherapy/laser treatment, or remains to be the first choice for



laryngeal cancer in many developing countries. We do not have enough experience of using these surgeries to previously irradiated patients, in which we are going to step. But technically as CHEP and modified CHEP are concerned, we prefer the latter one, which protects swallowing function more efficiently.

**Study limitations.** Firstly, all participants had no previously radiotherapy; thus, the data persuasion limited when these two surgeries performed as salvage methods. Secondly, it would be better if objective assessment of the swallowing function was used, along with SWAL-QOL questionnaire.

In conclusion, there was no significant difference in survival rate between the 2 surgical techniques: traditional CHEP and modified CHEP. Modified CHEP succeeded in earlier decannulation and better swallowing function leading to a satisfactory long-term quality of life. Thus, modified CHEP is worth promoting, as long as indications were strictly conformed.

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## Ethical Consent

All manuscripts reporting the results of experimental investigations involving human subjects should include a statement confirming that informed consent was obtained from each subject or subject's guardian, after receiving approval of the experimental protocol by a local human ethics committee, or institutional review board. When reporting experiments on animals, authors should indicate whether the institutional and national guide for the care and use of laboratory animals was followed.