Laparoscopic insertion of pelvic tissue expander to prevent radiation enteritis prior to radiotherapy for prostate cancer

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Abstract
Radiation enteritis is a significant complication of external beam radiotherapy (EBRT) to the pelvis, particularly in patients having high dose radiotherapy (>80 Gy) and in those with a low pelvic peritoneal reflection allowing loops of small bowel to enter the radiation field. Laparoscopic insertion and subsequent removal of a pelvic tissue expander before and after external beam radiotherapy is a relatively convenient, safe and effective method for displacing loops of bowel out of the pelvis. We report on a patient with prostate cancer who ordinarily would not have been a candidate for EBRT due to loops of bowel low in the pelvis. With laparoscopic insertion and subsequent removal of a tissue expander, he was able to have radiotherapy to the prostate without developing radiation enteritis.

Introduction
Prostate cancer is the second most common cancer in men. With the increasing use of primary radiotherapy for prostate cancer and improved survival, chronic radiation enteritis is an increasing problem occurring in over 20% of patients [1]. The very high doses of 80 Gy radiotherapy required for prostate cancer, which is double that given for most other pelvic malignancies, puts those patients with a low peritoneal reflection and low-lying loops of small bowel in the pelvis, at particular risk of radiation enteritis.

Laparoscopic insertion and subsequent removal of a tissue expander before and after radiotherapy is a relatively convenient and minimally invasive procedure that may be an option for displacing loops of bowel from the radiation field.

Case Presentation
The patient was a 75 year old man with prostate cancer, confirmed by FNA to investigate a raised PSA. He had stage 2 disease with a Gleason score of 3+4, and required primary radiotherapy. He was relatively fit and healthy, with a BMI of 29. He had a previous upper midline laparotomy for gastric lymphoma, and open appendicectomy for perforated appendicitis, and a laparoscopic cholecystectomy. Radiation planning CT demonstrated a low pelvic peritoneal reflection with loops of bowel in the pelvis within the planned radiation field of the prostate (Figure 1).

These loops of bowel would not move out of the planned radiation field despite several manoeuvres including extreme prone and Trendelenburg positioning, bladder filling, and use of an open table-top device (belly board). Laparoscopic insertion of a tissue expander into the pelvis to displace loops of bowel was his only option. No bowel prep was required. A 12 mm infra-umbilical incision was made and an open Hasson technique used to achieve pneumoperitoneum, with the placement of a 12 mm port at the umbilicus and 5 mm ports in both iliac fossa (Figure 2). Adherent loops of bowel from previous surgery were divided by scissored dissection.

In lithotomy and steep Trendelenburg positioning, the suprapubic incision was dilated up to 20 mm with the aid of a medium Alexis® wound retractor (Figure 3). A TRD 500 ml Nagor® tissue expander made of silicone with attached silicone tubing (Figure 4) was then rolled tight, lubricated with water soluble hydroxyethylcellulose and glycerine based (K-Y Jelly®) lubricant and inserted via the 20 mm suprapubic port and placed...
laparoscopically in the pelvis, leaving the normal-saline inflation port attached externally.

A running dissolvable 3/0 polydioxanone (PDA) purse-string stitch was then sutured to the peritoneum of the sacral promontory, and anterior and side walls of the pelvis below the level of the common iliacs, and tied snug to keep the expander in the pelvis. With a Huber™ needle inserted into the inflation port, the tissue expander was then filled with 350 ml of normal saline until the expander began to bulge against the retaining stitch (Figure 5).

The abdomen was then deflated of gas and the fascia of both the Pfannenstiel and umbilical port closed. The port of the expander was then placed in a small subcutaneous pocket and sutured to the fascia of the anterior
abdomen. Skin incisions were closed in the usual manner. Subsequent CT confirmed adequate placement of the expander device in the pelvis with loops of bowel now well out of the pelvis and the planned radiation field (Figure 6).

His recovery was uneventful being discharged home without complication after opening his bowels. Two weeks later he went on to have external beam radiotherapy to his prostate (80 Gy in 39 fractions over 8 weeks), achieving a good response without any side effects or symptoms. Repeat CT prior to removal of the expander showed a well placed expander within the pelvis, with no evidence of radiation injury to small bowel or the prosthesis.

The tissue expander was removed laparoscopically 6 weeks after completing radiotherapy using the same initial incisions, with a good cosmetic result. There were no adhesions to the silicone implant, and the PDA retaining string was intact, but easily broke with a gentle tug. These two factors facilitated its easy laparoscopic removal.

Discussion

Radiation enteritis causes considerable disability, and in many cases can be avoided. Any patient having external beam pelvic radiotherapy should have a planning CT, with particular attention given to those patients with a low peritoneal reflection, and loops of bowel within the planned radiation field. Methods of reducing injury to small bowel include multi-field conformal therapy with prior three dimensional planning where the profile of the radiation beam is shaped to fit the target. The delivery of intensity-modulated radiotherapy can also be adjusted and improves the ability of treatment volumes to conform to the shape of the tumour. Despite these techniques, loops of bowel still occasionally get injured from being in the radiation field. If available, brachytherapy or cryotherapy may be reasonable alternatives to external beam radiotherapy. Where external beam radiotherapy is the preferred or only option, various methods for removing small bowel from the radiation field exist.

Conventional non-operative manoeuvres to remove small bowel from the pelvis at the time of giving radiotherapy include extreme prone or Trendelenburg positioning, bladder distension, abdominal wall compression or the use of an open table-top device (belly board). The response of such manoeuvres is not always reproducible. More extreme measures described only in case reports include the surgical insertion of a peritoneal dialysis catheter and creation of a temporary artificial pneumoperitoneum[2] or ascites with the installation of gas or normal saline into the abdominal cavity[3]. These are time consuming, painful, and need to be repeated, and do not reliable remove bowel from the radiation field.

Early surgical procedures to keep small bowel out of the pelvis were aimed at abdomino-pelvic partitioning, either with the use of native tissue or prosthetic material. Native tissue partitioning frequently involves the use of the peritoneum, bladder, uterine broad ligaments and omentum. In 1979, Freund described suturing the
anterolateral peritoneum to the bladder and to the ante-
rior rectum[4]. In women, the uterus and broad liga-
ments may be used in addition to the posterior tissue.
In 1985, DeLuca and Ragins described the omental
envelope technique (also called an abomino-pelvic
omentopexy)[5], where omentum is draped over the
small bowel as an apron, and the lower edge sutured
to the sacral promontory. The lateral borders are sutured
to the ascending and descending colon. In 1995, Choi
and Lee described the omental pedicle hammock techni-
que[6] where a pedicle of omentum based on the left
gastroepiploics is sutured circumferentially to the perito-
eum where a pedicle of omentum based on the left
gastroepiploics is sutured circumferentially to the perito-
eum at the level of the sacral promontory and umbili-
cus. This creates a sling, or hammock, which keeps
small bowel out of the pelvis. Partitioning with prosthe-
tic material has also been described, and includes the
use of absorbable mesh slings.

There are many difficulties with partitioning tech-
niques. Firstly, native tissue is frequently not sufficiently
adequate or strong enough to achieve partitioning, and
prosthetic materials run the risk of infection or adher-
ence to loops of bowel or the creation of a fistula. Parti-
tioning of the pelvis from the abdomen may also create
an empty pelvic space. Loops of bowel may get caught
beneath the partition resulting in an internal hernia and
obstruction. The cavity beneath the partition may also
fill with fluid, and this has the potential to become
infected resulting in a chronic pelvis abscess.

Pelvic-space occupying techniques avoid some of the
problems inherent to partitioning techniques. In 1984,
Russ described using an omental pedicle flap based on the
left gastroepiploic vessels, which is placed along the
left para-colic gutter with the distal tip packed into the
pelvis[7]. This is particularly suitable during open color-
ectal surgery where mobilisation of the omentum off the
colon is required. But this procedure is difficult to per-
form laparoscopically, and in the thin patient, the omen-
tum is usually frequently not sufficient to fill or reach
the pelvis.

Normal saline filled silicone tissue expanders are easy
to insert and remove and have the benefit of being non-
adherent to both peritoneum and small bowel, as well
as radioresistant to degradation, and when filled with
normal saline, are similar in density to human tissues,
therefore do not alter the isodose distribution of radio-
therapy. In 1983, Sugarbaker first described the open
insertion of a normal-saline-filled silicone breast implant
into the pelvis to exclude small bowel from the pelvis to
prevent injury from post-operative radiotherapy[8].
Sugarbaker described covering the implant with a mesh
which was sutured to the peritoneum of the pelvic brim
to prevent migration or extrusion of the expander. How-
ever, over the years, mesh was found to be associated
with an increased risk of small bowel adhesions and
fistula formation. Therefore, there has been a trend
away from the use of mesh, with fixation of the expander
to the peritoneum with a suture the commonest and
safest method. Some expanders have suture tabs for this
purpose. Since Sugarbaker’s first description, there have
been over 160 reported cases of tissue expanders used
in the pelvis or the abdomen to prevent radiation injury
to small bowel (Table 1). All of these were inserted at
open laparotomy. Lasser first described its use prior to
radiotherapy for rectal cancer [9]. Many reported cases
involved the use of large tissue expanders for patients
requiring post-operative adjuvant radiotherapy for large
retroperitoneal sarcomas or gynaecological malignancies.
For all of these types of malignancies the radiation dose
received was usually less than 50 Gy (Table 1).

Early experience with tissue expanders found that
complications were more common when large expan-
ders where left in the pelvis long term, with the poten-
tial for bladder, ureteric and iliac vessel compression.
Heaviness is a common complaint of very large expand-
ers[10]. Deep vein thrombosis with pulmonary embo-
lus and constipation due to obstructive defecation have
been reported[11,12]. More recent reports using smaller
implants show them to be associated with fewer compi-
lations[13-17]. Infection, with abscess formation and fis-
tulisation, have been reported to occur in up to 7% of
cases[18]. Wound infections associated with large lapar-
otomy incisions are not uncommon, particularly when
the incision extends into the radiation field[19]. The
other disadvantage of tissue expanders, is that they do
very little to prevent radiation injury to the bladder or
test with radiation cystitis[20] and proctitis still
common complications.

Ours is the first report in the literature of a totally
laparoscopic insertion and removal of a tissue expander
prior to and following primary prostate radiotherapy. In
this case, a much higher dose of 80 Gy radiotherapy was
given. Previous major surgery was not a contraindication
to this procedure. In our case, a conventional 500 ml
normal-saline-filled silicone tissue expander without
suture tabs, was used, and it was kept in the pelvis by
means of a polydioxanone (PDA) purse string suture.
This monofilament has a tensile-strength half life of 5
weeks, with significant degradation of the suture at 10-
12 weeks. Therefore removal of the expander was per-
formed easily by gentle traction alone. However there is
a risk with dissolvable sutures of tissue expander migra-
tion, therefore a non-dissolvable suture may also be
appropriate. The choice of a conventional sized expan-
der and the avoidance of overfilling were because of lit-
erature reports of the risks of ureteric and iliac vessel
compression.

The ease, simplicity, reversibility, and minimally inva-
sive nature of laparoscopic tissue expander insertion are
| Author      | Year | Origin         | Number | Indication                | Radiotherapy | Site                | Insertion & removal | Expander size | fixation       | Radiation dose | complications due to prosthesis |
|-------------|------|----------------|--------|---------------------------|--------------|---------------------|---------------------|---------------|----------------|----------------|----------------------------------|
| Sugarbaker  | 1983 | Washington DC, USA | 1      | unspecified adjuvant       | pelvis       | open                | up to 1000 ml       | prosthetic mesh | pelvic brim    | 65 Gy           | no                                |
| Lasser et al | 1986 | Paris, France  | 9      | rectal cancer adjuvant    | pelvis       | open                | ?                   | ?             |                | 30 Gy           | no                                |
| Armstrong et al | 1990 | New York, USA | 2      | fibrosarcoma adjuvant     | renal bed    | open                | 400-500 ml          | none           |                | 30 Gy           | no                                |
| Cuttat et al | 1991 | Lausanne, Switzerland | 4      | rectal cancer adjuvant    | pelvis       | open                | 500 ml              | ?             |                | 30 Gy           | no                                |
| Delaloye et al | 1994 | Vadois, Switzerland | 18     | cervical cancer adjuvant  | pelvis       | open                | 350-400 ml          | absorbable suture | 56-60.8 Gy | hydrenephrosis (n = 1) constipation 9 (n = 1) |
| Hoffman et al | 1998 | Philadelphia, USA | 58     | sarcomas & endometrial, vaginal, rectal, colon & anal cancer adjuvant (n = 57) primary (n = 1) | pelvis & lower abdomen | open                | 550-1,500 ml       | absorbable suture | 40-50 Gy | abscess (n = 4), fistula (n = 4), extrusion (n = 1) |
| Sezeur et al | 1999 | Paris, France  | 22     | retroperitoneal sarcoma and pelvic cancer adjuvant | pelvis & abdomen | open                | ?                   | ?             | 30-65 Gy       | heaviness (n = 1), flank pain (n = 1) |
| Burnett et al | 2000 | Los Angeles, USA | 7      | cervical cancer adjuvant  | pelvis       | open                | 750-1,500 ml       | absorbable suture | 50.4 Gy | adhesions of bowel to implant (n = 1), pulmonary embolism (n = 1) |
| Abhyankar et al | 2005 | Wales, UK  | 1      | rhabdomyosarcoma adjuvant | right upper abdomen | open                | 250 ml              | mesh           | 45 Gy          | no                                |
| Hølmebak et al | 2006 | Oslo, Norway | 1      | Retroperitoneal recurrence of colorectal cancer adjuvant | pelvic       | open                | 500 ml              | sutured & omental sling     | 50 Gy          | no                                |
| White et al | 2007 | Calgary, Canada | 33     | sarcomas & endometrial, vaginal, rectal & colon cancer neo-adjuvant (n = 25) adjuvant (n = 1) primary (n = 11) | pelvis & abdomen | open                | 700 ml              | Dexon® mesh   | 45-50 Gy       | Cystitis (n = 1), ileus (n = 1) |
| Hong et al  | 2008 | Sydney, Australia | 2      | retroperitoneal sarcoma & abdominal wall sarcoma adjuvant | lower abdomen | open                | 1000 ml             | ?             | 50 Gy          | no                                |
| Angster et al | 2010 | Baltimore, USA  | 2      | cervical cancer & retroperitoneal sarcoma adjuvant | pelvis & abdomen | open                | 400 ml & 500 ml     | none          | ?             | no                                |
| McKay et al | 2011 | Sydney, Australia | 1      | prostate cancer adjuvant  | pelvis       | laparoscopic        | 500 ml              | absorbable suture | 80 Gy       | No                                |
its main appeal. It should be considered as an option for excluding small bowel from the pelvis prior to radiotherapy of the prostate.

Consent
Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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Authors' contributions
GM wrote the manuscript, KW did literature review and organised planning CT and radiotherapy, DK inserted and removed the tissue expander and supervised writing of manuscript. All authors read and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

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