1 Introduction

Carcinomas of the anorectal region are subdivided into three groups according to their anatomical site: tumours of the anal margin, tumours of the anal canal, and tumours of the low rectum.

Cancers of the anal canal and of the anal margin are much less frequent than those of the rectum. Cancers of the anal canal are more often seen in females, while those of the anal margin are more common in males. They are frequently associated with chronic irritation of the region, due to condylomata, fistula, fissure, haemorrhoids, etc. Association with HPV is also documented. They progress slowly by direct extension into neighbouring structures, especially the recto-vaginal septum. Lymph nodes are involved in about one-third of cases. They are either inguinal or pelvic. Perirectal nodes are accessible to rectal palpation and endorectal ultrasound. Hypogastric or iliac nodes are uncommon.

Cancer of the anal margin extends superficially, in particular within the anal canal. Inguinal lymph node metastasis is frequent, but metastasis to pelvic lymph nodes is infrequent.

Most early-stage squamous cell and cloacogenic tumours of the anal region can be cured by radiation with preservation of anal function and without serious morbidity. Mutilating surgery is now reserved for failures of radiation therapy (2,3,5,17).

Most cancers of the low rectum are adenocarcinomas, and are diagnosed at an advanced stage, although limited stage tumours are not rare. Because of the local extension and the risk of lymph node disease, a radical resection is required. Conservative management by more limited surgery and/or irradiation is only indicated in selected early-stage tumours (6,16).

2 Anatomical topography

The proximal end of the anal canal is the palpable upper border of the anal sphincter (Fig 23.1). The distal border is the palpable groove, between the lower edge of the internal sphincter and the external sphincter. The overall length of the anal canal is 3 to 4 cm. By convention, we separate the tumours of the anal canal, which are situated above or on the pectinate line, and the tumours of the anal margin, which are below.
3 Pathology

Ninety per cent of the tumours of the anal canal are well or moderately differentiated epidermoid carcinomas, while 10% are cloacogenic (transitional cell or basaloid). The vast majority of the tumours of the anal margin are squamous cell carcinomas, while a very few are basal cell carcinoma. Tumours of the low rectum are almost exclusively adenocarcinomas.

4 Work Up

All patients undergoing irradiation for anorectal cancer require a detailed clinical examination of the anorectal region as well as a thorough general physical examination, rigid anorectal endoscopy, biopsy, endorectal ultrasonography, and assessment of the clinical stage according to the UICC-TNM classification. For patients’ comfort, examination under general anaesthesia may be required for more accurate assessment. Both CT-scan and ultrasonography of the pelvis are useful for diagnosis of pelvic lymph nodes. Simple chest radiography is usually sufficient.

In rectal and anal cancer but not in anal margin cancer, liver investigation is mandatory.

5 Indications, Contra-indications

5.1 Anal canal

- Intracavitary brachytherapy may be indicated in the treatment of selected cases of anal canal carcinoma. Its main limitation is the tolerance of normal anal mucosa, which receives a much higher dose than the tumour extensions into the wall. Usually interstitial brachytherapy is preferred.

- Brachytherapy alone is effective in controlling most small lesions, but causes painful reactions in half the patients and late necrosis in 10 - 15%, and is therefore contraindicated (10-12).

- Interstitial brachytherapy is used as a boost to the tumour bed after 45 Gy conventional external beam irradiation or chemoradiation. Tolerance of treatment is acceptable if the target volume...
Anorectal Cancer does not exceed half the circumference of the canal, 5 mm in thickness, and 5 cm in craniocaudal length. In other words, brachytherapy is used for boosting T1 - 2, and small T3 squamous cell or cloacogenic anal tumours which have responded well to external beam radiation therapy or chemoradiation. Concurrent chemoradiation with 5-fluoro-uracil and mitomycin-C or 5-fluoro-uracil and cisplatin is recommended in locally advanced lesions (T2 > 4 cm, and T3 - 4) (2,5,17). The presence of lymph nodes in the rectal wall may not contraindicate interstitial boost as long as they are located in the distal 8 cm and respond well to chemoradiation.

- Iuxta-anal adenocarcinoma’s which can be locally resected can also be successfully treated with EBRT and brachytherapy (16).

Contraindications are the following:

- Insufficient tumour response after primary (chemo)radiotherapy for squamous cell or cloacogenic anal cancer (see target volume).
- Lesions involving more than the half the circumference of the anal canal, because there is a higher risk of stenosis and necrosis, should be referred to the surgeon for immediate colostomy.
- Lesions of which the proximal limit is not palpable and thus cannot be implanted.
- T4 tumours (however, in T4 tumours extending into the anovaginal septum and responding to external beam radiotherapy, brachytherapy is possible).
- Lymph node situated in the rectal wall at more than 8 cm from the anal margin (however, one can implant the anal canal and deliver an external beam boost to the pelvic nodes).

5.2 Anal margin

Brachytherapy alone is rarely indicated in the management of tumours of the anal margin. It is only used after external beam irradiation to deliver an additional boost.

5.3 Low rectum

Interstitial implantation is only indicated for low rectal carcinoma (3 - 10 cm above the anus) in two specific situations:

- Polypoid well differentiated T1N0 adenocarcinoma: Papillon (10 – 12) showed that these tumours could be treated with contact irradiation at a dose of 9000 R delivered in 4 - 5 fractions over 6 - 8 weeks. Such contact radiotherapy alone results in local control of the tumour and cure in 90% of cases. When complete regression remained doubtful at the end of the irradiation, he proposed, at least in medically inoperable patients, that the tumour bed should be boosted with an implant.
- T2 and small T3, which are classically treated with radical surgery. In some selected cases, conservative treatment can be proposed, combining external beam radiation therapy (and in most cases contact therapy) and a brachytherapy boost (10 - 12).

6 Target volume

The clinical target volume for well-delineated squamous cell carcinoma is the palpable and visible tumour before any treatment with a safety margin of apparently normal mucosa and skin of at least 5 mm. Small rectal lymph nodes accessible to the palpating finger may also be included in the implanted volume.

To allow exact localisation of the boost target area, especially after complete tumour regression following (chemo)radiotherapy, a very accurate clinical description with a drawing is also necessary because, at time of brachytherapy, a complete response has been obtained in two-thirds of cases. It
is also advisable to tattoo the tumour margins on the perineal skin and in the anal canal, and to place metal clips at the proximal and distal end of the gross disease during clinical examination under general anaesthesia. Careful delineation of the boost target area improves the ballistic selectivity of treatment, and reduces complication risks for anal stenosis or necrosis by limiting the high dose area to what is strictly needed.

7 Technique

7.1 Anal canal

A guide needle technique is recommended. Patient preparation the day before procedure includes perineal shaving and cleansing enemas. Further general or spinal anaesthesias may be used. The procedure is carried out in the lithotomy position. A Foley catheter is passed in women, and in male with urinary dysfunction or in anterior wall implants, when needles are inserted in the prostate or close to the bladder neck.

The implantation is carried out with blind ending steel guide needles, 15 cm long and 1.7 - 1.9 mm in diameter. Parallelism between needles is secured with a Papillon’s template, which is a crescent moon-shaped lucite plaque, 2 cm thick, perforated at 1 cm intervals in a circle, 3.2 cm in diameter. Other templates may be used as well. In that case, needle entrance positions should be marked on the perineal skin, with an anal dilator in place, before entering the rectal wall. However the open shape of the Papillon template allows the introduction of a palpating finger in the anus during needle insertion.

The procedure begins with meticulous examination under general anesthesia to determine the extent of any residual tumour. Since tumour lesions frequently regress completely after external beam radiation therapy, a precise report of the initial description is essential to perform implantation correctly. The presence of the formerly placed tattoos may help for exact localisation.

The template is then sewn firmly against the perineum (Fig 23.2); its orientation around the anus is determined by the perineal sector to be implanted. Needles are then implanted through the holes of the plaque into the tissues of the anal wall, while a finger is introduced into the rectum to verify that the needles do not penetrate the rectal lumen. Usually, the needles are inserted about 5 mm beneath the anorectal mucosa. It is somewhat more difficult to insert needles in the rectovaginal septum, without penetrating the rectal or vaginal lumen. In most cases, it is easier to implant the first needle in the recto-vaginal septum before to sewing the plaque to the perineum.

Fig 23.2: Guide needle technique for implantation of the anal canal
A typical implant contains 5 radioactive lines spaced at 1 cm, 5 - 7 cm long for a T1 - 2 tumour, and 6-7 needles, 7 - 8 cm long for a small T3 tumour.

In some cases, if at the time of brachytherapy the tumour is still thicker than 1 cm, a volume implant can be performed, or two single plane implantations with a three week interval, to allow for more tumour shrinkage.

All needles are positioned at the same depth and verification should be made that needles do not retract when the patient’s legs are extended.

A rubber tube covered with or wrapped in Vaseline gauze or an anal dilatator is inserted into the anal canal against the needles in order to hold the involved rectal wall against the needles and to keep healthy tissues away from the implant.

A compressive dressing is applied to prevent displacement of the system during the irradiation (Fig 23.3). A reliable method is to use 10 cm broad elastic taping: first a horizontal part with a central slit to hold the template against the perineum. Then long strips crossing from the right iliac crest to the left buttock, and left iliac crest to the right buttock, followed by a second horizontal strip with a central opening and a final vertical inverted Y shaped closing tape.

![Fig 23.3: Elastic tape dressing to fix the anal applicator to the pelvis; the taping will be completed with another horizontal strip and a vertical Y shaped closing strip.]

### 7.2 Anal margin

The technique employed in most cases uses the same plastic tubes as for skin cancers. Adequate parallelism between lines may be difficult to achieve because of the curvature of the region. Buttocks must be, as far it is possible, held apart during the irradiation, and it is sometimes necessary to keep the patient in the prone position for the duration of the treatment.

### 7.3 Rectum

#### 7.3.1 Lyon technique

The patient is prepared with cleansing enemas. The application can be performed without general anaesthesia since the rectal wall is insensitive. Only local anaesthesia of the perineal skin is necessary. The patient is placed in the knee chest position and a large rectoscope with a diameter of 3 cm is introduced into the rectum to visualise the area to be implanted.

A metal fork is inserted under the mucosa surface using long forceps (Fig 23.4). This metal fork consists of two curved or straight guide gutters held together at one end by a metal bridge, which can
be handled by the forceps. The pointed ends of the guides are occluded, and are preloaded with 4 cm iridium 192 wire sources (the two branches are spaced at 1.6 cm), which are held in place by a drop of rubber cement. The guide is not sutured but carries a silk suture, for extracting the fork from the rectal wall after treatment.

Fig 23.4A : The Lyon technique for implantation of tumours of the low rectum (A); Radiograph of implanted fork (B) (by courtesy of J.M. Ardiet)

A rubber drain wrapped in Vaseline gauze is inserted into the rectum and sutured to the perineum.

For low rectal cancer below 6 cm from the anal verge, the same template technique as for anal cancer is recommended.

7.3.2 Créteil technique

A conservative approach is proposed for well-differentiated superficial exophytic adenocarcinoma, 5 cm or less in diameter and within 10 cm of the anal orifice (4,9). A 35 Gy external beam irradiation delivered in 3 weeks is first delivered. The regression of the tumour is assessed one month later. If satisfying regression is obtained, transanal resection of the residual tumour and intraoperative implantation of a plastic loop to deliver an additional 20 - 30 Gy to the tumour bed (Fig 23.5) is performed. If the residual tumour is 3 cm or more, the patient is proposed an abdominoperineal resection, is recommended.

Fig 23.5 : The Créteil technique for implantation of tumours of the low rectum.

7.4 Low rectal cancers

Limited adenocarcinomas that are accessible for transanal resection are treated postoperatively with 45 Gy chemoirradiation and implantation of the tumour bed. The same template technique as for anal cancer is recommended.
7 Dosimetry

Computer dosimetry is based on two orthogonal films of the implant, and the duration of the irradiation calculated according to the rules of the Paris System adapted to curve planar implants (Fig 23.6). For the Papillon’s template, as the spacing is always 1 cm and the geometry of the implant identical, provisional dosimetry can be carried out.

![Fig 23.6: Distribution of dose in the central plane of an implant of the anal canal with 5 iridium wires (Papillon technique): isodoses 10%, 50%, 70%, 85% (Reference Isodose according to the Paris System), 100% (Mean Central Dose), 120% and 170% (High Dose Volume 2 x Ref. isodose).](image)

For the fork technique, provisional dose calculation can also be done because of the fixed geometry.

8 Dose, Dose Rate, Fractionation

In anal canal tumours, the boost dose delivered after 44 - 46 Gy external beam radiation therapy to the target volume is in most cases 15 - 20 Gy (LDR - PDR) at a 0.3-0.6 Gy dose rate. If a PDR afterloader is used, 0.5 Gy hourly pulses are recommended. If residual disease remains palpable at the time of the implant, the dose can be increased up to 30 Gy in the residual tumour volume with the central sources (boost within boost technique). Experience achieved with high dose-rate brachytherapy is not sufficient to allow us to give recommendations. However, because of the fragility of the anal canal mucosa, it seems preferable to deliver fractions 3 Gy or less, spaced to at least 6 hours apart.

In the fork technique for low rectal carcinoma, the dose delivered varies from 10 to 30 Gy, and depending on the size of the residual tumour and the dose of irradiation given with contact therapy. The duration of this implant is usually less than 48 hours.

9 Monitoring

During the application, the patients are kept on strict bed rest and received a low residue diet, sedatives and anticoagulants.
Removal of the Papillon template and needle can be performed at the bedside. The sutures holding the template are cut, and the entire system, including the central tube, is extracted en bloc. When a system with needles and anal dilatator in a fixed position are used, it is recommended to remove needle one at a time and finally the anal dilatator. If gently done, this procedure needs neither anaesthesia nor analgesia.

Mucositis develops 1 - 2 weeks after the implant. The reaction is maximal after 3 - 4 weeks, and heals progressively in 5 - 8 weeks. Local ointments and, if necessary, oral analgesics should be given.

## 10 Results

### 10.1 Anal canal

Overall, authors using interstitial brachytherapy as a routine boost technique, report local control rates between 80 and 90% of cases, with severe necrosis rate requiring colostomy not exceeding 5%.

At the Centre Léon Bérard, 221 patients have been treated conservatively with the above-described technique for T1 - 3 cancer of the anal canal. Five-year overall survival rate was 66% (12). Local failure rate was 8% and anal function was preserved in 90% of cases. Severe complications were uncommon with, in total, 7 cases needing colostomy. The authors insisted on the fact that these favourable results were obtained because the above described protocol indications were rigorously followed. They in particular recommended that the intersource spacing should remain less than 1.5 cm.

At the University Hospital of Geneva, for 125 patients definitively treated with radiation for anal cancer (with a Ir-192 boost in 108), at 5 years, overall survival rate was 66.5%, overall local control rate 83%, and local control rate with sphincter preservation 68% (1). At the Lyon-Sud hospital, 95 patients were treated between 1982 and 1993 for a T1-4N0-3 squamous cell carcinoma of the anal canal with high dose external beam radiation therapy and concomitant chemotherapy with cisplatinum and 5-fluorouracil, followed by a boost with low dose-rate iridium 192 implant (7). At 5 and 8 years, the overall survival rates were 84% and 77%, the cancer specific survival rates 90 and 86%, and the colostomy-free-survival rates 71% and 67%, respectively. A local recurrence was seen in 14 patients. Among 78 patients who preserved their anus, anal sphincter function was excellent or good in 72 (92%).

At the Centre Alexis Vautrin, 101 patients were treated from 1976 to 1994 for a T1-4N0-3 squamous cell carcinoma of the anal canal with 36 - 45 Gy external beam radiation therapy and concomitant chemotherapy with 5-fluorouracil and mitomycin C, followed by a 20 Gy boost with a low dose-rate iridium 192 implant (15). Six others had a boost with external beam irradiation, and 12 an abdominoperineal resection. At 5 years, the overall survival rate was 60%, and the specific survival rate 75%; it was 94% for T1, 79% for T2, 53% for T3, and 19% for T4. Thirty-two locoregional recurrences were distributed according to stage into 2, 17, 10, and 3 recurrences for 19 T1, 70 T2, 22 T3, and 7 T4. Severe late complications were observed in 17 patients, and were treated with abdominoperineal resection in 4 and colostomy in 11 (of which 7 were permanent). The rate of sphincter preservation after conservative treatment in cured patients was 100% for T1, 82% for T2, 58% for T3, and 100% for T4.
At the Clinique Sainte Catherine, Avignon, France, 69 patients were treated with external irradiation (40 Gy in 20 fractions) and 20 Gy interstitial Ir-192 implant for a localised epidermoid carcinoma of the anal canal (3). Complete response rate was 81%. Actuarial local control rate at two and five years was 65% and 59%, respectively, and colostomy rates 26%, and 33%. Overall survival at two, five, and ten years was 61%, 47%, and 37%, respectively. Overall treatment times of less than 12 weeks and time interval between external radiotherapy and brachytherapy less than 6 weeks were associated with a better local control rate (P = 0.05).

A PDR afterloader was recently used for treating these patients, using the same technique of implantation and delivering the same total dose with hourly 0.5 Gy pulses. Results obtained seemed similar to those described with the low-dose rate technique (8).

10.2 Rectum and iuxta-anal adenocarcinoma

The 90 patients treated in Lyon for an adenocarcinoma of the rectum with the fork technique had a 74 % five-year overall survival rate and, in total, 16% of local failures were observed (12).

Between 1980 and 1987, 25 patients with rectal cancer were treated at the Henri Mondor Hospital with a combination of preoperative external irradiation of 35 Gy in 15 fractions over 3 week, which was followed, 6 to 8 weeks later, by tumorectomy preoperative and peroperative plastic loop implant (fig 23.5) with iridium 192 (4,11). This boost dose was 20 Gy for submucosal lesions (seven patients) and 25 Gy for intramural (eight patients) and extramural lesions (ten patients). With a mean follow-up of 40.5 months, there have been five recurrences, the latest occurring 16 months post-tumourectomy. The 20 patients with local control have preserved a fully functional sphincter, and 19 of them were disease-free.

Between 1986 and 1992, Gerard et al treated 29 patients for infiltrating adenocarcinoma of the rectum with a combination of contact x-ray (50 kV ) given first (70 Gy / 3 fractions), accelerated external beam irradiation (39 Gy / 13 fractions / 17 days) with a concomitant boost “field within field” (4 Gy / 4 fractions), and six weeks later an Ir-192 implant (6). There were 2 T1, 14 T2, 13 T3, the diameter of which exceeded 3 cm in 19. Twenty tumours were at 5 cm or less from the anal verge. The median age was 72 years. Overall and specific 5-year survival rates were 68% and 76%, respectively. Local control rate was 72%.

Another approach combining surgical resection with external beam RT and brachytherapy for iuxta-anal adenocarcinoma has also been proven effective. In a series of 28 patients with small T1-T3 adenocarcinoma, only 2/12 (17%) of those who were treated at Leuven University hospital with combined surgical, EBRT and brachytherapy had a local recurrence (16).

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11 References


