

Intra-luminal iodine-125 brachytherapy in patients with esophageal carcinoma and 3/4 dysphagia score: A feasibility study

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Abstract

Purpose: To evaluate the clinical results of nasal feeding nutritional tube (NFNT)-loaded iodine-125 (¹²⁵I) seeds in intra-luminal brachytherapy (ILBT) for esophageal carcinoma (EC) patients with a 3/4 dysphagia score.

Material and methods: From January 2019 to January 2020, 26 patients (female/male: 17/9, mean age: 75.3 years, dysphagia score 3/4: 6/20, mean Karnofsky score: 58.4) with EC underwent NFNT-loaded ¹²⁵I seed placement for both nutrition and brachytherapy. Technical and clinical success, D₉₀ (radiation dose received by 90% of tumor volume) and organ at risk (OAR) dose, complications, dysphagia-free time (DFT), and overall survival (OS) time were documented. Local tumor diameter, Karnofsky score, dysphagia score, and quality of life (QoL) were compared before and 6 weeks after tube placement.

Results: Technical and clinical success rates were 100% and 76.9%, respectively. The D₉₀ and OAR doses were 39.7 Gy and 2.3 Gy, respectively. Eight cases (30.8%) experienced mild complications, but no seed loss, fistula, and massive bleeding were observed. Median DFT and OS were 3.1 months and 13.7 months, respectively. Tumor diameter and dysphagia score significantly decreased ($p < 0.05$), Karnofsky score significantly improved ($p < 0.05$), and QoL scores related to physical function, physical functioning, general health, vitality, and emotional functioning improved ($p < 0.05$).

Conclusions: NFNT-loaded ¹²⁵I brachytherapy for ILBT is technically a safe and effective strategy for EC patients with low Karnofsky scores, and can be a bridging therapy for advanced anti-cancer treatment.

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Key words: ¹²⁵I seed, brachytherapy, esophageal cancer, dysphagia.

Purpose

Esophageal carcinoma (EC) is a common malignant tumor in China, and has the third highest incidence rate and second highest mortality rate among all tumors [1]. Majority of patients visit a hospital because of severe esophageal obstruction, of which only 15-20% can undergo radical surgical treatment [2]. Patients with advanced EC cannot tolerate traditional treatments, such as irradiation and chemoradiotherapy, because of their weakness; however, some elderly patients from underdeveloped areas of China have very low Karnofsky scores of less than 50, and the first goal of treatment for these patients is to improve their nutritional state as quickly as possible.

Iodine-125 (¹²⁵I) brachytherapy (BT) has become an important part of the comprehensive treatment of malignant tumors, such as prostate cancer, lung cancer, liver cancer, and bone metastases, because it involves low-dose continuous irradiation, satisfactory local effects, and strong repeatability [3-6]. Animal studies confirmed that ¹²⁵I BT can significantly inhibit squamous cell carcinoma [7].

Theoretically, ¹²⁵I BT is sensitive to esophageal squamous cell carcinoma. Some scholars have combined covered esophageal stent with ¹²⁵I seed to form a brachytherapy stent, which was then implanted into malignant esophageal obstruction segment to reduce the obstruction and perform brachytherapy. Results showed that quality of life (QoL) of patients and overall survival (OS) improved significantly [8]. However, palliative esophageal stenting is not suitable for some patients, including those with high cervical EC, dyspnea caused by tumor compression, and those who refuse esophageal stenting. For such patients, nasal feeding nutritional tubes (NFNTs) are the simplest and most effective alternative strategy. Can nutrition tubes be loaded with radioactive ¹²⁵I seeds and placed across malignant EC areas to improve nutrition and perform intra-luminal brachytherapy (ILBT) simultaneously? In this pilot study, ¹²⁵I seeds were regularly placed on a sticky medical device, and then attached to NFNT to form a brachytherapy nutritional tube (BNT), which was used to treat elderly EC patients.

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Material and methods

General information

With the approval of ethics committee of our hospital (ethical number: 2017-KY-441), 26 esophageal carcinoma elderly patients with a 3/4 dysphagia score underwent NFNT-loaded ¹²⁵I BT for ILBT simultaneously. Inclusion criteria were: 1) Age from 65 to 85 years, 2) Esophageal carcinoma confirmed by a pathological examination, 3) Clinical symptoms including a 3/4 dysphagia score, 4) Inability or unwillingness to undergo surgical resection or traditional chemoradiotherapy, 5) Karnofsky score ≥ 40 and ≤ 80 , 6) Maximum diameter of the tumor ≤ 5.0 cm. Exclusion criteria were: 1) A benign esophagus tumor, 2) A platelet count $< 30 \times 10^9/l$ and prothrombin time > 25 sec, 3) A New York Heart Association class III or IV.

Pre-procedure investigations

All patients underwent routine blood examinations, including liver, kidney, electrolyte level, heart function tests, coagulation function tests, and electrocardiograms. Karnofsky and QoL scores (SF-36, Boston, USA) were applied to assess patient’s physical and physiological functions. An enhanced thoracic CT scan was performed within 1 week before the interventional procedure.

Equipment and apparatus

Regarding the production of BNT (Figure 1), three-column ¹²⁵I seeds were regularly placed on a sticky medical

device with a 5 mm interval distance, which was adhered to NFNT. The position was consistent with the occlusion according to pre-operative CT and esophagography results; ¹²⁵I seeds exceeded the tumor length by 2 cm above and below the tumor. Finally, No. 7 non-absorbable nylon wire was used to fix ¹²⁵I seeds to prevent displacement. Every ¹²⁵I radioactive seed (Tianjin Saide Biopharmaceutical Co., Ltd., China) was 4.5 mm \times 0.8 mm, with an average energy of 27-35 keV, half-life of 59.6 days, tissue penetration capacity of 1.7 cm, and single seed radioactivity of 0.8 mCi. Fluoroscopy was performed with a flat-panel detector and digital subtraction angiography (Artis Zeego, Siemens, Germany).

Procedure

CT scan image (thickness of 5 mm) was transmitted to treatment planning system (TPS) (Beijing University of Aeronautics and Astronautics, China) for target area delineation, prescription dose definition (60 Gy in this pilot study), and setting of dose limits for organs at risk. Gross tumor volume (GTV) referred to visible tumor area on imaging. Dosage requirements were $D_{90} \geq$ prescription dosage, $V_{100} > 95\%$, and $V_{150} < 100\%$.

Patient was placed in a supine position on a digital subtraction angiography operation table, and monitored by oxygen and electrocardiography equipment. Patient was anesthetized with a 2% lidocaine in the nasal cavity and oral mucosa. With a 0.035 inch soft guidewire (Cook, USA), a 5-F vertebral artery catheter (Cordis, USA) was introduced through esophageal occlusion segment, and

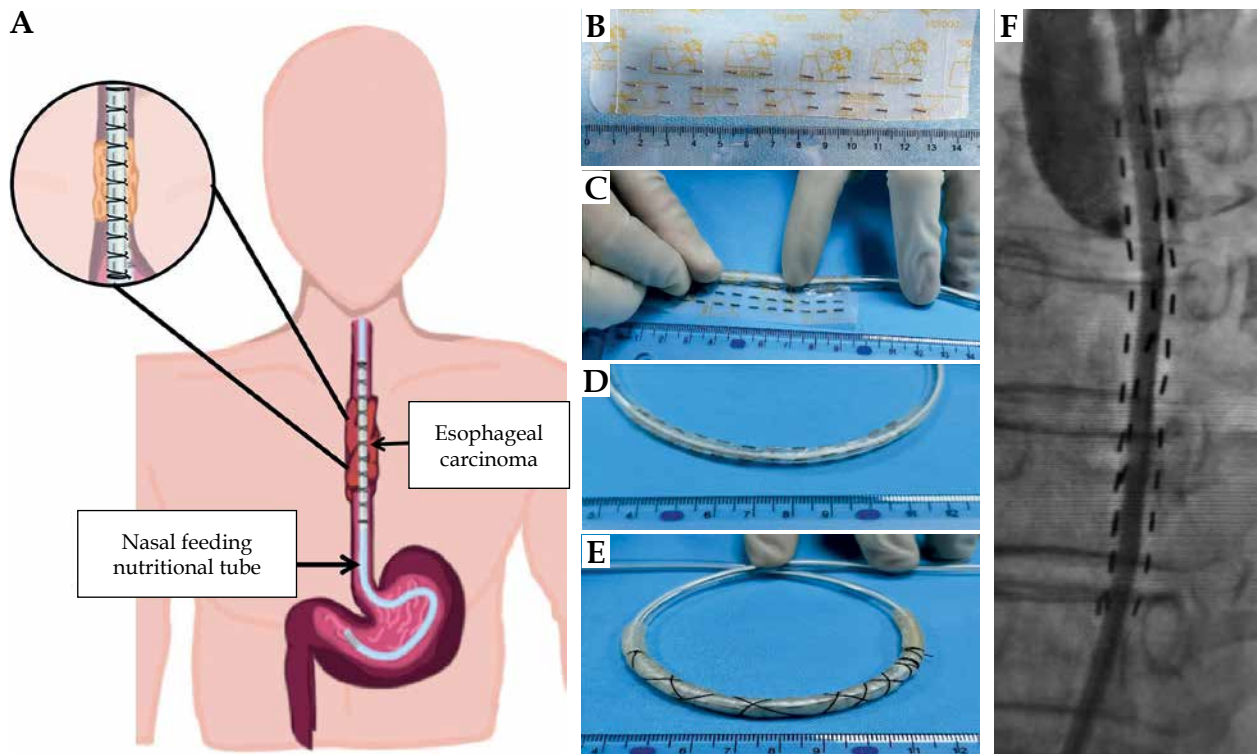


Fig. 1. Schematic diagram of the production and implantation process of brachytherapy nutritional tubes (BNTs) for the treatment of esophageal carcinoma. **A)** Diagrammatic sketch of BNT for esophageal carcinoma. **B-E)** The production process of BNT: three-column ¹²⁵I seeds regularly placed on a sticky medical device with a 5 mm interval distance, which adhered to the nasogastric feeding tube. **F)** ¹²⁵I seeds evenly distributed on the outside of NFNT under fluoroscopy

the length of obstruction was measured with trans-catheter angiography. Then, the 0.035 inch soft guidewire was exchanged with a reinforced guidewire (length, 180 cm; Terumo, Japan). Along with the reinforced guidewire, BNT was advanced to the occluded area. The head end of nutrient tube was located in the stomach cavity. An 8 mm diameter balloon was used to expand the occluded segment, if necessary. BNT completely covered the upper and lower occluded areas by less than 2 cm, and BNT was placed within the body for 6 weeks.

Table 1. Patient characteristics

Parameter	Mean \pm SD/range
Sex (male/female)	17/9
Age (year)	75.3 \pm 6.7 (69.0-85.0)
Tumor location (high/middle/low)	
Dysphagia grade (3/4)	7/21
Axial maximum diameter (cm)	3.1 \pm 0.6 (2.1-4.6)
Length of obstruction	3.7 \pm 0.7 (2.5-5.8)
Previous treatment	
No treatment	16
Surgery	5
Chemotherapy	3
Others	2
Clinical stage (TNM)	
T ₃ N ₁ M ₀	6
T ₄ N _x M ₀	12
T ₄ N _x M ₁	8
Reason for choosing nutrition tube	
Pre-treatment Karnofsky score \leq 50	16
Tumor location	5
Tracheal compression by tumor	3
Patient's preference	2
Technical success	26/26
Procedure time (min)	20.9 \pm 4.3 (14.5-33.2)
Clinical success	76.9% (20/26)
Complication (major/minor)	0/8
Dysphagia grade (0/1/2/3/4)	3/9/8/2/4
Seeds number	39.6 \pm 8.6 (24.0-56.0)
D ₉₀ dose (Gy)	39.7 \pm 7.2 (28.5-55.3)
OAR dose (Gy)	2.3 \pm 0.8 (1.4-4.3)
Follow-up anti-cancer treatments	
Chemotherapy	12
Irradiation therapy	2
Apatinib combined with PD-1	5
Follow-up time	8.3 \pm 3.2 (2.6-15.8)
Dysphagia-free time (days)	3.1 \pm 1.2 (1.6-5.7)
Median overall survival (months)	13.7 (95% CI: 11.8-15.5)
6-, 12- overall survival rate	96.0%/75.5%

SD – standard deviation

Definition and follow-up

The successful placement of BNT into the area of malignant esophageal carcinoma was defined as technical success. Clinical success was defined as the successful removal of BNT and a dysphagia score \leq 2. Dysphagia scores were interpreted as follows: score 0 – ability to maintain a normal diet, score 1 – ability to swallow some solid food, score 2 – ability to swallow semisolids only, score 3 – ability to swallow liquids only, score 4 – complete dysphagia. Dysphagia-free time (DFT) was defined as the time span from the removal of NFNT to the recurrence of a dysphagia score \geq 3. Karnofsky, dysphagia, and QoL scores were evaluated 6 weeks after the procedure. CT data obtained within post-operative 3 days were uploaded to TPS for dose verification. The prescription dose was 60 Gy, and the spinal cord was considered an organ at risk (OAR). A SPECT (NM/CT 670, GE company, USA) scan was performed to evaluate γ -ray radiation distribution in EC zone. A health-related short form-36 (SF-36) questionnaire was used to assess eight domains, including physical functioning (PF), physical role (RP), bodily pain (BP), general health (GH), vitality, social functioning (SF), emotional role (RE), and mental health (M). All domains were scored on a scale of 0 to 100. All patients were followed up after BNT placement and underwent systemic treatments after ILBT. Dysphagia score and OS were determined by a telephone every 2 months. The last follow-up was performed in December 2020.

Statistical methods

Continuous data were expressed as mean \pm standard deviation, range, or median value. SF-36 and Karnofsky scores were compared with Pearson's χ^2 test; the tumor diameter was compared using paired *t*-test, and TFS and OS were calculated using Kaplan-Meier method (SPSS v. 17.0 software, USA). *P*-value $<$ 0.05 was considered statistically significant.

Results

The technical success rate was 100%. Five (19.2%) patients needed small balloon-assisted dilatation (diameter, 8 mm). Twenty patients underwent BNT removal and had a dysphagia score of less than 2, leading to a clinical success (76.9%, 20/26). The remaining 6 patients (4 and 2 with dysphagia scores of 4 and 3, respectively) were defined as technical failure. Five patients immediately underwent esophageal stenting (stent size, 18 mm \times 120 mm; Taewoong, Korea), and one patient underwent conventional nutrition tube placement instead of BNT to resolve nutrition problems. Among the 20 patients with technical success, four patients underwent esophageal stenting at 2.3, 3.6, 5.2, and 6.2 months due to dysphagia recurrence after BNT removal. The mean durations required to place BNT and perform interventional procedure were 4.2 \pm 1.3 min (range, 3.3-6.5 min) and 20.9 \pm 4.3 min (range, 14.5-33.2 min), respectively. The mean D₉₀ and OAR doses were 39.7 \pm 7.2 Gy (range, 28.5-55.3 Gy) and 2.3 Gy (range, 1.5-3.4 Gy), respectively (Table 1). Eight patients (30.8%) complained of intermittent postero-sternal pain

during ILBT, and one of these patients experienced mild hematemesis (< 10 ml), which resolved after symptomatic treatment without major complications, such as seed loss, fistulas, or massive bleeding. The maximum transverse tumor diameter and dysphagia score significantly decreased from 3.1 ± 0.6 cm and 3.8 ± 0.4 to 1.9 ± 0.3 cm and 1.8 ± 1.2 , respectively ($p < 0.05$) (Figures 2, 3). The mean Karnofsky score significantly increased from 58.4 ± 9.4 to 77.2 ± 7.4 ($p < 0.05$). The mean DFT was 3.1 ± 1.2 months after BNT removal in 20 cases. SF-36 scores are listed in Table 2. The QoL assessments at 6 weeks showed significant improvements compared with pre-treatment data of PF, RF, GH, vitality, and RE scores ($p < 0.05$), while BP ($p = 0.54$), SF ($p = 0.10$), and MHI scores ($p = 0.07$) showed no significant improvements.

During a median follow-up period of 8.3 months (range, 2.6-15.8 months), 19 patients (73.1%) underwent additional systemic chemotherapy ($n = 12$), oral anti-angiogenic agent (apatinib mesylate tablets) combined with PD-1 treatments ($n = 5$), and external irradiation ($n = 2$). Some patients ($n = 7$) did not undergo additional treat-

ments due to various personal reasons. The mean DFT was 3.1 ± 1.2 months. Four patients died, of whom two died due to multiple organ failure, one died of pulmonary infection due to local tumor progression, and one died of sudden massive hematemesis; the remaining 22 patients survived. The median overall survival time was 13.7 months (95% CI: 11.8-15.5).

Discussion

Dysphagia is the most common clinical symptom in patients with advanced EC, which severely affects their nutritional status and QoL, but more than 30% of patients, especially elderly patients, cannot tolerate surgery or concurrent chemoradiotherapy due to a poor health status [9]. Nutritional support is very important for elderly patients with EC and low Karnofsky scores, as nutritional support not only improves QoL but also is a form of continued anti-tumor treatment. Patients with Karnofsky scores above 70 can better tolerate conventional anti-tumor treatments [10]. External beam radiation therapy

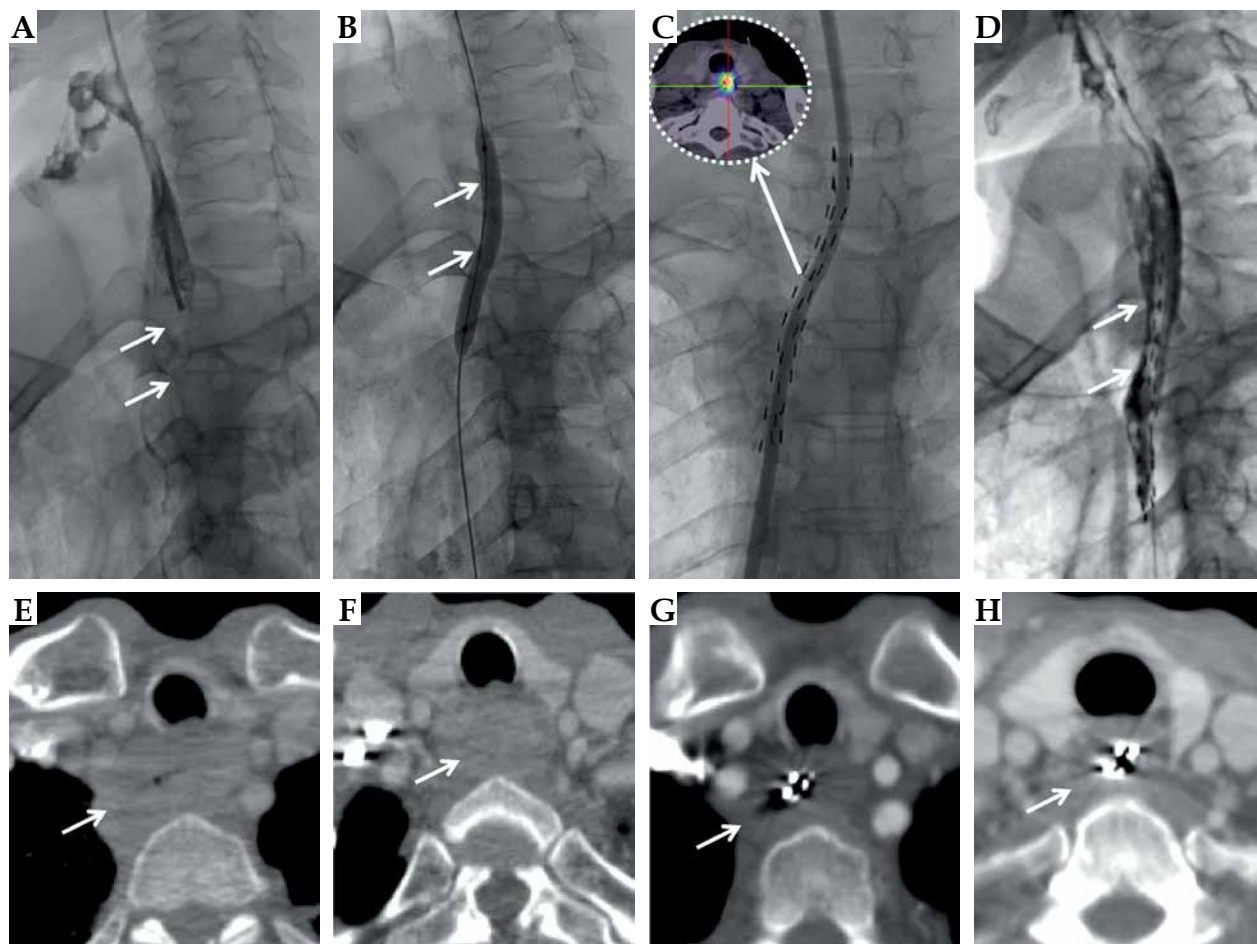


Fig. 2. A 76-year-old male patient with cervical esophageal carcinoma (Karnofsky score, 50; dysphagia score, 4). **A)** Esophagography showed local esophageal complete occlusion (arrow). **B)** A small balloon (arrow; diameter, 8 mm) was used to dilate the occluded esophageal segment. **C)** Brachytherapy nutritional tube was placed across the tumor area, and post-operative SPECT (arrow) showed no seed migration and loss. **D)** Esophagography after 6 weeks showed that the contrast medium passed smoothly. **E, F)** Pre-operative CT showed that the esophageal wall had significantly thickened (diameter, 3.82 cm). **G, H)** Six weeks after the operation, the local tumor had significantly decreased according to CT (arrow)

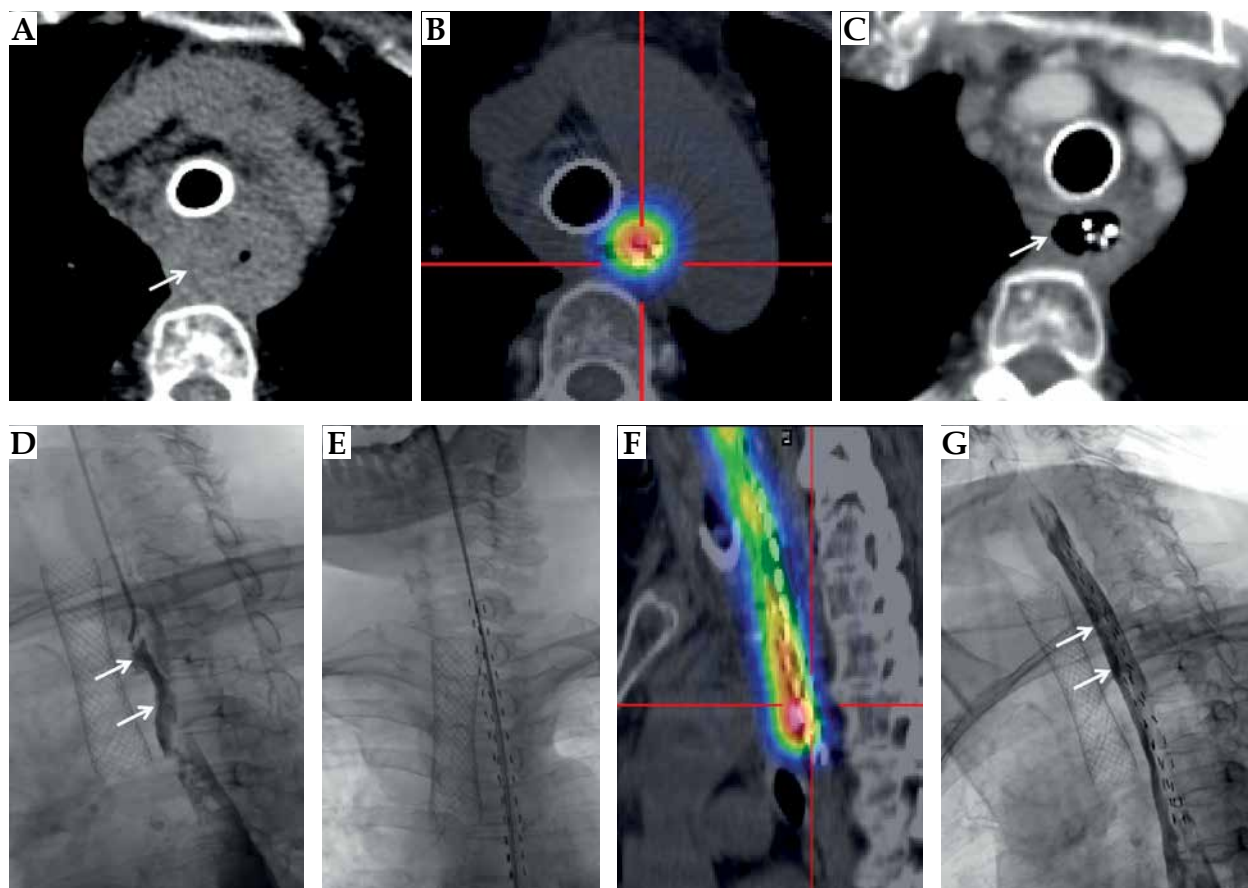


Fig. 3. An 82-year-old female patient with cervical esophageal carcinoma (Karnofsky score, 50; dysphagia score 4) underwent tracheal stenting because of difficulty in breathing after systemic chemotherapy failure. **A)** Pre-operative CT showed that the esophageal wall had significantly thickened (arrow; diameter, 2.8 cm). **B)** The post-operation SPECT showed the γ -ray covered the tumor satisfactorily. **C)** Six weeks after the operation, the local tumor had significantly decreased according to CT (arrow). **D)** Esophagography showed local esophageal complete occlusion (arrow). **E, F)** Brachytherapy nutritional tube was placed across the tumor area (**E**), and post-operative SPECT (**F**) showed no seed migration or loss. **G)** Esophagography after 6 weeks showed that the contrast medium passed smoothly

Table 2. Pre- and post-treatment changes

Item	Pre-treatment	Post-treatment	<i>t</i> -value	<i>p</i> -value
Diameter (cm)	3.1 \pm 0.6	1.9 \pm 0.3	11.9	< 0.001
Karnofsky score	58.4 \pm 9.4	77.2 \pm 7.4	-8.9	< 0.001
Dysphagia score	3.8 \pm 0.4	1.8 \pm 1.2	7.5	< 0.001
Physical function	46.1 \pm 5.6	59.8 \pm 6.8	-8.4	< 0.001
Physical role	53.0 \pm 11.0	69.0 \pm 18.1	-4.2	< 0.001
Body pain	34.5 \pm 5.5	35.5 \pm 4.8	-0.6	0.54
General health	48.4 \pm 8.5	68.7 \pm 8.2	-11.1	< 0.001
Vitality	48.8 \pm 7.3	59.8 \pm 4.5	-7.1	< 0.001
Social function	45.0 \pm 12.5	49.0 \pm 14.4	-1.7	0.10
Emotional role	51.9 \pm 16.8	59.9 \pm 13.6	-2.8	0.01
Mental health	50.4 \pm 6.7	52.8 \pm 6.8	-1.9	0.07

(EBRT) can help relieve dysphagia in long-term; however, there is a long period of time from the beginning of treatment to the remission of symptoms [11]. Moreover, due to uneven regional economic development, some county hospitals in China lack EBRT equipment. Esophageal stents are the first choice in non-surgical palliative care

for patients with EC and 3/4 dysphagia scores, as these stents can quickly resolve obstructions. However, stenting may not be the best choice for patient with advanced cervical esophageal cancer because of foreign body sensation, for patients with cardiac cancer due to the risk of stent migration, and for patients with severe tracheal

Table 3. Recent studies on esophageal carcinoma brachytherapy using ¹²⁵I seeds

Author(s), year [Ref.]	Design	Sample size	Median age	Technical success	Complication	Dysphagia change	Overall survival	Conclusions
Qin J, 2020 [17]	Rs	153 (103 and 54 pts. in 18 mm and 20 mm stent groups)	72.6 vs. 67.9 yrs.	100% vs. 100%	Sp 15.4% in 18 mm vs. 32.7% in 20 mm stent groups	2.02 in 18 mm stent vs. 2.0 in 20 mm stent	Median OS: 176 days in 18 mm vs. 109 days in 20 mm stent group	18 mm stent showed a similar outcome of DR with 20 mm stent
Bi Y, 2020 [18]	Rs	22 pts.	72.2 yrs.	100%	27.3% incidence of stent migration	3.4 vs. 0.5 after stenting	9.9 months	Technical feasibility
Qin J, 2019 [19]	Rs	201 pts.	71.0 yrs.	100%	Hemorrhage: 9%, Ap: 11.9%, fistula: 6.5%	3.3 vs. 2.0 after treatment	Median OS: 153 days (95% CI: 128-181)	T-stage/tumor location/age were associated with DR
Zhao P, 2017 [20]	Rs	43 pts. (18 in Is vs. 25 in Cs groups)	70.4 yrs.	100% vs. 100%	Sp/esophageal re-stenosis occurred in 16.7/11.1% and 16.0/12.0% in Is/Cs groups, respectively	Dysphagia scores decreased to 0-1 in all cases	9.8 months in Is group and 4.8 in Cs group	Is group showed prolonged DR and OS
Tian D, 2016 [21]	Rs	131 pts. (40/91 in Is/ Cs groups, respectively)	66.3/66.9 yrs. in Is and Cs groups	100% vs. 100%	Massive hemorrhage/Sp/stent migration in 2.5/6.6%, 13.3/40%, 2.2/12.5%, respectively	Dysphagia score decreased in all cases	4.4/4.2 months in Is and Cs groups, respectively	Is group showed improved OS and hospitalization costs
Liu N, 2014 [22]	Rs	63 pts. (31/32 pts. in Is and Cs groups, respectively)	65.0 yrs.	93.5% vs. 93.8%	Sp/Gr/bleeding/fistula occurred 25.8/28.1%, 29.0/21.9%, 35.5/21.9%, 3.2/3.1%	Dysphagia score decreased in all cases	4.0 vs. 3.0 months in Is and Cs groups, respectively	Is has potential benefit of longer DR but no significant on OS
Zhu HD, 2014 [23]	Ps	160 pts. (80/80 in Is/ Cs groups)	71.0 yrs.	91.5% vs. 93.8%	Sp/fistula/Ap/hemorrhage/recurrent dysphagia were 23/20%, 8/7%, 11/14%, 7/7%, 21/20% in Is/Cs groups	Dysphagia scores decreased from 3.3 to 1.4 in Is and from 3.4 to 1.4 in Cs group	177 and 147 days in Is and Cs groups	Is had benefit on OS than in Cs group
Zhong-min W, 2012 [24]	Rs	58 pts. (28/30 in Is/Cs groups)	65.0/68.8 yrs. in Is/Cs groups	100% vs. 100%	Sp/Gr/migration/re-stenosis were 53.6/80%, 7.1/10%, 3.6/6.7%, 3.6/6.7% in Is/Cs groups, respectively	Dysphagia scores decreased from 3.4 to 1.0 in Is and 3.4 to 1.0 in Cs groups	11 and 4.9 months in Is and Cs groups	Implantation is technically feasible and effective
Guo JH, 2008 [8]	Ps	53 (27/26 in Is/Cs groups)	69.5/72.1 yrs. in Is/Cs groups, respectively	100% vs. 100%	Sp/fistula/Ap/hemorrhage/stent migration/re-stenosis were 29.6/26.9%, 3.7/0.0%, 3.7/7.7%, 33.3/26.9%, 7.4%/11.5%, 29.6/23.1% in Is/Cs groups	Dysphagia scores decreased from 3.4 to 1.1 in Is and 3.4 to 1.2 in Cs group	7 and 4 months in Is and Cs groups	Is implantation having potential benefit of longer DR and OS

Rs – retrospective study, Ps – prospective study, Is – irradiation stent, yrs. – years, pts. – patients, Na – not available, OS – overall survival, DR – dysphagia relief, Cs – conventional stent, Gr – gastroesophageal reflux, Sp – severe pain, Ap – aspiration pneumonia

compression caused by EC [12]. Moreover, stent-related granulation proliferation and dysfunction are common complications for long-term stent placement.

Iodine-125 brachytherapy compared with EBRT, offers a fast reduction of intra-luminal portion of the tumor, thus rapidly restoring swallowing function and delivering a very low-dose of the agent to surrounding normal tissues, such as the lung, spinal cord, and adjacent normal esophageal mucosa. Moreover, ^{125}I brachytherapy can be completed at home, and reducing social costs. Other scholars have applied ILBT using ^{125}I strands to treat malignant biliary obstruction [13, 14] and vascular thrombus [15, 16], and showed that the local tumor response was better than that of single stenting, which was expected. Local ^{125}I brachytherapy inhibits the proliferation of intra-luminal tumors to some extent, resulting in long-term stent patency. The present pilot study showed the technical success rate of 100% without major complications, and the dysphagia scores were also satisfactory comparing with those reported in previous studies on ^{125}I brachytherapy stents, as shown in Table 3 [technical success rate, 91.5-100%; complication rate, 0-29.6%; dysphagia scores decreased from before (3.3-3.4) to after treatment (0.0-2.0)] [8, 17-24]. The results were not unexpected; this treatment takes advantage of not only the above-mentioned ^{125}I bio-dosimetry, but also NFNT. Six cases (23.1%) with long areas of occlusion experienced clinical failure, possibly because the ^{125}I seeds were arranged uniformly and linearly on the surface of BNT, while the tumor distribution at the esophageal lumen was uneven. In addition, the mean D_{90} of the six patients was only 29.3 Gy, which means that insufficient dosage and excessive tumor size are still the core reasons for poor local control effect. Further changes in the seed activity and number, or adding radiotherapy after physical recovery of elderly patients, are still a very important clinical topic, and we plan to examine this idea in the future.

Regarding complications, 30.8% of patients complained of intermittent postero-sternal pain during ILBT, which could be related to tissue edema during ^{125}I brachytherapy. No severe tumor bleeding or esophageal fistula occurred, indicating that the level of tissue tolerance was good. As the local tumor cumulative dose increased, the tumor shrank, the patients' physical strength improved, and positive nitrogen level increased, which laid a foundation for further anti-tumor treatments. Although all the patients in this study were elderly patients with a mean age of 75.3 years, 73.1% of the patients underwent additional systemic anti-tumor therapy, which means that it could be an acceptable bridging therapy for advanced anti-cancer treatment, especially for patients with very low Karnofsky scores.

The present study paid more attention to QoL than nutrition status. The PF, RF, GH, vitality, and RE scores showed significant improvements after ^{125}I brachytherapy, which could be caused by nutritional status improvements. The BP, SF and MH scores showed no significant improvements. The reason was that the BNT in the nose affected patients' level of social participation and self-esteem, especially among the elderly patients, and mental health of these patients should be considered more carefully. SPECT

was used to evaluate ^{125}I seed displacement and loss. Although the cost is high, the dose coverage can be observed more directly with SPECT. Because the dose decreases by 80% within 2 cm of ILBT, this method needs to be combined with subsequent external radiotherapy for tumors with obvious wall thickening. Most of the cases in this study exhibited partial responses, suggesting that further improvement of local dose and radiosensitivity are still needed.

This study has several limitations. First, it was a retrospective study with a small sample size, no control group, and a limited observation period. In addition, the effects of follow-up treatments on the outcomes were not evaluated.

In summary, BNT for ILBT is technically a safe and effective strategy for elderly EC patients with low Karnofsky scores, and can be a bridging therapy for advanced anti-cancer treatment.

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Data availability

The clinical data were obtained from the Interventional Department of the First Affiliated Hospital of Zhengzhou University. Data used to support the findings of this study are available from the corresponding author upon request.

Conflict of interest

The authors report no conflict of interest.

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