# INTRALUMINAL RADIATION FOR ESOPHAGEAL CANCER: A HOWARD UNIVERSITY TECHNIQUE

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**The objective of radiotherapeutic management in esophageal cancer is to accomplish maximum tumor sterilization with minimal normal tissue damage. This sincere effort is most often countered by the differential in tumor dose response vs normal tissue tolerance. Intraluminal isotope radiation, with its inherent advantage of rapid dose falloff, spares the lungs, the spinal cord, and other vital structures, yet yields adequately high doses to esophageal tumor. Though in existence since the turn of the century, the method of intracavitary radium bougie application dropped out of favor due to technical difficulties imposed by the size of the radium source and radiation exposure to the personnel involved. The authors describe a simple "iridium 192 afterloading intraluminal technique" that eliminates technical problems and reduces radiation exposure considerably.**

Esophageal cancer is a fatal disease that accounts for 2 percent of all cancer deaths in the United States.[1] For the year 1981 there will be an estimated 8,800 new cases and 8,100 deaths due to this disease.[2] Management of esophageal cancer remains an enigma to surgeons, radiation oncologists, and medical oncologists alike. Deeply situated growths in close proximity to the vital structures, advanced disease at diagnosis, and presentation in elderly cachectic individuals incapable of supporting any radical surgical attempts, make the resectability rates low (30.1 percent),[3] survival rates poor (five-year survival rate of 12.9 percent of the resected group),[3] and operative mortality rates high (40 to 60 percent).[6] Chemotherapy for esophageal cancer is still in the experimental stage, with varying response rates.

Though the results of palliation with radiation would seem to be encouraging, nevertheless, the survival and recurrence rates remain unchanged, hampered by the dose constraining radiosensitive structures that limit radiation of adequate doses to inadequate volumes or inadequate doses to adequate volumes in this aggressive disease that is so well known to have longitudinal spread.

The low resectability rates, poor survivals, and high mortality rates with available surgical options; consistently disappointing chemotherapeutic responses; and technical problems and morbidity associated with high dose external radiation—all prompted the authors to explore the benefit of esophageal intraluminal isotope radiation.

Barcat and Guisez were among the first to observe the results of local application of radium in esophageal cancer. Jean Guisez,[4] from Paris, discussed their 15-year experience using this method in 270 patients, 30 of whom had prolongation of life for more than 18 months. In several cases, disappearance of the tumor was demonstrated esophagoscopically. The major disadvantage of intraluminal radiation is the limited depth of penetration. To overcome this problem, external and intraluminal radiations are used in combination.

In 1969 Rider and Mendoza[5] reported their Toronto experience of treating a selected group of

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patients with external radiation of 3,500 rads to 4,000 rads in 3½ to 4 weeks to the mediastinum, followed by insertion of radium bougie on three consecutive days at a dose rate of 1,000 rads/day as measured on the surface of the radium bougie (13 mm diameter). This technique yielded the best survival pattern with 24 months median survival, 37 percent three-year survival, and even one patient who survived for 11 years. These authors noted that if radium bougie is inserted immediately after completion of external radiation, the result was often necrosis. However, this problem was rectified by allowing an interval of one or two weeks between the two procedures.

Despite the impressive results, these techniques dropped out of favor, probably because of technical difficulties imposed by the size of the radium source and undue radiation exposure to the personnel involved. In an attempt to overcome these difficulties, the authors (at Howard University Hospital) developed a simple, noninvasive, afterloading technique that utilizes iridium 192 radioisotopes. This procedure needs neither anesthesia nor sedation and permits oral fluid intake or nasogastric (NG) tube feeding, though we do recommend an intravenous line to be kept open for the period of time the radioactive sources are in place.

## TECHNIQUE OF APPLICATION

Before commencing the procedure, it is necessary to ascertain the size of the lumen, which should be adequate enough to permit at least a size 12 NG tube. Also, the patient should neither be in an impending respiratory embarrassment situation that may need emergency procedures, nor in any serious condition that would demand constant, round-the-clock care, subjecting the involved personnel to the risk of longer periods of nonpermissible radiation exposure. One can carry out the procedure in four simple steps.

### Step 1

Placement of NG tube and insertion of afterloading nylon catheter (or catheters): A well-lubricated NG tube of appropriate size (as permitted by the lumen of the esophagus) is carefully passed through the nose into the esophagus and stomach. (It is highly important to make sure that the NG tube is not in the respiratory passage.) Then, the wall of the NG tube is pierced at a point 4 to 5 cm away from the nose with a 17-gauge needle that is slowly advanced for 2 to 3 cm into the lumen of the NG tube. Through this needle, a blind-ended, afterloading, nylon catheter (40 to 50 cm long and 1.5 mm in diameter) with an inner guide wire is passed with the blind end of the catheter advancing into the lumen of the NG tube, and leaving at least 4 to 5 cm of the open end of the catheter outside the NG tube. Then, a semilunar plastic button and a metal button are threaded to the nylon catheter until they fit snugly at the junction of the catheter with the NG tube. A metal button is then tightly secured to the wall of the NG tube with a suture. The metal button helps to keep the nylon catheter and the radioactive source ribbon intact while the plastic button helps to occlude the opening made by the needle, thus preventing leakage from the NG tube (Figure 1, Step 1). It may be necessary to tape the opening to prevent the leakage.

### Step 2

Insertion of dummy source ribbon for localization: The guide wire is taken out and the inactive (dummy) source ribbon (with 30 to 40 dummy sources) is threaded through the nylon catheter until it reaches the blind end. Then anterior-posterior and lateral localization films are taken with a marker for magnification (Figure 1, Step 2).

### Step 3

Assessment of loading pattern: Depending on the extent of the disease on the esophagogram, the length of the esophagus needed to be radiated is marked on the localization films (Segment A-B in Figure 2, Step 3). The number of sources in segment A-B on localization films gives the actual number of iridium 192 sources to be loaded. The length of the ribbon below the B mark on the films gives the length of the spacer to be used before loading the radioactive sources. (Either catgut or nylon ribbon of appropriate diameter and length can serve as a spacer.) The dummy ribbon is removed and the patient is sent back to the special private room suited for radioactive safety precautions.

### Step 4

Loading of the radioactive iridium 192 sources (carried out in the patient's room): First, the spacer

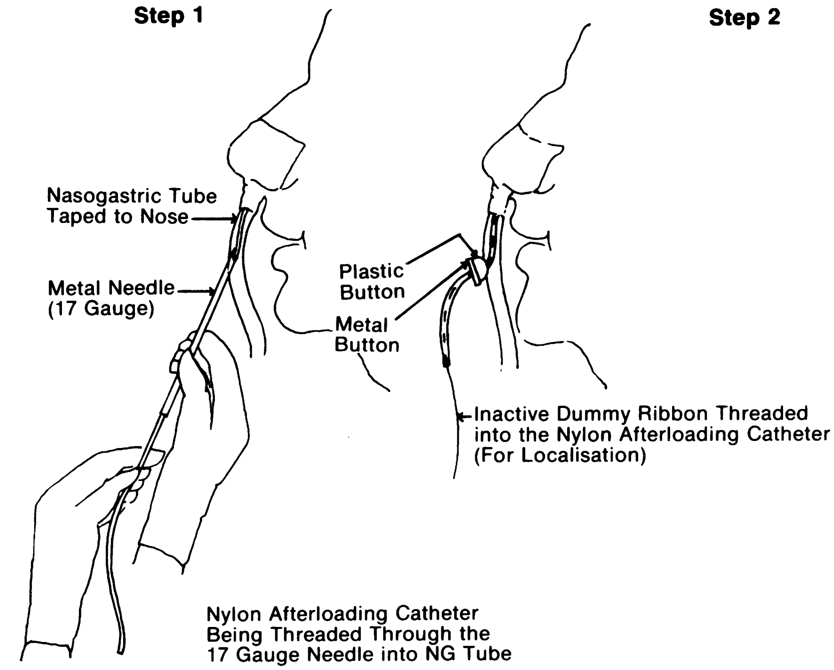


**Figure 1. Step 1: Insertion of empty afterloading nylon catheter into the NG tube. Step 2: Introduction of dummy source ribbon into the previously inserted nylon catheter**

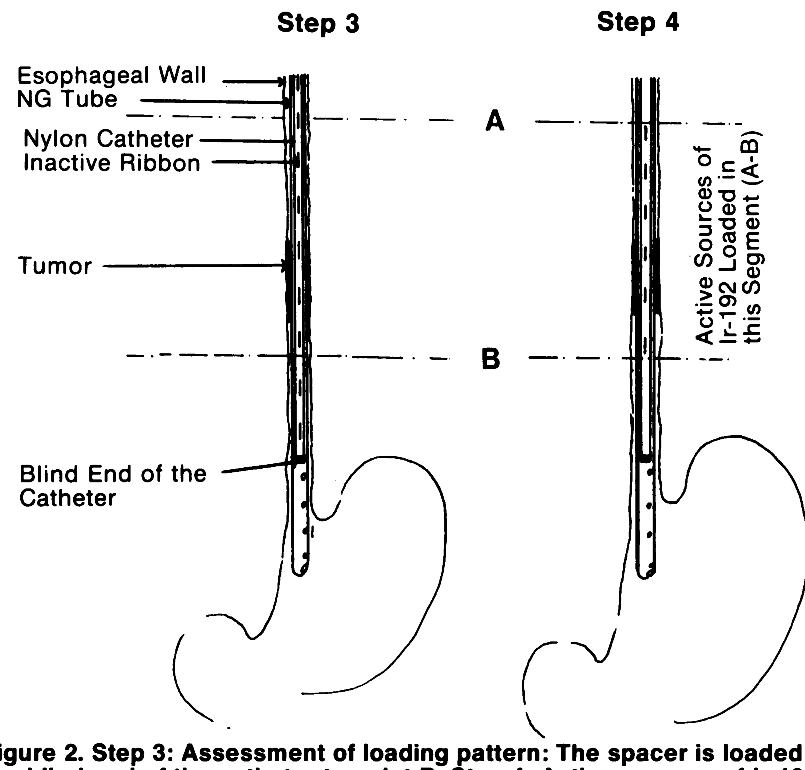


**Figure 2. Step 3: Assessment of loading pattern: The spacer is loaded from the blind end of the catheter to point B. Step 4: Active sources of Ir-192 are loaded in the segment B-A. A = upper margin of treatment volume; B = lower margin**

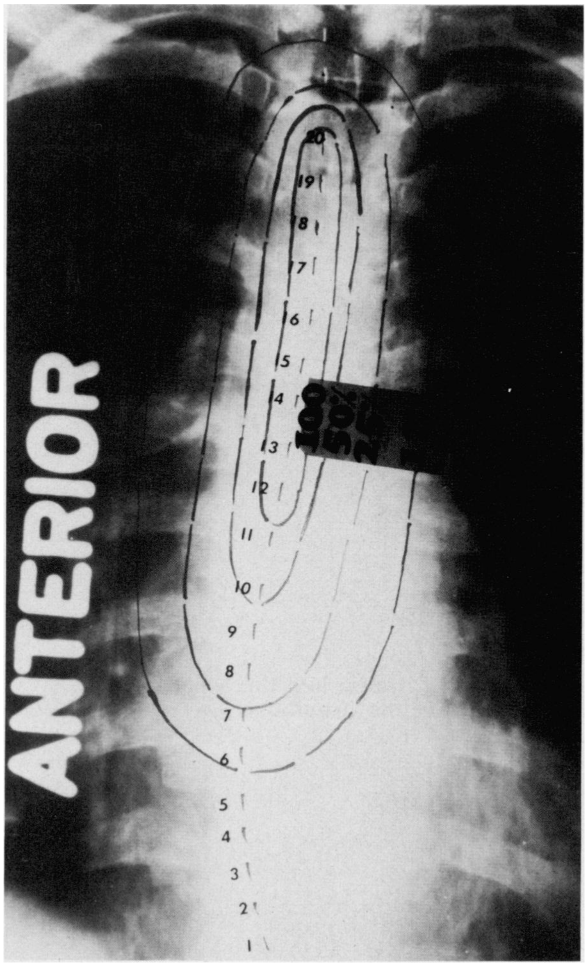


**Figure 3. Isodoses projected on AP localization film**

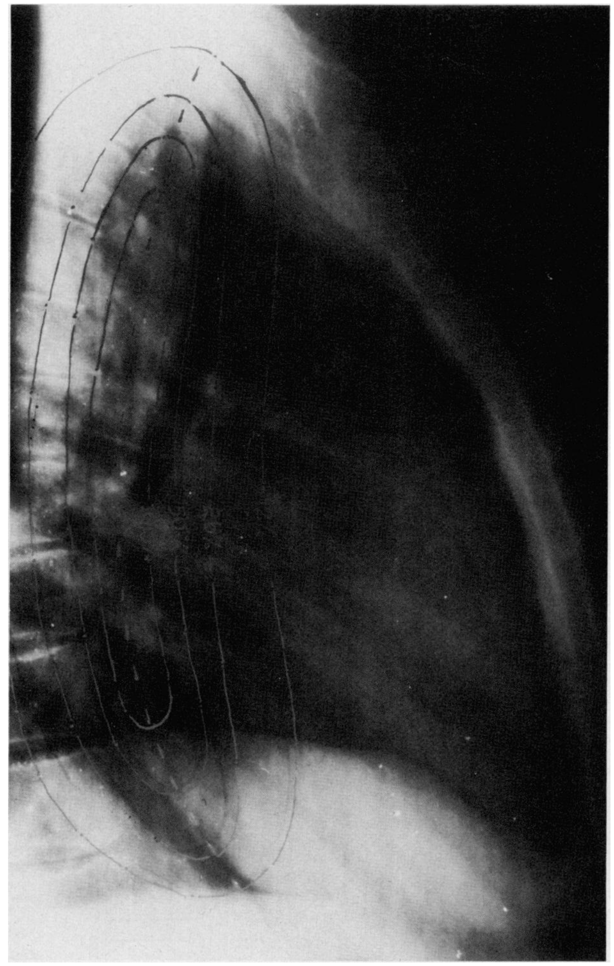

**Figure 4. Isodoses projected on the lateral localization film**

of predetermined length is loaded until its tip reaches the blind end of the catheter. Then, with long forceps, the radioactive iridium 192 source ribbon, of predetermined total activity, is loaded until the advancing tip of the active ribbon touches the spacer. The neck of the metal button is clamped tightly around the nylon catheter to prevent the slipping or sliding of the active ribbon. After the desired dose is delivered, the sources are unloaded by unclamping the metal button and pulling out the ribbon with long forceps. Then the NG tube is removed (Figure 2, Step 4).

## Computerized Dose Calculations

Isodoses should be made available before loading the radioactive sources. Localization films are utilized for isodoses in anterior-posterior and lateral projections and CT scan is used for transverse plane isodoses (Figures 3 through 6). The minimal, average, and maximal dose to the spinal cord are recorded. It is desirable to keep the mucosal dose rate below 1,000 rads/day. Adequate dose rates from a single centrally placed ribbon are made possible currently by the availability of high ac-

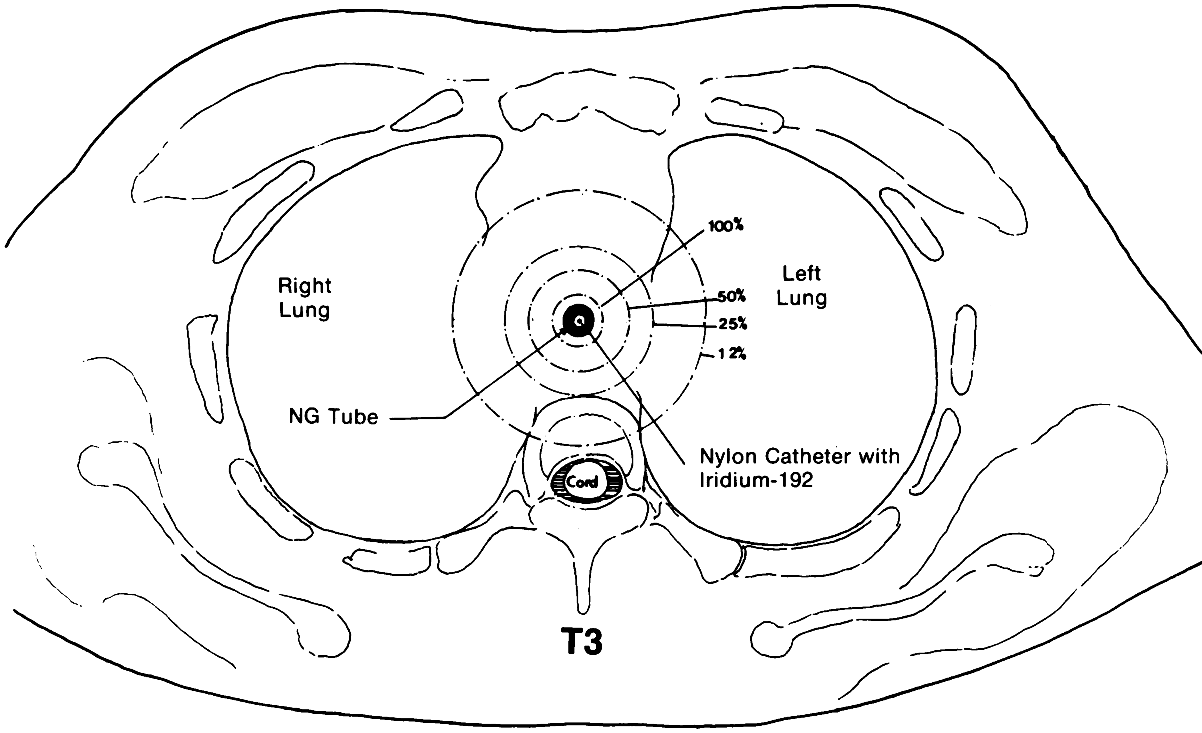


**Figure 5. Isodoses in transverse plane at T3 vertebral level**

tivity iridium sources, up to 2 mrem/source, 6 mrem/cm.*

A 15 cm long ribbon with 15 iridium sources of 1 mrem/source, ie, a total of 15 mrem activity and 360 mg hrs/day, is adequate to deliver 1,000 rads/day at 0.5 cm from the plane of the implant. The dose distributions from such an implant, computed for various distances from the source ribbon, are given in Table 1. Usually the spinal cord is at least 3.5 cm away from the implant and receives about 10 percent of the total dose from the implant.

The authors suggest the following eight advantages of the technique:

1. Simple noninvasive procedure that is easy to carry out in most institutions
2. Performed without anesthesia or sedation
3. Can be carried out in lumen small enough to permit a size 12 nasogastric tube
4. Permits oral fluid intake or NG tube feeding even with radiation in progress
5. Accommodates to the curvature and configuration of the esophagus
6. Adequate dose to adequate lengths of the esophagus achieved, yet sparing lungs, spinal cord and other vital structures from significant dose contribution
7. Minimizes radiation exposure to personnel
8. Saves time for patients while limiting their visits for external radiation

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## CONCLUSIONS

Esophageal cancer is a uniformly fatal disease with singularly poor prognosis despite the best efforts through aggressive sophisticated surgical techniques, meticulous radiotherapeutic plans,

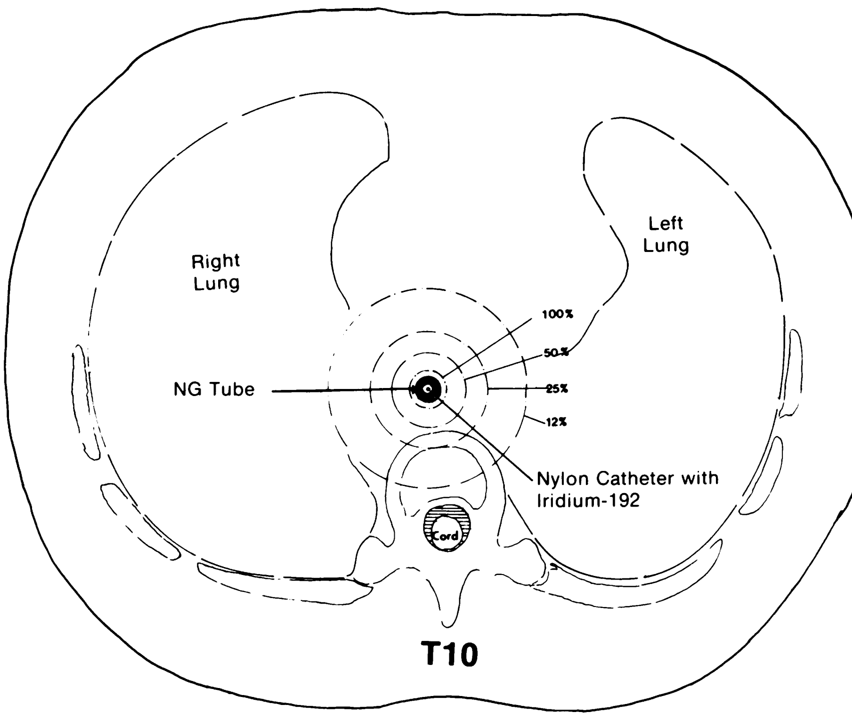


**Figure 6. Isodoses in transverse plane at T10 vertebral level**

**TABLE 1. DOSE FOR 360 MG HRS/DAY (15 CM RIBBON, 15 MREM TOTAL ACTIVITY)**

| Distance from the Central Source (cm) | Tissue Dose (rad/day) |
|---|---|
| 0.5 | 1,000 |
| 1.0 | 425 |
| 1.5 | 300 |
| 2.0 | 240 |
| 2.5 | 190 |
| 3.0 | 150 |
| 3.5 | 120 |

and, yet to be successful, chemotherapeutic regimens. There is evidence in the literature to suggest better tumor response at radiation doses above 6,000 rad.[6] Faced with the difficulties of achieving good therapeutic ratio at such high doses through the conventional radiation techniques, and encouraged by the earlier results of local radium application,[4,5] the authors developed a simple method of delivering low doses of continuous radiation to larger segments of the esophagus. This paper describes the authors' technique and demonstrates that esophageal intraluminal radiation with afterloading iridium is technically feasible.

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