Int. J. Radiation Oncology Biol. Phys., Vol. 9, pp. [illegible]

● *Technical Innovations and Notes*

FLETCHER-SUIT-DELCLOS GYNECOLOGIC APPLICATOR: EVALUATION OF A NEW INSTRUMENT

JUDITH STITT HAAS, M.D.,[1] R. DALE DEAN, PH.D.[2] AND CARL M. MANSFIELD, M.D.[2]

[1]Department of Radiation Oncology, William Beaumont Hospital, Royal Oak, MI; [2]Department of Radiation Therapy, University of Kansas Medical Center, Kansas City, KS

A new instrument has been added to the Fletcher-Suit-Delclos group of gynecologic applicators. The colpostats can be used as mini-ovoids, but by adding a shielded cap, the instrument has the configuration of the original preload Fletcher colpostat. Dosimetric studies show that this applicator produced transmission ratios (the fraction of radiation transmitted through the tungsten shield) and isodose curves similar to the bladder trigone and anterior rectal wall of 10–25%. With the shield-containing cap removed, the mini-ovoid provides little reduction in dose to those areas and should be used with caution.

Cesium-137, Fletcher applicator, Dosimetry.

INTRODUCTION

The lineage of Fletcher applicators has a new generation of instruments—the Fletcher-Suit-Delclos afterloading applicators (FSD). These instruments maintain the principles established by Fletcher in the 1950's of a colpostat system that produces an increase in paracervical and parametrial irradiation, while shielding the bladder trigone and anterior rectum.[2] The FSD applicator systems are composed of colpostats that are fitted with 2 cm shield-containing caps. When used without the caps, the applicators have a Delclos mini-ovoid configuration. With the caps in place, the shields produce a decrease in dose to the local tissues as prescribed by Fletcher in the original preload Fletcher applicator.[2]

A new Fletcher-Suit-Delclos instrument* has been added to the Fletcher family of gynecologic applicators. This device is composed of stainless steel colpostats designed as Delclos mini-ovoids. However, unlike the Delclos mini, there is partial tungsten shielding in the colpostat. A 2 cm nylon cap that slips over the colpostat contains half-moon tungsten shields to give medial shielding in accordance with the original Fletcher system. Sets of 2.5 cm and 3.0 cm caps fit over the colpostat to push the vaginal mucosa further from the source, and thereby lower the mucosal dose. Stainless steel afterloading source carriers hold sources up to 20.0 mm × 3.1 mm. End caps that screw onto the applicator handle are spring-loaded to keep pressure on the source carrier. This pressure keeps the source in position and prevents an eccentric position between the shielded ends.

So that comparison could be made with previously studied Fletcher colpostats, dosimetric evaluation of this new FSD applicator was undertaken. The colpostat was examined regarding (1) its dimensions, (2) the position of the tungsten shields, (3) the position of the source when loaded, (4) transmission ratios across the colpostat wall, (5) transmission ratios across the shielded surfaces of the colpostat, (6) the isodose curves around the colpostat, and (7) its usefulness in the clinical situation.

METHODS AND MATERIALS

All dosimetry was performed in a water phantom necessitating special modifications in the film, dosimeter and experimental set-up. Details of the experimental method are described in reference 4. Transmission ratios and isodose curves were determined for planes 1.2 cm from the colpostat top, and 1.0 cm from the colpostat bottom. These planes correspond approximately with the bladder trigone and anterior rectal wall respectively, and have been used by other investigators.[1,5]

Reprint requests to Judith S. Haas, M.D., William Beaumont Hospital, 3601 W. 13 Mile Rd., Royal Oak, MI 48072
Acknowledgements—The authors wish to thank William Paige for graphic illustrations, Darwin Zellmer, M.S. and Kenneth Weeks for their computer assistance, Elizabeth Donnelly, R.T. for applicator radiographs, Marcia Dombrowski for typing the manuscript, and Arlene Lamert-Brow who created the proper setting.

Accepted for publication 10 December 1982.

*3M.

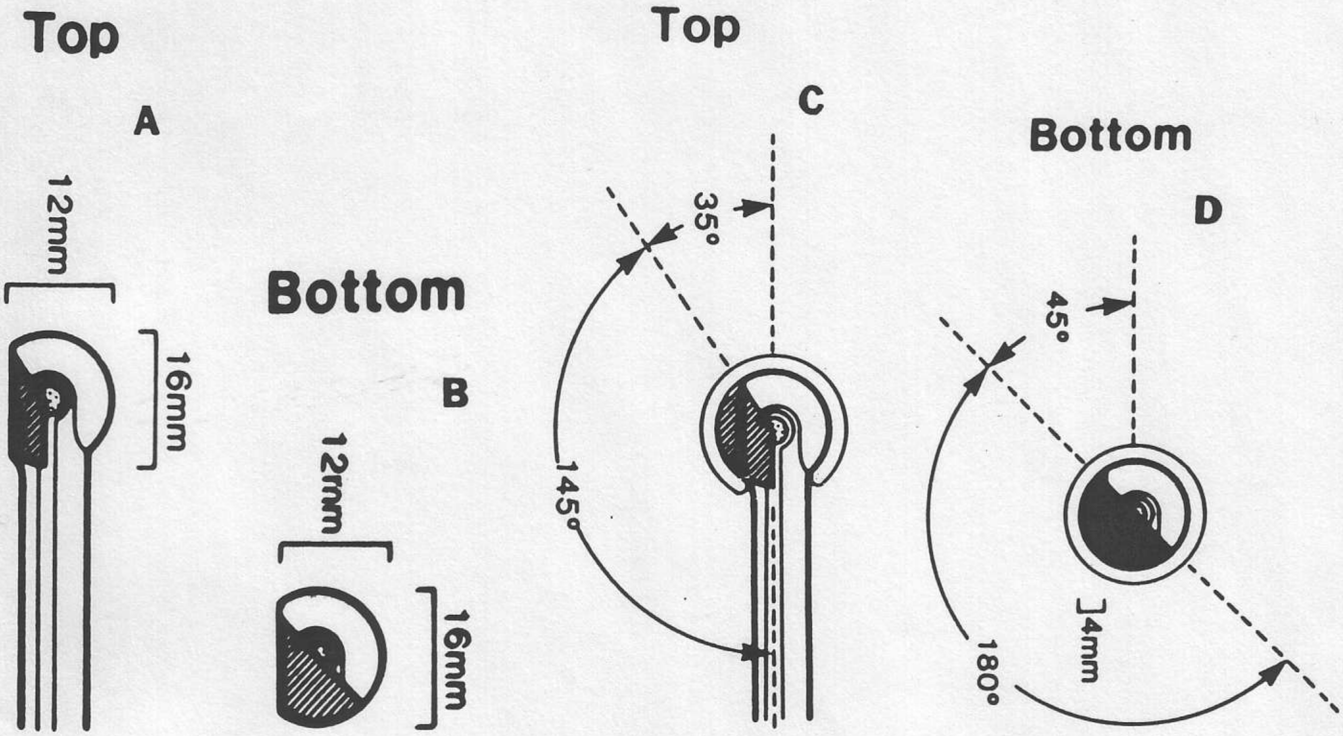

Fig. 1A, B, C, D. Internal shielding is present in the mini-colpostat (A, B). With the shield containing cap in place, the dimensions and shield positions correspond to the original Fletcher preload system. The shield placement differs in the top and bottom of the colpostat. (C,D)

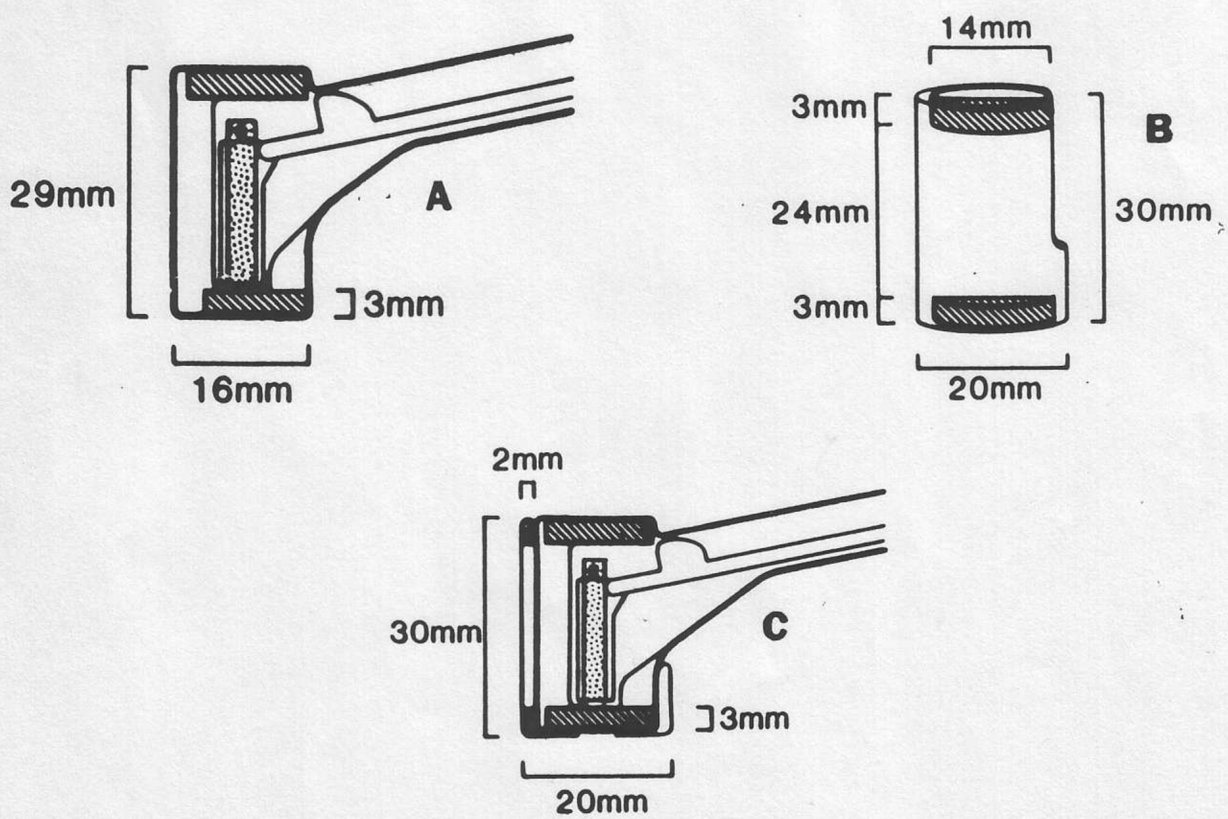

Fig. 2A, B, C. The tungsten shields are at opposite poles of the nylon cap, with the source mid-position between them. With the cap in place, the partial shield in A is extended as in C.

RESULTS

Colpostat dimensions, shield location, and source position

Dimensions of the colpostat were obtained by direct measurement of the instrument and from radiographs. The mini-ovoid is 1.2 cm in medio-lateral diameter and 1.6 cm in cephalo-caudal diameter with partial tungsten shielding placed medially. These medially located shields are at different positions at the top and bottom of the colpostat. Additional tungsten shields are symmetrically placed in the 2.0 cm nylon cap. With the shielded cap in place, the top shield begins 35 degrees from the axis of the handle and subtends an arc of 145 degrees. The bottom shield is placed 45 degrees from the axis and shields a 180 degree arc (Figure 1).

The shields are half-moon shaped and measure 4 mm in widest dimension by 3 mm in thickness. There is a 24 mm separation between the shields at the top and bottom of each cap. The cap snaps into position as it is advanced onto the colpostat. This alleviates problems of improper shielding because of misalignment of the cap on the colpostat when the source ends are not equally screened by the shields. The mini-ovoid has some internal shielding but addition of the cap completes the configuration to one that corresponds with the original Fletcher preload ovoid. The lateral view of the colpostat shows the source and carrier bucket to be centrally located (Figure 2).

The bucket-loading source carriers are constructed with a flange that prevents the source from moving up and down in the bucket. The afterloading carriers are spring-loaded so as the cap is screwed onto the handle, the position of the source bucket will not change. The carrier

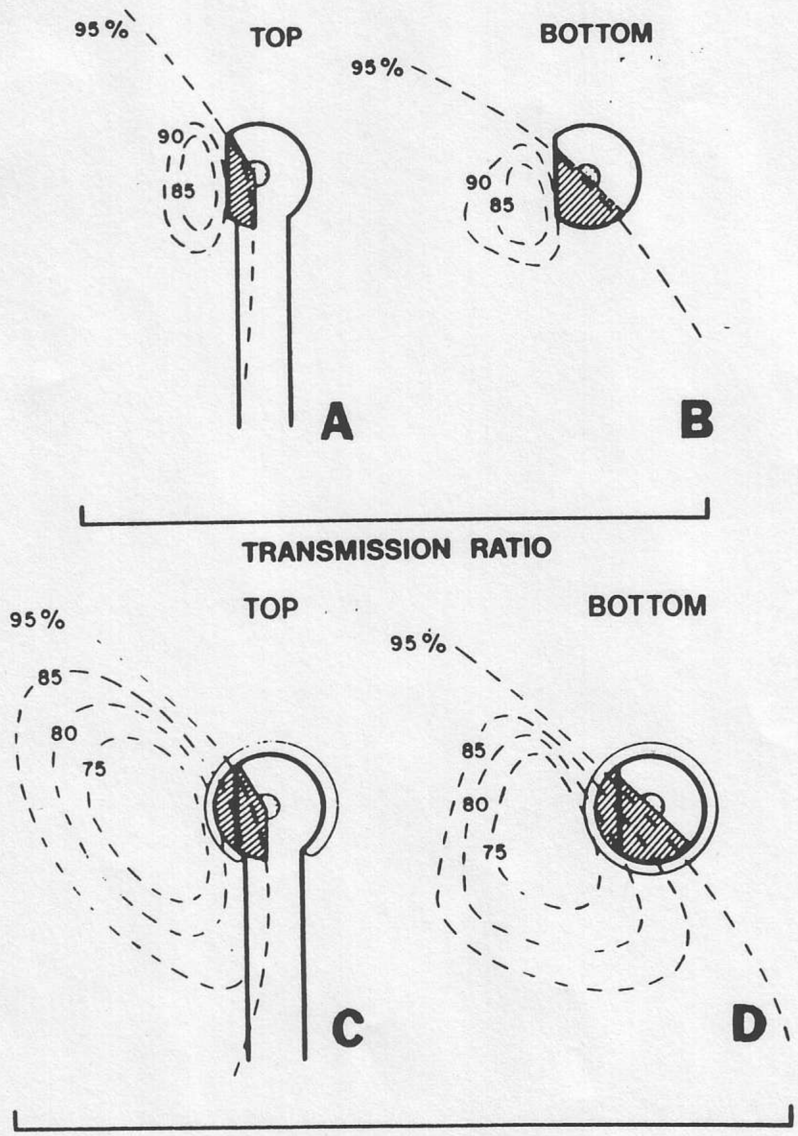

Fig. 3A, B, C, D. The transmission ratios for the mini-ovoid show a minor amount of dose reduction over a limited area (A, B). Tissues receive 15–25% less radiation over the shielded area because at the tungsten screen placement in the FSD (C,D). The configuration and position of the transmission ratios are different at the top and bottom of the colpostat because the shield placement differs.

handles are marked Right and Left, but are marked with respect to the applicator, not to the patient. As the carrier marked "R" is inserted, it will be placed into the colpostat on the patient's left.

Transmission ratios

The transmission ratio describes the fraction of the radiation dose that is transmitted through the tungsten shield when compared with the unshielded source. The transmission ratio for the shielded portion of the colpostat is determined by dividing the radiation delivered to a point through the shielded source by the radiation delivered to the same point through the unshielded source.

The FSD applicator exhibits transmission ratios from 95 to 75% over the areas shielded by the screens. This is up to a 25% reduction in the dose of radiation delivered to the tissues affected by the shield. Since the shield positions are different for the top and bottoms aspects of the colpostats, it follows that the distribution of the transmission ratios for these areas will also be different. Transmission ratio distributions are shown in Figure 3 for the mini-ovoid and for the FSD ovoid. There is some dose reduction because of the internal shielding of the mini-ovoid, however it is of little magnitude and covers a small area when compared with the dose reduction of the standard ovoid.

The transmission across the colpostat wall measures 7%. This means that attenuation by the stainless steel colpostat reduces the source strength by this amount.

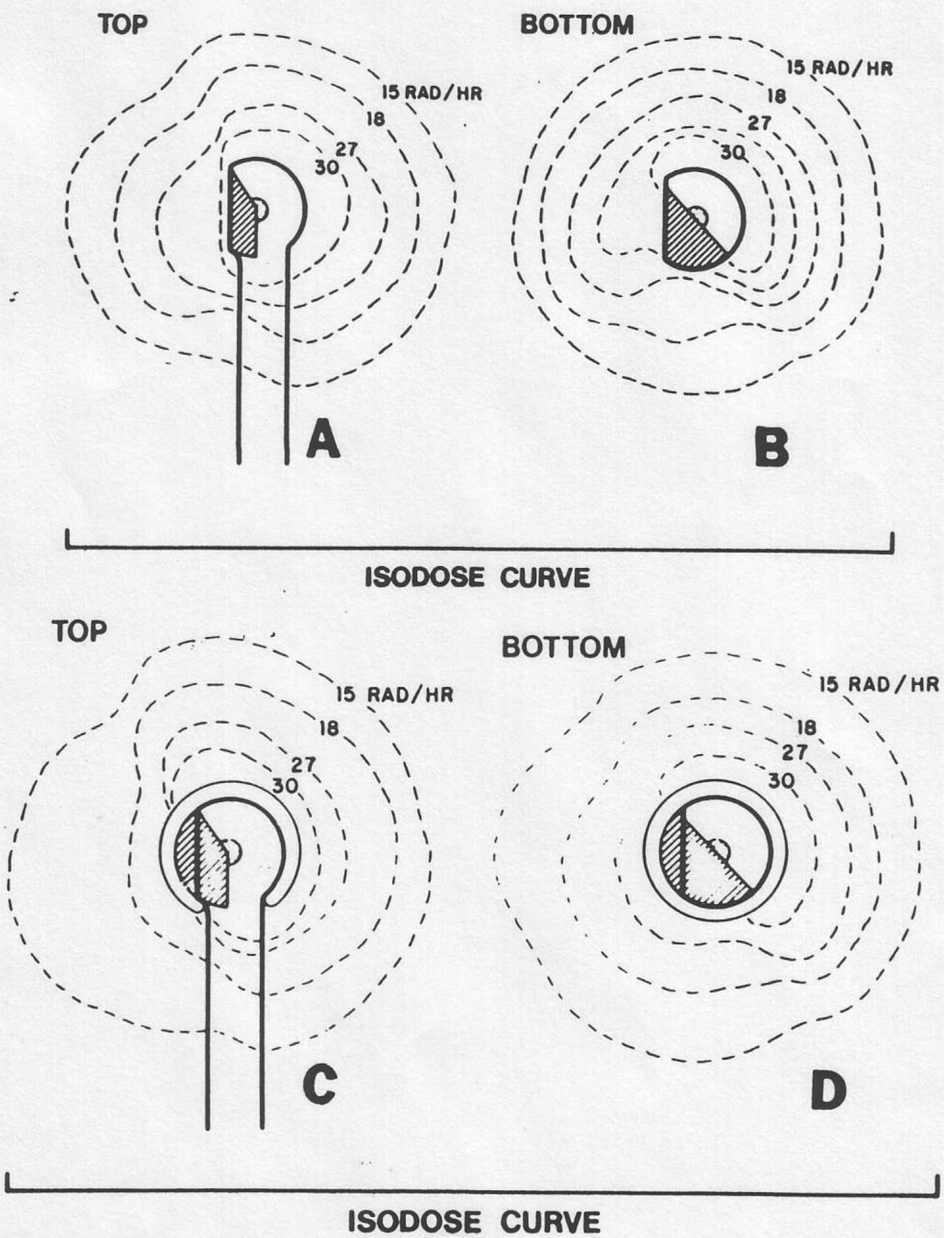

Fig. 4A, B, C, D. Isodose curves show a small area of narrowing of the dose lines in the mini-ovoid (A, B). The FSD colpostat produces pinched-in isodose curves over a 1.5 to 2 cm area (C, D). The isodose pattern differs from top to bottom of the colpostat because of shield position changes.

Isodose curves

The isodose curves in the plane of the shields are affected over a 1.5 to 2.0 cm area adjacent to the shield. The pinched-in isodose lines indicate that a reduced dose of radiation is delivered to the tissues screened by the shielded colpostat. In the clinical situation where both colpostats are used, the reduction in dose to the bladder trigone and anterior rectal wall is a result of the contribution from both shielded colpostats. The isodose curve distribution is different for the top and bottom colpostat surfaces because of the difference in shield location; however, the magnitude of the isodose curves is essentially the same. The dose to the bladder and rectum is about 25% less than if the shields were not present (Figure 4).

If the mini-ovoids are used, there is an area of reduced dose because of the shielding incorporated in the colpostats; however, the isodose lines are contracted over a small area and are only slightly different from isodose lines around a bare source.

The isodose distribution in the sagittal plane of the colpostat with the cap in place demonstrates a dose reduction in the direction of the bladder and anterior rectal wall (Figure 5). These areas of reduced dosage are symmetrical and there is no source displacement toward the rectum as in the original preload Fletcher.

Comparative isodose curves showing the difference between the mini-ovoid and the FSD ovoid are shown in Figure 6 A & B. If the shielded cap is added to the mini colpostat, the areas that receive a lower dose are indicated by the shaded marks. This emphasizes the fact that although shielding is present in the mini-ovoid, it has a

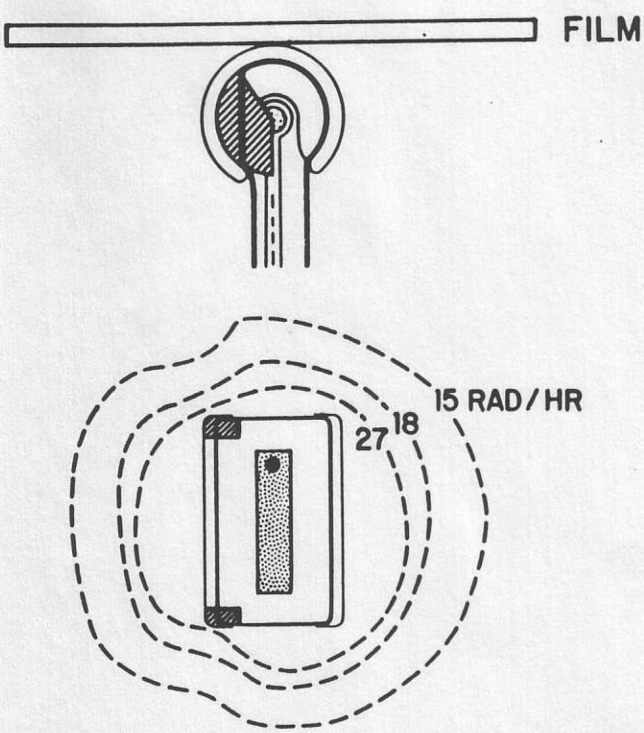

Fig. 5. Isodose distribution in the sagittal plan shows dose reduction to the bladder and rectum. There is no displacement of the source towards the rectum as in the preload Fletcher.

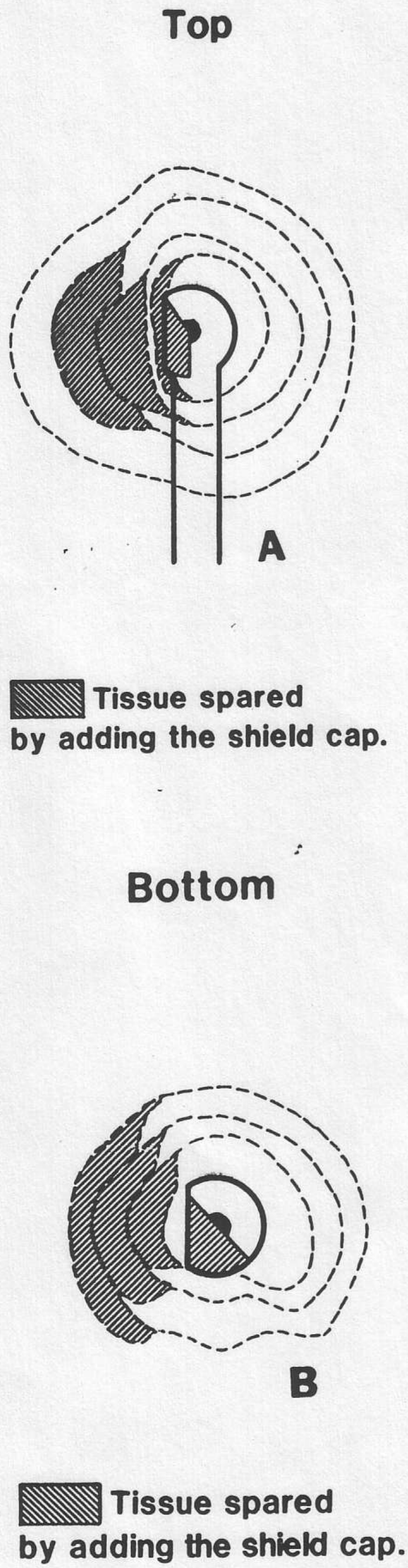

Fig. 6A, B. The shaded area represents the tissue that is spared additional radiation dose if the shielded cap is added to the mini-ovoid, converting it to a FSD ovoid.

minor effect on lowering the dose to surrounding structures. Additionally, the dose to the vaginal wall will be higher in the mini-ovoid, since there is no spacing effect from the nylon cap.

During clinical use, the applicator and its multiple parts fit together well and are easy to use. However, we have had several buckets break off the afterloading carriers and have had the top and bottom colpostat plates fall off the ovoids. The set screw that holds the right and left colpostat together is on the underside and is difficult to loosen at the completion of an application.

DISCUSSION

This addition to the Fletcher group of gynecologic applicators reflects a recent trend toward development of instruments with afterloading mini-ovoid and standard ovoid combinations. Such devices should be evaluated in the context of the original Fletcher colpostat system with regard to size, shape, and shield placement, and dose distribution around the ovoid. This FSD applicator has the same general size and shape as the Fletcher preload radium and the Fletcher-Green colpostats.[2,3] In these three applicators, the top shield position is different from the bottom colpostat shield. The shield configurations and their locations are similar in this group, but differ from the afterload Fletcher-Suit and other FSD devices.†[4,6]

The isodose curves reflect the shield shape and position and demonstrate a dose reduction over a 1.5 to 2 cm area in the region of the bladder trigone and the anterior rectal wall. Transmission ratios describe the fraction of radiation transmitted through the tungsten screen and show a 10–25% reduction in the dose to surrounding tissues. The stainless steel construction of the colpostat causes a 7% reduction in dose as a result of self-absorption through the applicator wall. This is the highest absorption among the Fletcher group. The isodose curves and transmission ratios of this FSD applicator are similar in location and configuration to those of the preload Fletcher and the Fletcher-Green instruments.[2,3,5]

The mini-ovoid configuration that results from removal of the shielded caps produces isodose curves and transmission ratios that exhibit a 5% dose reduction over a few millimeters of tissue. This dose reduction is a result of small sectors of internal shielding in the mini-ovoid. The Delclos mini-ovoid has no shielding present. However, the amount of dose reduction and the volume of tissue that is shielded is rather slight. The physician should use this form of the applicator with caution. Comparative isodose curves best demonstrate the differences in relative dose and shielded area between the mini-ovoid and the FSD ovoid.

This colpostat has a number of characteristics that improve its use clinically in regard to maintenance of source position in the applicator and immobilizing the after-loading bucket in its position. The spacer caps are made of nylon and can be autoclaved. Since they are made in two separate sections, changing and removing the caps is easier. The after-loading bucket size accommodates cesium sources and should not be used with sources with exterior dimensions greater than 20 × 3.1 mm.‡ The manufacturer provides a booklet with each applicator describing the instrument, its dosimetry, use, and how to care for the instrument. Like many applicators, wear and tear of usage and cleaning caused shields to fall out of the caps and the hinged after-loading buckets to break off.

REFERENCES

1. Delclos, L., Fletcher, G.: Can the Fletcher gamma ray colpostat system be extrapolated to other systems? *Cancer* **41:** 970–979, 1978.
2. Fletcher, G.: Cervical radium applicators with screening in the direction of the bladder and rectum. *Radiology* **60:** 77–84, 1953.
3. Green, A., Broadwater, J., Hancock, J.: Afterloading vaginal ovoids. *Am. J. Roentgenol.* **105:** 609–613, 1969.
4. Haas, J., Dean, R., Mansfield, C.: Evaluation of a new Fletcher applicator using Cesium-137. *Int. J. Radiation Oncology Biol. Phys.* **6:** 1589–1595, 1980.
5. Hanson, E., Oliver, G.: Dosimetry measurements on ovoids used and proposed for use at the M.D. Anderson Hospital. Presented to the South West Chapter of the American Association of Physicists in Medicine, 1972.
6. Suit, H.: Modification of the Fletcher ovoid system for afterloading using standard sized radium tubes. *Radiology* **81:** 126–131, 1963.

†Nuclear Associates.

‡3M, Package Insert, Medical Products Division, St. Paul, MN.