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ORIGINAL RESEARCH

The voice quality after laser surgery versus radiotherapy of T1a glottic carcinoma: systematic review and meta-analysis

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Background and objectives: The voice quality assessment of laser surgery (LS) in comparison with radiotherapy (RT) remains uncertain in T1a glottic carcinoma treatment. This systematic review and meta-analysis were conducted to compare the voice quality of the two treatments.
Methods: Searches were conducted in PubMed, EMBASE, and Cochrane with the following index words: glotti*, layn*, vocal cord, vocal, surgery, cordectomy, laser, radiation, irradiation, radiotherapy, cancer, and carcinoma for relative studies that compared the voice quality between LS and RT. Random-effect models were used, and heterogeneity was assessed.
Results: A total of 14 studies were included in the analysis, consisting of 1 randomized controlled trial, 1 prospective study, and 12 retrospective studies. RT has increased the maximum phonation time (MPT; mean difference [MD] =–1.89, 95% confidence interval [CI] =–3.66 to –0.11, *P*=0.04) and decreased the fundamental frequency (MD =14.06, 95% CI =10.30–17.83, $P<0.00001$) in comparison with LS. No statistical difference was observed between the two groups in terms of Voice Handicap Index, Jitter, Shimmer, and airflow rate.
Conclusion: RT may be a better choice for T1a glottic carcinoma treatment compared with LS because patients undergoing RT may have the advantage of increased MPT and decreased fundamental frequency. However, more multicenter, randomized, controlled trials are urgently needed to verify these differences.
Keywords: laser therapy, radiotherapy, meta-analysis, glottis, laryngeal neoplasms

Introduction

Laryngeal carcinoma is the most common malignant tumors of head and neck, and the majority of laryngeal carcinoma are confined within the glottic area.[1,2] Owing to the involvement of the vocal folds, patients with glottic carcinoma always present with hoarseness in early stages. Therefore, glottic carcinoma can usually be diagnosed at the early stage and related treatment can often be achieved early.[3,4]

Laser surgery (LS), radiotherapy (RT), and open surgery all are accepted modalities of treatment for T1a glottic carcinoma. Open laryngectomy has been applied for >100 years. This method is still being used to cure T1a glottic carcinoma in locations that do not have access. Open surgery provides excellent exposure and has a higher rate of locoregional control, but voice quality is generally worse than that after RT or after LS.[5–7] Furthermore, with the development of RT and the improvements in LS, open surgery is gradually being substituted. Therefore, open surgery should not be used any more for primary treatment of T1a glottic carcinoma.

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Nowadays, T1a glottic carcinoma is usually treated by LS or RT. Both LS and RT have good oncology and survival outcomes.[8,9] Low et al displayed a retrospective review covering all consecutive patients from 2003 to 2013; patients of T1a glottic carcinoma were offered the options of either LS or RT.[10] There were 105 patients, of whom 53 were treated with LS and 52 were treated with RT. The 5-year overall survival of patients with T1a glottic carcinoma treated with LM versus RT was 86% versus 85% (P=0.887), laryngectomy-free survival (LFS) was 65% versus 77% (P=0.198), laryngectomy-free disease-specific survival (LFS-DSS) was 100% versus 88% (P=0.030), disease-free survival was 69% versus 78% (P=0.151), and ultimate locoregional control was 100% versus 100%.

Thus, the treatment option of LS and RT for patients of T1a glottic carcinoma often depends on quality of life, particularly the voice quality.[1,11–13] In this paper, this meta-analysis is conducted to compare the voice quality of LS and RT, which can help better patients of T1a glottic carcinoma to choose a reasonable treatment.

Methods

Data sources and literature search strategy

Literature review was separately conducted by two investigators (GJH and MSL) through online data sources PubMed, EMBASE, and Cochrane (up to October 2016), using the following index words: glotti*, layn*, vocal cord, vocal, surgery, cordectomy, laser, radiation, irradiation, radiotherapy, cancer, and carcinoma.

Study selection

Inclusion criteria were: 1) randomized controlled trials, prospective studies or retrospective studies; 2) patients who underwent first treatment for T1a glottic carcinoma; 3) comparing LS with RT on interest outcomes such as Voice Handicap Index (VHI), acoustic analysis, and perceptual analysis; and 4) written in English language.

Study quality assessment

Study quality assessment was all conducted by The Newcastle–Ottawa Quality Assessment Scale (NOS). The study that is considered as high quality is eligible for the research.

Data extraction

The data on characteristics of studies, VHI, and acoustic analysis were extracted from the selected studies by one author (GJH) and checked by another author (JXZ). Information included are study name, publication year, study design, number of patients, age, sex, tumor stage, follow-up time, VHI, and acoustic analysis.

Statistical analysis

Review Manager Version 5.3 was applied to perform this meta-analysis. Outcome data reported as mean ± standard deviation (SD) were adopted, and mean difference (MD) was calculated. Continuous outcome variables were compared using weighted MD and 95% confidence intervals (CIs). Heterogeneity of the studies was evaluated by the chi-squared statistic and publication bias by funnel plots, in which significance was set at $P<0.1$. The I^2 test was involved to measure the extent of inconsistency among results. The z statistic was used to test the overall pooled effect, and significance was set at $P<0.05$. All the statistical results use random-effect models. The subgroup analysis was conducted based on the study design.

Results

Eligible studies and characteristics of studies

In this meta-analysis, 14 studies were included: 1 randomized controlled trial, 1 prospective study, and 12 retrospective studies (Figure 1). Only one randomized controlled trial is included. A total of 701 patients were included in the research, of whom 395 (56%) underwent LS and 306 (44%) underwent RT. The characteristics of the included studies are shown in Table 1, and detailed data are shown in Tables 2 and 3.

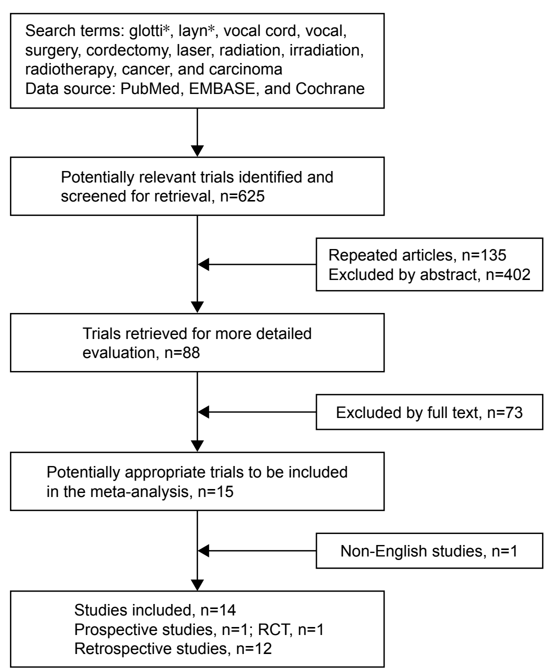


Figure 1 Stages of the systematic review of the trials.
Abbreviation: RCT, randomized controlled trial.

Table 1 Characteristics and demographics of included studies

Reference	Year	Design	Group, n		Classification of LS, n			Classification of RT, n			Male/female, n		Mean age, years		Follow-up time, months		NOS
			LS	RT	T1a	T1b	T2	T1a	T1b	T2	LS	RT	LS	RT	LS	RT	
Cragle and Brandenburg[24]	1993	Retrospective	11	20	11	0	0	20	0	0	n/a	n/a	n/a	n/a	≥5.0	≥5.0	7
McGuirt et al[25]	1994	Retrospective	11	13	11	0	0	13	0	0	11/0	13/0	n/a	n/a	≥6.0	≥6.0	7
Rydell et al[26]	1995	Retrospective	18	18	18	0	0	18	0	0	18/0	18/0	65.2	63.9	24.0	24.0	7
Wedman et al[27]	2002	Retrospective	15	9	15	0	0	9	0	0	n/a	n/a	n/a	n/a	≥24.0	≥24.0	7
Tamura et al[28]	2003	Retrospective	14	6	14	0	0	6	0	0	14/0	6/0	69.0	71.0	26.3	21.3	6
Krengli et al[29]	2004	Retrospective	30	27	30	0	0	27	0	0	29/1	26/1	67.5	69.0	62.0	60.0	7
Peeters et al[30]	2004	Retrospective	52	40	52	0	0	40	0	0	47/5	38/2	66.0	64.0	≥12.0	≥12.0	7
Loughran et al[31]	2005	Retrospective	18	18	18	0	0	18	0	0	18/0	18/0	69.4	70.3	27.6	31.4	7
Goor et al[32]	2007	Retrospective	54	35	54	0	0	35	0	0	49/5	30/35	67.4	63.8	24.0	24.0	7
Nunez et al[33]	2008	Retrospective	19	18	19	0	0	13	5	0	n/a	n/a	64.0	67.0	30.0	43.0	8
Sjogren et al[15]	2008	Retrospective	18	16	18	0	0	16	0	0	14/4	13/3	67.0	69.0	45.0	60.0	7
van Gogh et al[34]	2012	Prospective	67	39	67	0	0	39	0	0	67/0	39/0	n/a	n/a	24.0	24.0	8
Aaltonen et al[16]	2014	RCT	31	25	31	0	0	25	0	0	31/0	25/0	69.0	61.0	24.0	24.0	9
Kono et al[14]	2016	Retrospective	37	27	37	0	0	27	0	0	33/4	22/5	n/a	69.0	24.0	37.0	8

Abbreviations: LS, laser surgery; n, number of patients; n/a, not available; NOS, Newcastle–Ottawa Quality Assessment Scale; RCT, randomized controlled trial; RT, radiotherapy.

Meta-analysis of postoperative outcomes

Voice Handicap Index

Among the included studies, only 5 studies provide detailed data on VHI with 162 patients in the LS group and 123 patients in the RT group. Heterogeneity was identified between the studies (Chi^2 =25.26, $P<0.0001$, I^2=84%); therefore, a random-effects model was used to calculate the pooled effect. Results of the pooled effect showed that the difference between LS and RT with respect to the VHI was not statistically significant (test for subgroup differences: MD =5.86, 95% CI =–5.22 to 16.84, P=0.30); in VHI (2004–2007) studies subgroup: MD =–5.32, 95% CI =–13.77 to 3.14, P=0.22, whereas in VHI (2008–2016) studies subgroup: MD =16.79, 95% CI =14.85 to 18.74, $P<0.00001$ (Figure 2).

Acoustic analysis

Among the included studies, 10 studies provide detailed data on acoustic analysis with 258 patients in the LS group and 224 patients in the RT group. RT has increased the maximum phonation time (MPT; MD =–1.89, 95% CI =–3.66 to –0.11, P=0.04; Figure 3A) and decreased the fundamental frequency (F_0) (MD =14.06, 95% CI =10.30 to 17.83, $P<0.00001$; Figure 3B) in comparison with LS. There are no statistical significances in Jitter (MD =0.73, 95% CI =–0.37 to 1.83, $P<0.00001$; Figure 3C), Shimmer (MD =0.93, 95% CI =–0.81 to 2.67, $P<0.00001$; Figure 3D), and airflow rate (AFR) (MD =21.46, 95% CI =–78.79 to 121.72, $P<0.00001$; Figure 3E).

All outcomes of interest were listed in Table 4, and the funnel plots show the publication bias of the F_0 (Figure 4).

Table 2 VHI of the two treatment groups in the included studies

Reference	LS group			RT group		
	n	Mean	SD	n	Mean	SD
Peeters et al[30]	52	12	30	40	18	26
Loughran et al[31]	18	22.2	24.6	18	25.4	24.7
Goor et al[32]	36	10.6	32	20	17.1	38.7
Nunez et al[33]	19	28.79	19.8	18	9.67	9.1
Kono et al[14]	37	29.3	4.9	27	12.6	3.2

Abbreviations: LS, laser surgery; n, number of patients; RT, radiotherapy; SD, standard deviation; VHI, Voice Handicap Index.

Perceptual analysis

One important method of voice quality evaluation is the perceptual analysis by GRBAS scale, and three studies were included. Voice quality was assessed on the GRBAS scale, consisting of grade (G), roughness (R), breathiness (B), asthenia (A), and strain (S). Ratings of these five aspects of voice quality varied from 0 (normal) to 3 (extremely abnormal).[14–16] The higher the score, the more dysphonic the voice. Kono et al[14] proved that tissue loss because of LS causes incomplete closure, which in turn is related to breathiness. Sjogren et al[15] reported that patients showed mainly a mixed pattern of roughness and breathiness after RT, whereas patients were characterized as predominantly breathy after LS. They discussed that a possible explanation for these differences may be related to differences in classification of roughness. Aaltonen et al[16] reported that breathiness improved after RT over the 2-year observation period, whereas no improvement in any of the five voice quality measures of the GRBAS scale occurred in the TLS group.

Discussion

In 2009, the European Laryngological Society developed a classification of transoral laser vocal cord resection.[17]

Table 3 Acoustic analysis of the two treatment groups in the included studies

Reference	LS group						RT group					
	n	MPT	F_0	AFR	Jitter	Shimmer	n	MPT	F_0	AFR	Jitter	Shimmer
Cragle and Brandenburg[24]	11	16.00±1.00	n/a	204.00±1.0	n/a	13.14±1.00	20	17.50±1.00	n/a	142.00±1.00	n/a	14.46±1.00
McGuirt et al[25]	11	15.81±1.00	157.0±1.00	118.5±1.1	0.74±1.00	n/a	13	19.26±1.00	136.00±1.00	177.21±1.10	0.84±1.00	n/a
Rydell et al[26]	18	n/a	125.0±1.00	n/a	1.20±1.50	8.00±1.00	18	n/a	107.00±1.00	n/a	0.70±0.03	8.25±0.50
Wedman et al[27]	9	n/a	144.0±20.00	n/a	8.67±2.89	1.31±0.26	15	n/a	137.00±12.00	n/a	8.38±1.66	1.68±0.31
Tamura et al[28]	14	14.30±6.46	169.0±37.83	237±123.7	1.13±0.85	3.80±1.60	6	18.06±3.48	160.00±43.20	165.00±73.88	0.93±0.58	2.82±1.78
Krengli et al[29]	30	n/a	134.5±33.39	n/a	5.90±5.70	12.20±2.90	27	n/a	167.80±55.88	n/a	2.30±1.39	8.00±4.32
Nunez et al[33]	19	11.83±5.28	173.4±47.41	n/a	0.44±0.24	5.08±4.72	18	8.63±3.23	199.04±51.46	n/a	0.72±0.91	4.07±4.09
Sjogren et al[15]	18	n/a	156.0±1.83	n/a	n/a	n/a	16	n/a	145.00±2.74	n/a	n/a	n/a
van Gogh et al[34]	67	n/a	141±33	n/a	0.46±0.49	5.28±3.19	39	n/a	124±29	n/a	0.62±0.62	5.81±3.75
Kono et al[14]	37	14.5±4.2	180.6±16.6	n/a	4.13±0.63	7.45±1.06	27	18.1±4.7	167.2±11.1	n/a	1.64±0.34	3.39±0.39

Abbreviations: AFR, air flow rate; F_0, fundamental frequency; LS, laser surgery; MPT, maximum phonation time; n, number of patients; n/a, not available; RT, radiotherapy.

Type I: resection of vocal cord mucosa; Type II: resection of vocal cord mucosa and acoustic ligament; Type III: resection of vocal cord mucosa, acoustic ligament, and part of the vocal cord; Type IV: total vocal resection, including glottic fissure; Type V: total vocal resection, including anterior or arytenoid cartilage or part of the glottis or part of the subglottic structure. LS has plenty of unique advantages. It can achieve precise cutting, bloodless operation, short operation time, and significantly reduce the recurrence rate.[11,18–20] Besides, the length of hospital stay will be shortened, and the cost of hospitalization is greatly reduced.[21]

At the same time, RT for T1a glottic carcinoma is more and more important, which has obvious therapeutic effects on T1a glottic carcinoma. RT can protect the laryngeal function and also can achieve similar therapeutic effects of surgery for patients of T1a glottic carcinoma.[10,13,19] With the development of science and technology, modern RT technology tends to be more targeted accurately. Compared with conventional RT, modern RT technology can be accurately applied to the tumor location and reduce the damage to normal cells.[22,23] Nowadays, RT has been the gold standard for T1a glottic carcinoma treatment, but gradually the use of LS has increased. Therefore, patient-related factors may be the most important when choosing the treatment option for T1a glottic carcinoma.

With respect to VHI, sensitivity testing was conducted by subgroup analysis because there is moderate heterogeneity among the studies. The studies are subgrouped by the published

Reference: study or subgroup	LS Mean	SD	Total	RT Mean	SD	Total	Weight (%)	Mean difference IV, random, 95% CI	Year
VHI (2004–2007)									
Peeters et al[30]	12	30	52	18	26	40	20.6	–6.00 (–17.46, 5.46)	2004
Loughran et al[31]	22.2	24.6	18	25.4	24.7	18	17.0	–3.20 (–19.30, 12.90)	2005
Goor et al[32]	10.6	32	36	17.1	38.7	20	14.3	–6.50 (–26.42, 13.42)	2007
Subtotal (95% CI)			**106**			**78**	**51.9**	**–5.32 (–13.77, 3.14)**	
Heterogeneity: τ^2=0.00; χ^2=0.09, *df*=2 (*P*=0.95); I^2=0%									
Test for overall effect: *Z*=1.23 (*P*=0.22)									
VHI (2008–2016)									
Nunez et al[33]	28.79	19.8	19	9.67	9.1	18	21.9	19.12 (9.27, 28.97)	2008
Kono et al[14]	29.3	4.9	37	12.6	3.2	27	26.2	16.70 (14.71, 18.69)	2016
Subtotal (95% CI)			**56**			**45**	**48.1**	**16.79 (14.85, 18.74)**	
Heterogeneity: τ^2=0.00; χ^2=0.22, *df*=1 (*P*=0.64); I^2=0%									
Test for overall effect: *Z*=16.90 (*P*<0.00001)									
Total (95% CI)			**162**			**123**	**100**	**5.86 (–5.22, 16.94)**	
Heterogeneity: τ^2=120.83; χ^2=25.26, *df*=4 (*P*<0.0001); I^2=84%									
Test for overall effect: *Z*=1.04 (*P*=0.30)									
Test for subgroup differences: χ^2=24.95, *df*=1 (*P*<0.00001), I^2=96.0%									

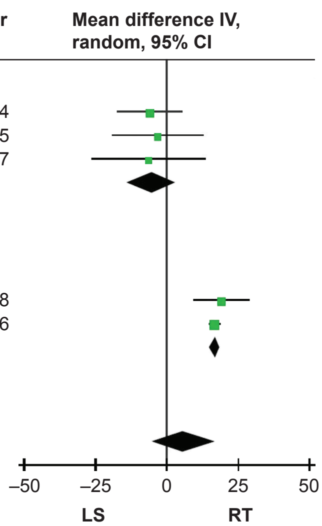


Figure 2 Forest plots of Voice Handicap Index (VHI).

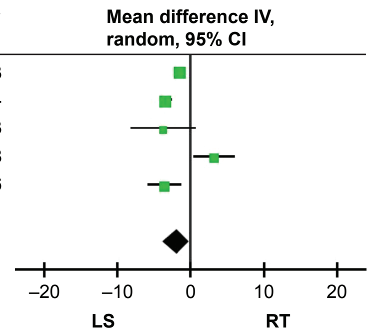
Notes: The random-effects meta-analysis model (Mantel–Haenszel method) was used in this analysis. This is presented graphically as a black diamond, where the center of the diamond is the overall estimate and the width of the diamond is the overall confidence interval; the size of the green squares denotes the weight given to the study, with larger squares reflecting more weight.

Abbreviations: CI, confidence interval; IV, inverse variance; LS, laser surgery; RT, radiotherapy; SD, standard deviation.

A

Reference: study or subgroup	LS Mean	LS SD	LS Total	RT Mean	RT SD	RT Total	Weight (%)	Mean difference IV, random, 95% CI	Year
Cragle and Brandenburg[24]	16	1	11	17.5	1	20	26.9	–1.50 (–2.24, –0.76)	1993
McGuirt et al[25]	15.81	1	11	19.26	1	13	26.6	–3.45 (–4.25, –2.65)	1994
Tamura et al[28]	14.3	6.46	14	18.06	3.48	6	10.4	–3.76 (–8.14, 0.62)	2003
Nunez et al[33]	11.83	5.28	19	8.63	3.23	18	16.6	3.20 (0.40, 6.00)	2008
Kono et al[14]	14.5	4.2	37	18.1	4.7	27	19.5	–3.60 (–5.83, –1.37)	2016
Total (95% CI)			**92**			**84**	**100**	**–1.89 (–3.66, –0.11)**	

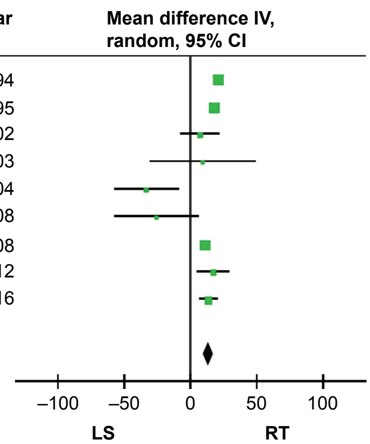
Heterogeneity: $\tau^2=2.92$; $\chi^2=28.93$, $df=4$ ($P<0.00001$); $I^2=86\%$
Test for overall effect: $Z=2.08$ ($P=0.04$)



B

Reference: study or subgroup	LS Mean	LS SD	LS Total	RT Mean	RT SD	RT Total	Weight (%)	Mean difference IV, random, 95% CI	Year
McGuirt et al[25]	157	1	11	136	1	13	23.5	21.00 (20.20, 21.80)	1994
Rydell et al[26]	125	1	18	107	1	18	23.6	18.00 (17.35, 18.65)	1995
Wedman et al[27]	144	20	9	137	12	15	5.3	7.00 (–7.41, 21.41)	2002
Tamura et al[28]	169	37.83	14	160	43.2	6	0.9	9.00 (–30.84, 48.84)	2003
Krengli et al[29]	134.5	33.39	30	167.8	55.88	27	2.2	–33.30 (–57.53, –9.07)	2004
Sjogren et al[15]	173.4	47.41	19	199.04	51.46	18	1.3	–25.64 (–57.57, 6.29)	2008
Nunez et al[33]	156	1.83	18	145	2.74	16	22.8	11.00 (9.41, 12.59)	2008
van Gogh et al[34]	141	33	67	124	29	39	6.9	17.00 (4.95, 29.05)	2012
Kono et al[14]	180.6	16.6	37	167.2	11.1	27	13.4	13.40 (6.61, 20.19)	2016
Total (95% CI)			**223**			**179**	**100**	**14.06 (10.30, 17.83)**	

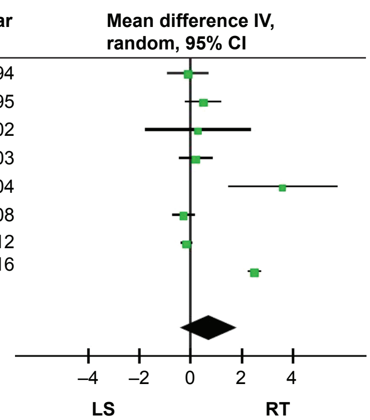
Heterogeneity: $\tau^2=15.49$; $\chi^2=154.82$, $df=8$ ($P<0.00001$); $I^2=95\%$
Test for overall effect: $Z=7.32$ ($P<0.00001$)



C

Reference: study or subgroup	LS Mean	LS SD	LS Total	RT Mean	RT SD	RT Total	Weight (%)	Mean difference IV, random, 95% CI	Year
McGuirt et al[25]	0.74	1	11	0.84	1	13	13.1	–0.10 (–0.90, 0.70)	1994
Rydell et al[26]	1.2	1.5	18	0.7	0.03	18	13.3	0.50 (–0.19, 1.19)	1995
Wedman et al[27]	8.67	2.89	9	8.38	1.66	15	9.4	0.29 (–1.78, 2.36)	2002
Tamura et al[28]	1.13	0.85	14	0.93	0.58	6	13.4	0.20 (–0.44, 0.84)	2003
Peeters et al[30]	5.9	5.7	30	2.3	1.39	27	9.3	3.60 (1.49, 5.71)	2004
Nunez et al[33]	0.44	0.24	19	0.72	0.91	18	13.7	–0.28 (–0.71, 0.15)	2008
van Gogh et al[34]	0.46	0.49	67	0.62	0.62	39	13.9	–0.16 (–0.39, 0.07)	2012
Kono et al[14]	4.13	0.63	37	1.64	0.34	27	13.9	2.49 (2.25, 2.73)	2016
Total (95% CI)			**205**			**163**	**100**	**0.73 (–0.37, 1.83)**	

Heterogeneity: $\tau^2=2.25$; $\chi^2=298.25$, $df=7$ ($P<0.00001$); $I^2=98\%$
Test for overall effect: $Z=1.30$ ($P=0.20$)



D

Reference: study or subgroup	LS Mean	LS SD	LS Total	RT Mean	RT SD	RT Total	Weight (%)	Mean difference IV, random, 95% CI	Year
Cragle and Brandenburg[24]	13.14	1	11	14.46	1	20	13.3	–1.32 (–2.06, –0.58)	1993
Rydell et al[26]	8	1	18	8.25	0.5	18	13.4	–0.25 (–0.77, 0.27)	1995
Wedman et al[27]	1.31	0.26	9	1.68	0.31	15	13.6	–0.37 (–0.60, –0.14)	2002
Tamura et al[28]	3.8	1.6	14	2.82	1.78	6	12.1	0.98 (–0.67, 2.63)	2003
Krengli et al[29]	12.2	2.9	30	8	4.32	27	11.6	4.20 (2.27, 6.13)	2004
Nunez et al[33]	5.08	4.72	19	4.07	4.09	18	10.0	1.01 (–1.83, 3.85)	2008
van Gogh et al[34]	5.28	3.19	67	5.81	3.75	39	12.5	–0.53 (–1.93, 0.87)	2012
Kono et al[14]	7.45	1.06	37	3.39	0.39	27	13.5	4.06 (3.69, 4.43)	2016
Total (95% CI)			**205**			**170**	**100**	**0.93 (–0.81, 2.67)**	

Heterogeneity: $\tau^2=5.81$; $\chi^2=452.76$, $df=7$ ($P<0.00001$); $I^2=98\%$
Test for overall effect: $Z=1.05$ ($P=0.29$)

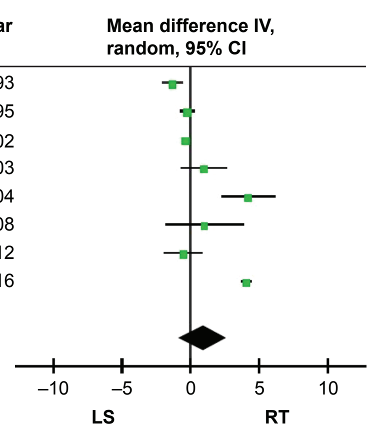


Figure 3 *(Continued)*

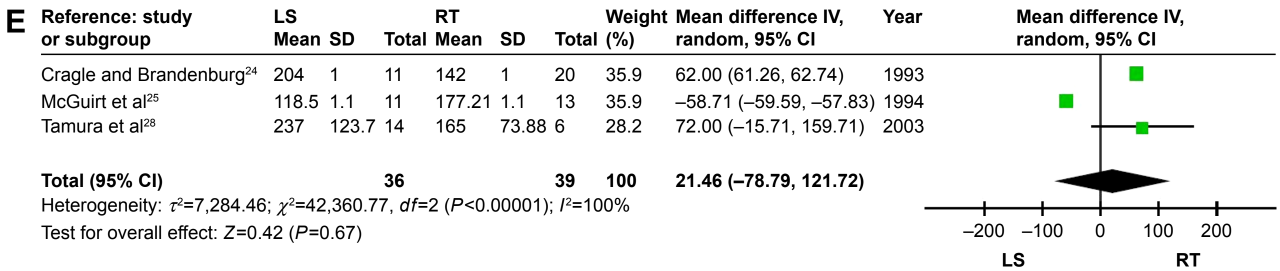


Figure 3 Forest plots of acoustic analysis outcomes.

Notes: Forest plots of (**A**) MPT, (**B**) F_0, (**C**) Jitter, (**D**) Shimmer, and (**E**) AFR. The random-effects meta-analysis model (Mantel–Haenszel method) was used in this analysis. This is presented graphically as a black diamond, where the center of the diamond is the overall estimate and the width of the diamond is the overall confidence interval; the size of the green squares denotes the weight given to the study, with larger squares reflecting more weight.

Abbreviations: AFR, air flow rate; CI, confidence interval; F_0, fundamental frequency; IV, inverse variance; LS, laser surgery; MPT, maximum phonation time; RT, radiotherapy; SD, standard deviation.

year. The pooled effect of studies published before 2007 shows no significant difference for VHI between the two treatment modalities. However, a different result is gained in the meta-analysis on studies published after 2008, which shows that VHI is significantly higher in patients treated with LS than that in those treated with RT, which proves that RT may be superior than LS on VHI. This demonstrates the fact that from the last decade, modern RT technology for T1a glottic carcinoma is becoming increasingly mature.

This meta-analysis of the parameters of acoustic analysis displayed that there is no significant difference between patients treated with LS and RT with respect to AFR, Jitter, and Shimmer. Only in the meta-analysis of MPT and F_0, differences between patients treated with LS and RT are proved to be statistically significant. When comparing parameters of acoustic analysis between LS and RT, MPT is analyzed alone because MPT offers favorable outcomes, whereas the other parameters lead to unfavorable outcomes. Therefore, we could cautiously speculate that RT may be superior than LS on VHI.

With respect to perceptual analysis, overall voice quality was almost similar in RT group and LS group, however, indicating a need for careful consideration of patient-related factors to choose the treatment option. The vocal cord defect is caused by carcinoma, and TLS frequently causes long-lasting voice impairment.[16] Yet, individual compensation is an important factor contributing to final voice quality, and it may sometimes lead to an excellent voice.[15]

However, we still have some limitations for such this meta-analysis: 1) the sample number of the analysis is relatively low, and selection bias could be excluded; 2) only one randomized controlled trial is included, and the proportion of the prospective study is relatively small. Most of them are retrospective studies, which undoubtedly led to the increase in the heterogeneity of our analysis; 3) the studies included lacked detailed information on the radiation dose for RT and different types of the laser equipment for LS, which may also cause additional heterogeneity; 4) the treatment of a patient generally depends on the doctors' preferences or the patient's wishes; the follow-up times and sample sizes were also inconsistent; 5) the aforementioned factors lacked unified standards, and thus, may have had an uncertain impact on the final results.

Our results show no statistically significant differences in most of VHI and the acoustic outcomes between patients of T1a glottic carcinoma treated with LS and those treated with RT. Although data do not reach a level of statistical significance, there is a mild tendency in all parameters that favors RT. This finding should be cautiously speculated because of significant heterogeneity among the included studies, which could be originated from limited quality attributed to variable reporting, small sample size, and various types of

Table 4 Summary statistics of pooled data comparing LS versus RT

Outcome	Number of studies	Number of cases	MD	95% CI	Heterogeneity	Test for overall effect
VHI	5	285	5.86	–5.22, 16.94	$P<0.00001$, $I^2=96.0\%$	$Z=1.04$, $P=0.30$
MPT	5	176	–1.89	–3.66, –0.11	$P<0.00001$, $I^2=86\%$	$Z=2.08$, $P=0.04$
F_0	9	402	14.06	10.30, 17.83	$P<0.00001$, $I^2=95\%$	$Z=7.32$, $P<0.00001$
AFR	3	75	21.46	–78.79, 121.72	$P<0.00001$, $I^2=100\%$	$Z=0.42$, $P=0.67$
Jitter	8	368	0.73	–0.37, 1.83	$P<0.00001$, $I^2=98\%$	$Z=1.30$, $P=0.20$
Shimmer	8	375	0.93	–0.81, 2.67	$P<0.00001$, $I^2=98\%$	$Z=1.05$, $P=0.29$

Abbreviations: AFR, air flow rate; CI, confidence interval; F_0, fundamental frequency; LS, laser surgery; MD, mean difference; MPT, maximum phonation time; RT, radiotherapy; VHI, Voice Handicap Index.

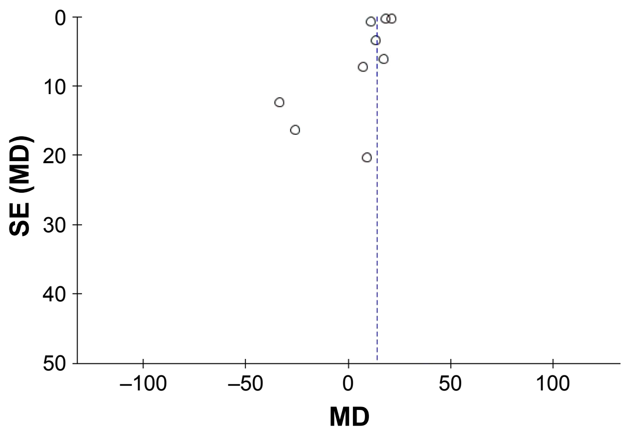


Figure 4 Publication bias: funnel plots of F_0.
Abbreviations: F_0, fundamental frequency; MD, mean difference; SE, standard error.

biases discussed. Therefore, the work needs to be improved when there are more large, multicenter, and randomized controlled trials.

Conclusion

Patients who had undergone RT have increased MPT and decreased F_0 in comparison with LS. No statistical difference was observed between the two groups in terms of VHI, Jitter, Shimmer, and AFR. In conclusion, RT may be a better choice for T1a glottic carcinoma treatment, and patient-related factors may be the most important when choosing the treatment option for T1a glottic carcinoma. To confirm our findings, more large, multicenter, and randomized controlled trials are urgently needed.

Disclosure

The authors report no conflicts of interest in this work.

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