1 Introduction

Bladder cancer occurs after the fifth decade and more frequently in men than in women (sex ratio 2:1 to 3:1). It has been associated mainly with smoking, but also with occupational exposure to carcinogens from aniline dyes, paints, rubber, etc, and chronic irritation of the bladder mucosa due to bladder stones, or schistosomiasis. The main symptom is painless hematuria, which in the adult patient is an indication for cystoscopy.

The tumour grows either as a polypoid lesion (Ta), which becomes invasive, or from flat mucosal lesions with dysplasia and carcinoma in situ (Tis), which are frequently multiple and have a much worse prognosis.

From the therapeutic point of view, it is important to distinguish between superficial lesions, confined to the mucosa or submucosa, and lesions invading the muscle of the bladder wall. Bladder preservation is usually possible in the solitary superficial lesions, and has been investigated by several authors as an alternative to mutilating cystectomy. Partial cystectomy, external beam radiotherapy (including chemoradiation), interstitial bladder wall brachytherapy, and various combinations of these have been proposed in selected cases. For superficial tumours, the choice also includes transurethral resection and intravesical immunotherapy or chemotherapy.

Brachytherapy plays a definitive role in the conservative approach of selected high-risk superficial lesions and selected solitary muscle infiltrating tumours.

2 Anatomical Topography

The bladder is roughly pyramidal in shape when empty and becomes ovoid when filled, the bladder dome extending out of the pelvis into the abdomen. The trigone, at the bladder base, is triangular and is situated deeply in the true pelvis, behind the pubis, so that it is less accessible to implantation procedures. The ureters enter the bladder at the superolateral angles of the trigone, and the urethra leaves the bladder at the inferior angle. The wall consists of mucosa, submucosa and muscle layers of the detrusor vesicae. The mucosa is smooth at the trigone, but is thrown into folds at the dome when the bladder is empty. The bladder has no serosa but is surrounded by perivesical fat at its fixed inferior part, while the dome is covered by abdominal peritoneum.

3 Pathology

Most bladder cancers are transitional cell carcinomas. They are graded according to 3 categories of differentiation. Squamous cell carcinoma is more often seen in patients with an history of local bladder irritation. Adenocarcinoma arising from residual urachal mucosa is rare.
Depth of invasion, lymph node status, and pathological grade, are the most important prognostic factors for local control, disease-free survival and overall survival, and are key parameters in the therapeutic decision. The indications for brachytherapy depend on the size of the tumour, its location (bladder neck versus upper trigone and dome) and the presence or absence of multifocal disease elsewhere in the bladder mucosa. Tumour stages according to depth of invasion are illustrated in Fig 19.1.

![Fig 19.1: UICC 1995 T staging of bladder cancer](image)

### 4 Work Up

After recording the patient's history and a full clinical examination, fresh urine is sampled for cytological examination and a cystoscopy is carried out for diagnosis and biopsy. Positive cytology raises suspicion of the presence of a carcinoma in situ.

For staging the primary tumour should be assessed by bimanual suprapubic and transrectal palpation during anaesthesia for cystoscopy. Ultrasonography, CT or MRI, may be helpful in assessing the depth of invasion. If possible, a complete transurethral resection of the tumour is performed (TUR), and random biopsies are taken of the remaining bladder mucosa. An accurate drawing of the tumour and its relation to the ureteral ostia should be made. The pathologist should carefully assess grade and depth of invasion.

Blood chemistry, an intravenous pyelogram, a CT scan of the pelvis and abdomen or MRI and PET scan, especially looking for retroperitoneal lymph node and liver metastasis, as well as chest radiography, will complete the staging procedure.
Staging must be recorded according to the UICC staging system, which has been recently changed for bladder cancer (Fig 19.1).

The final therapeutic decision should be taken jointly by the urologist, the radiation oncologist and, if indicated, the medical oncologist. It requires close collaboration with the pathologist.

5 Indication, Contra-indications

Experience with interstitial implantation for bladder cancer shows that this technique can be carried out in nearly all parts of the bladder for solitary T1-T2 tumours (UICC 1997), 50 mm or less in diameter. For tumours located in the bladder dome, the technique can be associated with a partial cystectomy when indicated.

After TUR, low grade-low stage (T1 G1-2 N0) tumours are usually treated with preoperative irradiation to the bladder (e.g. 10.5 (3.5 Gy/fraction fx) to 12Gy (4Gy/fraction fx) in 3 daily fractions) to prevent tumour cell implantation in the surgical wound (4). Brachytherapy is performed immediately after bladder irradiation.

Muscle invading stage T2 or high-grade T1 G3 patients tumours are treated with a preoperative dose of 40 Gy (2 Gy) in 26 days, to the pelvis, followed 2 to 3 weeks later by cystoscopy (or 20 Gy (4 Gy) in 5 days).

Depending on the response seen, a decision is made as to whether the patient will be treated with brachytherapy or partial or total cystectomy.

Contraindications to brachytherapy are the following:

- Tumour invasion of the bladder neck, since very low tumour extension is not accessible to the plastic tube technique because of hampering by the pubic bone. With an experienced team of urologist releasing the bladder wall from the perivesical fat, and radiation oncologist using implantation needles mounted on a "boomerang" device (Fig 19.5), lesions in the lower part of the trigone can still be implanted.
- Tumour extending to perivesical fat (T3).
- Multifocal bladder cancer.
- Lymph node involvement. These patients should be treated with external beam RT and not brachytherapy.

6 Target Volume

The clinical target volume includes the gross disease (or the bladder scar after partial cystectomy), and a security margin of 10 mm. The full thickness of the bladder wall should be irradiated.
7 Techniques

Today, peroperatively implanted plastic tubes as developed by Henscke, Chassagne and Pierquin are the technique of choice and have been extensively described in the literature (11,24). The tubes, which follow the normal anatomic curvature of the bladder, exit through the abdominal wall (Fig 19.2).

Fig 19.2: The plastic tube technique for interstitial bladder implantation. A two line implant for small target volumes or after partial cystectomy. A three line implant for a larger implant.

The implanted catheters are afterloaded, either manually with iridium wires, or using LDR, or PDR afterloaders. There is little experience with HDR brachytherapy in the interstitial treatment of bladder cancer.

Brachytherapy may preceded by partial cystectomy. The choice depends on the size of the tumour, its location in the bladder, and on the persistence or not, at the time of implantation, of gross tumour left after TUR, external beam radiotherapy and or chemotherapy.

7.1 Patient Preparation

Patients are treated under general or peridural anaesthesia

A median suprapubic laparotomy is performed. The operation starts with a subvenous iliac node dissection, homolateral to the tumour side and bilateral when central. An immediate frozen section examination is carried out. If lymph nodes are touched treatment is stopped and patients will be treated further by external beam radiotherapy.

7.2 Plastic Tube Technique (Fig 19.2)

The bladder is then opened at some distance from the tumour site, to make the implantation easier. After inspection and palpation of the tumour site, the urologist and radiation oncologist make the final decision whether to perform a partial cystectomy or not. In difficult cases, biopsies and frozen section examination may guide the decision.
The PTV for the interstitial radiation is first defined (Fig 19.3). A safety margin of 10 mm is taken around the macroscopic tumour localisation or scar after partial cystectomy. Next, the implant geometry is designed, according to the rules of the Paris system. Source spacing is chosen so that the full thickness of the bladder wall is treated. Spacing of 10 to 20 mm will result in a treated volume of 5 to 12 mm thick. Then the number and the length of radioactive sources are determined.

Fig 19.3: Delineation of the CTV – PVT: a safety margin of 10 mm is taken around the scar or any visible or palpable tumour residue at the time of the implantation.

The bladder wall is then implanted with curved hollow needles of 1.6 mm external diameter and a special needle holder forceps, or by a Reverdin needle (18). The length (40 to 80 mm) and curvature of the needles (Fig 19.4) are chosen depending on the site of the tumour in the bladder.

Fig 19.4: Bladder implantation needles of different length (4 - 8 cm) and curvature
To implant deep localisations close to the bladder neck, it may be helpful to use a boomerang device (Fig 19.5), which helps to make a tight bend behind the pubic bone.

Fig 19.5: A "boomerang" device, used for endoscopical prostate resections, with a curved steel bladder implantation needle welded to it. Pressure on the button advances the needle in a semicircular movement forwards and permits implantation deeply into the small pelvis.

Because curved source lines result in an asymmetrical dose distribution towards the concave side (Fig 19.6), the needles should be placed in the outer part of the bladder wall, so that the reference isodose will cover the entire thickness of the bladder wall.

Fig 19.6A and B: Dose distribution of a curved plastic loop bladder implant. The plastic tubes must be implanted deeply in the muscle to assure complete covering of the CTV-PTV at the convex site of the implant.

Usually 2 source lines parallel with the surgical scar will be sufficient to cover the target after partial cystectomy, while 3 source lines may be required in other cases when a larger surface must be covered (Fig 19.2). When loading with sources of uniform linear activity (iridium wires), the active source length must extend 15% more than the length of the target at each end (ratio of the active length to the treated length is about 1.43). For sites very low in the trigone, it may be better to make a loop than two parallel lines, to be able to cover the target adequately. With stepping source PDR or HDR afterloaders, using geometrical optimisation facilities, the source track extension may be reduced to 8% at each side.
7.3 Double Sided Open Tubes (Manual Afterloading)

A plastic guide wire is inserted into the needles. Over this guide a plastic tube is slipped and pulled through the bladder wall while the needle is removed. When in place, the tubes are fixed one to the other, by perforated gastric tubes that are pulled at both extra-abdominal ends of the loop. If necessary, the source catheters may be stitched (without constricting the lumen) to the bladder wall to them parallel. When all plastic tubes are in place and fixed, the guide wires are retracted to one side of the loop and fixed by metal buttons in a position, where it will stop the radioactive source when loaded from the other end of the tube. A metal dummy guide wire is then inserted through the loading canal. The exact source length is then measured by retracting the wire in the tube. After that, the guide is fixed to the tube by a metal button, to keep the treatment canal open. The target length is marked by metal markers, implanted in the bladder wall at both ends of the target area. This allows control and correction of source positioning afterwards, if the catheters have moved. To prevent stone formation, the markers should not be clipped to the mucosa surface, but implanted into the muscle.

The tubes are gently brought through the suture, as much as possible following the anatomical shape of the bladder, and respecting the spacing of the plastic tubes when the bladder is closed. In some cases e.g. when implanting the bladder dome, the tubes may come out directly at one or both sides, at the outer surface of the bladder, without passing through the cystostomy suture. A Foley catheter and if indicated, a suprapubic cystostomy catheter is introduced into the bladder. While closing the abdominal wall, the parallel spacing of the plastic loops must be maintained. The plastic tubes are finally fixed by stitching the gastric tube bridges to the skin at both sides of the scar (Fig 19.7).

Fig 19.7: End situation: plastic tubes, held by spacers are stitched to both sides of the sorting loops to the skin.
7.4 Modifications Of The Plastic Tube Technique For Closed Tubes With Wire-Ends 
(Remote Control Afterloaders)

These implantation catheters are constructed with two guide wires attached to both ends and contain a plastic wire inside to protect the lumen. One plastic guide wire is inserted into the implanted needle. Since these plastic tubes are thicker than the needles, it is important to insert the wire in the needle, so that the needle can still be removed. This can be a problem in very low bladder implants, close to the bladder neck, where the needles can only be retracted in the cranial direction because of restriction by the pubic bone. In this situation, the guide wire should then be inserted into the caudal end of the needle. It is also important to consider the source track length of the afterloader used. If it has a limited range, the tip of the tube must be retracted until the treatment range of the afterloader corresponds to the defined source position in the bladder.

8 Dosimetry

After implantation, the tubes are loaded with dummy sources and their position is checked by fluoroscopy and corrected if necessary. Then radiographs (projection images) are taken. These images are often taken from an AP and a lateral direction used for the 3-D reconstruction of the source positions and markers. Then the dose distributions can be calculated.

According to the Paris system, the prescribed Minimal Target Dose is specified at the 85% peripheral isodose line (100% being the Mean Central Dose between the source lines), which must encompass the PTV.

With stepping source afterloader technology, it is possible to reduce the ratio source track length/ treated length by using geometrical optimisation or to correct for slight divergences of the sources, which may easily occur when the bladder is closed after implantation. Large deviations however can not be corrected without causing unacceptable enlargement of the hyperdose sleeves around the sources.

9 Dose, Dose Rate, Fractionation

The prescribed dose depends on the dose given by the preoperative irradiation, and on the surgical techniques used. After a preoperative dose of 10 - 12 Gy by EBRT, 60 - 65 Gy LDR is given by the brachytherapy. After 40Gy (2 Gy fractions fx) by EBRT a boost dose of 25 - 30 Gy LDR is prescribed. After partial cystectomy somewhat lower doses may be advised (55 - 60 Gy or 20 Gy LDR respectively). At lower doses, more recurrences are reported (15). Dose rates to be aimed at in LDR, should range between 40 and 80cGy.h⁻¹. Higher dose rates lead to higher complication rates (18,15). With PDR treatment, the same brachytherapy doses in 50 - 70 cGy hourly pulses are prescribed.

Up to now, there is no clinical HDR data available to recommend doses and fraction sizes for this kind of brachytherapy.
10 Monitoring

After the operation the patient stays a few days in the urology department to receive adequate post surgical care until urinse flow is restored. Since the implanted material is very fine and supple, it is well tolerated by the patient. Urine leakage and wound infections are much less frequent with plastic tube implants than reported after radium or caesium needle implants (1,20,18).

Patients should receive adequate prophylaxis for venous thrombosis. Urinary antiseptics, and if needed appropriate antibiotics are prescribed as well as analgesics and spasmyotics.

After 4 - 5 days, the patient is admitted to the brachytherapy department for simulation and loading of the plastic tubes. Earlier loading might expose the patient to a higher risk of complications (15).

Depending on the dose prescribed and the dose rate of the implant, treatment times vary from 24 h to 120 h. The output of urine, through the Foley and suprapubic cystostomy catheters, is followed-up daily. The latter is removed after one week, the Foley after two weeks.

Removal of the plastic tubes can easily be done without sedation or anaesthesia. Only very exceptionally it is necessary to resort to endoscopy to remove the tubes.

11 Results

11.1 Local Control And Survival

The results reported in the literature with this treatment policy are excellent (table 19.1). Most reports on interstitial radium come from Rotterdam. (20,21,23). These authors reported local control in 91% of T1 lesions, in 84% of T2 (now T2a) and in 72% of T3a (now T2b) lesions. Secondary bladder tumours were noted in 7%, 7% and 5%, respectively. The experience with caesium 137, reported by two other Dutch centres shows 5 year actuarial local control of 85% for T1 and 69% - 81% for T2 tumours (1,5). Results obtained with the plastic tube technique give similar survival and local control rates.

Patients with T1 tumours, have a survival rate of 70 to 90 % at 5 years (2,5,8,18,15,20) and this excellent outcome persists to 72 to 78% at 10 years (2,5,11,21). Bladder recurrences are seen in about 15 % with local recurrence rates of about 10% and secondary bladder cancers in about 5 % of cases. In a large retrospective study, these results after TUR and radium implant were superior to those obtained after TUR alone (20). The retrospective data also suggest that in combination with surgery (TUR or partial cystectomy) is associated with a lower incidence of recurrence than surgery plus intravesical chemotherapy (4,13,16) or surgery and intravesical BCG (6). Nevertheless nowadays, most high risk Ta Tis and T1 lesions are considered candidates for these intravesical instillation. Interstitial brachytherapy is reserved for a subgroup of solitary T1 G3 cases with negative random biopsies, although its value in comparison with instillation has never been tested in a randomised study.

Patients with superficial muscle invading bladder cancer (T2a), treated with brachytherapy have reported 5-year survival rates of 51 - 66% (2, 8,15,18,22) and 10 year survival rates of 34 - 37% (2, 11,21). Bladder relapse rates of 7 - 36% have been reported with local recurrences in about 15% and secondary bladder tumours in less than 10% (8,11,12,15,18).
Patients with deeply invading cancer (T2b) have five-year survival rates of 34 - 70% (8,15,18,21-23). Bladder relapse rates of 10 - 32 %, have been reported with local recurrences in 15-28% and secondary bladder cancers in about 5% (9,23,25).

The survival rates obtained in these muscle invading cases treated with surgery and brachytherapy, (51 - 70% at five years for T2a and 34 - 66% for T2b), are similar to those obtained with radical cystectomy, which gives 40 to 80% five-year survival in T2a and 40 to 50% in T2b (5,22). There seems to be no major difference in outcome between T2b (old T3a) and T3 (old T3b) patients selected for brachytherapy (21) at least when corrected for lymphatic invasion and grade (22). These resulted superior to those reported with external radiotherapy alone (5), although the selection of patients may be of course be brand in favour of patients selected for brachytherapy.

Table 19.1: Five-year local control results according to T stage, for invasive bladder cancer treated by interstitial brachytherapy.

<table>
<thead>
<tr>
<th>Author</th>
<th>SX</th>
<th>EBRT (GY)</th>
<th>Technique</th>
<th>5-Y in-Bladder Recurrence Rates (% Secondary tumours included)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>vdWerf 1981</td>
<td>TUR</td>
<td>3*3.5)</td>
<td>Ra226ND 65Gy</td>
<td>197</td>
</tr>
<tr>
<td>(20) 1983 b (22)</td>
<td></td>
<td>3*3.5</td>
<td>Ra226ND 65Gy</td>
<td>391</td>
</tr>
<tr>
<td>VdWerf et al.</td>
<td></td>
<td>40 Gy</td>
<td>Cs137ND 37.5Gy</td>
<td>90</td>
</tr>
<tr>
<td>1989 (23)</td>
<td></td>
<td></td>
<td>Ra226ND 65Gy</td>
<td></td>
</tr>
<tr>
<td>Batterman et</td>
<td>TUR</td>
<td>3*3.5</td>
<td>Cs137ND 60 Gy</td>
<td>123</td>
</tr>
<tr>
<td>al. 1986 (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straus et al.</td>
<td></td>
<td>2.35Gy</td>
<td>Cs137ND 60 Gy</td>
<td>14</td>
</tr>
<tr>
<td>1988 (19)</td>
<td></td>
<td>36-50 Gy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deneve et al.</td>
<td>TUR</td>
<td>2*6Gy</td>
<td>Cs137ND 53 Gy</td>
<td>32</td>
</tr>
<tr>
<td>1992 (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gerard et al.</td>
<td>PCEC</td>
<td>3*3.5</td>
<td>Ir192 PT 40-50 Gy</td>
<td>60</td>
</tr>
<tr>
<td>1985 (8)</td>
<td></td>
<td>30 Gy</td>
<td>20-25 Gy</td>
<td></td>
</tr>
<tr>
<td>Mazeron et al.</td>
<td>PCEC</td>
<td>2*6.5</td>
<td>Ir192 PT 45 Gy</td>
<td>55</td>
</tr>
<tr>
<td>1988 (11)</td>
<td>or</td>
<td>2*6.5</td>
<td>60 Gy</td>
<td></td>
</tr>
<tr>
<td>Rozan et al.</td>
<td>PCEC</td>
<td>25.4</td>
<td>Ir192 PT 50-10 Gy</td>
<td>205</td>
</tr>
<tr>
<td>1992 (18)</td>
<td>or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grossman et</td>
<td>TUR</td>
<td>45 Gy</td>
<td>Ir192 PT 45 Gy</td>
<td>7</td>
</tr>
<tr>
<td>al. 1993 (9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pemot et al.</td>
<td>PCEC</td>
<td>3*3.5</td>
<td>Ir192 PT 50 Gy</td>
<td>85</td>
</tr>
<tr>
<td>1996 (15)</td>
<td>or</td>
<td>30 Gy</td>
<td>30Gy</td>
<td></td>
</tr>
<tr>
<td>Leuven series</td>
<td>PCEC</td>
<td>3*3.5</td>
<td>Ir192 PT 60 Gy</td>
<td>85</td>
</tr>
<tr>
<td>2002 (10)</td>
<td>or</td>
<td>40 Gy</td>
<td>25 Gy</td>
<td></td>
</tr>
</tbody>
</table>

1. Restaged from original paper according to UICC 1997 classification
2. Bad prognosis T2 (now T2a)
3. In recurrent T1GIII
4. T1 GIII
Table 19.2: Local recurrence rates of invasive bladder cancer in function of the number of previous TUR.

<table>
<thead>
<tr>
<th>Author</th>
<th>No TUR before</th>
<th>1 previousTUR</th>
<th>Multiple TUR</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>vdWerf et al. 1983</td>
<td>Solitary T2a</td>
<td>14%</td>
<td>38/269</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>Solitary T2b-T3</td>
<td>24%</td>
<td>12/51</td>
<td>NS</td>
</tr>
<tr>
<td>Rozan et al. 1992</td>
<td>solitary T1,T2,T3</td>
<td>27%</td>
<td>12/115</td>
<td>0.01</td>
</tr>
<tr>
<td>Pernot et al. 1996</td>
<td>solitary T1,T2,T3</td>
<td>45%</td>
<td>14/63</td>
<td>0.005</td>
</tr>
</tbody>
</table>

A major point affecting the results of interstitial brachytherapy is the selection of patients. Patients who are primarily treated with surgery and brachytherapy do far more better than those that are treated after multiple TUR both local control (Table 19.2) and survival (21,22,15).

The role of partial cystectomy (PCEC) in combination with brachytherapy is not clear. Results from retrospective studies did not show a clear advantage for local control or survival. In the French multicentre study (18), local recurrences were seen in 17.8% (21/118) of cases treated with PCEC and brachytherapy, and in 16.5% (14/85) treated with TUR and brachytherapy. Certainly in T1 lesions partial cystectomy seemed of no additional value since local recurrences developed in 22.2% after PCEC and 9.4% after TUR and brachytherapy. On the other hand, partial cystectomy may add to local control in muscle invading T2 cases, since recurrences were seen in 14.8% after PCEC versus 25.8% after TUR and brachytherapy although differences were not statistically significant (p = 0.2). In the Leuven series, local recurrences were noted in 4/18 (22%) after TUR and RT-BT and in 5 of 25 (20%) after PCEC and RT-BT (10).

Finally local control has been related to the dose administered (15), but not to dose rate (15). Geometrical parameters such as surface area treated was of no influence in outcome in the Nancy series (15) but Batterman and Boon (2) noted more recurrences in small tumours treated with small RT volumes(<7cm² mucosa surface), and in tumours larger than 3 cm in diameter.

11.2 Complications And Side Effects

The acute post-treatment mortality is the same for implanted patients (0 - 2%) (2,5,15,18,20) as for patients treated with bladder conserving surgery (0 - 2%) (17,7).

Acute postoperative complications such as thromboses, infections, delayed wound healing and fistulae, occur in 19.5 - 30% of cases (8,18,20,22). In the vast majority they are minor side effects (GI) and are slightly more frequent than those (12 - 26,7%) reported (3,7,14) after bladder conserving surgery alone, without implantation. There is some evidence that acute complications such as delayed wound healing and fistula formation are somewhat commoner after Ra²²⁶ or Cs¹³⁷ needle implants than after plastic tube afterloading implants with Ir¹⁹². This is also reflected in the mean hospitalisation time: 38 days in the Batterman series versus 26 days in the French multicentre study.
The incidence of wound dehiscence and subsequent fistula formation has also been related to early loading. Delay in loading from one day to one week in the Nancy experience in 85 patients decreased delayed wound healing from 18 to 2, and the rate of fistula formation from 2 to 0 in the period before and after 1983 (15). However it is not clear if this observation was related to the early versus delayed loading or to a change in technique that took place in the same period; before 1983, implanted tubes exited together through the cystectomy scar and later separately, through the bladder wall and the skin.

The performance of a partial cystectomy maintains the incidence of wound dehiscence and fistulae. In the French multicentre study (18) however, fewer complications (p< 0.01) were noted after PCEC and BT (8.4%), versus TUR and BT (22%), which might be related to the smaller volume implanted (only 2 source lines) or to more careful double layer closing of the scar.

Late post treatment complications are reported in 25 to 39% of patients (5,8,10,15,18,21). They are usually no worse than grade 1 or 2 and consist mainly of asymptomatic ulceration in the first year, haematuria, stone formation (7 - 17%) and chronic cystitis. Symptomatic ulceration or fistula formation needing treatment or ureter stenosis with hydronephrosis is rare (1 - 6%). Chronic radiocystitis resulting in contracted a non-functional bladder is very rare and only reported in 6/896 (0.6%) in the joint series of van der Werf et al. (21), Batterman et al. (2), Gerard (8), Rozan et al. (18), Deneve et al. (5) and Pernot et al. (15).

The incidence of complications increases with dose (18) and dose rate (15,18) as well as treated volume. In the Nancy series significantly more GIII and GIV complications were noted when the treated area was larger than 14 cm² (15). Source spacing (more than 20 mm) (15) has also been reported as a factor.

Overall, 88 to 96% of survivors keep a functional bladder (10,11,18) which makes this treatment a valid treatment option in well selected solitary bladder cancer stage T1GIII, T2, (T3).

12 References


