Impact of Neoadjuvant Chemoradiotherapy on Surgical Outcome of Rectal Cancer

Authors
Dr S. Karthikeyan, Dr R. Prabhakaran
MMC, Madurai

Background
Multimodality treatment is the most important component of potential for curative resection of Rectal cancer. Local recurrence and metastatic disease in locally advanced Rectal cancer are due to positive circumferential resection margin and lymph node involvement. Overall survival and local recurrence control are improved by Postoperative chemo Radiotherapy, Preoperative Chemo Radiotherapy has increased local control rates, tumor down staging, sphincter saving procedures and enhancing resectability a fact shown by several studies. This study on Neoadjuvant Chemoradiotherapy for carcinoma Rectum evaluates presentation, potential benefits and outcome following multimodality treatment for locally advanced operable Rectal cancer.

Aim
Trials comparing different treatment modalities for carcinoma Rectum have arrived at different conclusions. The aim of the study is to analyze the surgical outcome following neondjuvant Chemo Radiotherapy in patients with locally advanced operable rectal cancer (T3, T4 and Node positive tumor).

1. Beneficial to the patient or not.
2. Analyzing the primary end points- are downsizing of tumor, down staging of the tumor, sphincter preserving rates. Radiotherapy regimen and compliance for the regimen
3. Analyzing Secondary endpoints- which are analyzed in other rials are the incidence of local recurrence, distant metastases. The incidence of peroperative complications and postoperative complications also analyzed.

Material and Methods
This study was conducted in the Department of Surgical Gastroenterology, Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai from March 2012 to February 2014. All patients with lower and mid rectal locally advanced T3, T4 node positive tumors without distant metastasis, histologically confirmed adenocarcinoma within 12 cm from anal verge with upper Anal canal involvement and Radiological evidence of mesorectal invasion were included in this study. Patients who had received radiotherapy or chemotherapy, Contraindications of chemoradiotherapy, Tumor involving pelvic side walls, upper sacral vertebra, involving upper rectum, Distant metastasis, Patients with poor performance status were excluded. Medical ethics committee of the hospital approved the study.
Preoperative Evaluation

After obtaining informed written consent from patients, Colonoscopy was done to confirm diagnosis and to rule out synchronous lesions. Loco regional staging done with contrast enhanced CT of abdomen and pelvis, Endorectal ultrasound and cystoscopy in cases suspected of bladder invasion. A lymph node metastasis of four or greater than four as detected by imaging was staged as N2 disease. Distant metastasis was excluded by contrast enhanced CT of abdomen and Pelvis, chest X-Ray and if necessary a CT chest. basic work up including complete hemogram, Renal function tests, Liver function tests, Tumor markers –CEA, Pulmonary function tests and Cardiac tests –ECG & Echocardigram was done to rule out any major illness and to confirm the patients fitness for surgery.

Treatment

Preoperative external beam radiotherapy was given for a total does of 50.4 in 28 fractions of 180 cGy each, five times per week for total duration of five and a half weeks. It was given as anterior and posterior opposed portals using Telcobalt machine of 1.33 meV. The radiotherapy was given to include the tumor area and its drainage lymph nodes (pelvic-internal, external iliac, obturator). The upper margin of radiotherapy field was L5-S1. The lower margin was obturator foramen, 1.5 cm below lower border of public symphysis. The lateral margin was 1 cm lateal to true pelvis at leval of mid inguinal point. If the tumor extended to anal canal, inguinal nodes were included in the field. Laterally the radiotherapy field was extended to anterior superior iliac spine. The chemotherapeutic agent used was 5 Fluoracil, used as a bolus of 350mg/m2/d for 5 days, during the first and fifth weeks of radiotherapy along with 20mg/m2 of leucovorin. Postoperatively 5 Fluorouracil was given for four cycles (350mg/m/d, once in four weeks five times weekly) started postoperatively for weeks after surgery. Patients were assessed five weeks after surgery regarding the response to treatment CT abdomen and pelvis

Decision for abdominoperineal excision of rectum, an anterior resection or pelvic exenteration was made preoperatively and modified according to the preoperative findings. According to the standardized technique Total mesorectal excision was done. All patients who underwent anterior resection had a protective ileostomy. Patients with unresectable growth due to locally advanced disease had colostomy only. During therapy, for sings of acute toxic effects requiring change in dosage or regimen patients were monitored weekly. According to the Radiation Therapy Oncology Group criteria – Acute and long term toxic effects were graded with respect to acute and late adverse effect of radiotherapy. Patients were observed for Peroperative and postoperative complications which included bleeding, ileus, intestinal fistulas, intra – abdominal abscess, perineal wound complications, urinary retention and death.

Follow up

Patients were followed at three monthly intervals for two years. Evaluations consisted of History and physical examination, a Complete blood count and Liver function tests and Renal function tests, Tumor marker –CEA, Proctoscopy, Abdominal ultrasonography, CT of Abdomen and Chest radiography (annual) Local recurrence was to be confirmed hisotpathologically or by sequential radiological studies to detect mass lesion. Distal recurrence was confirmed histopathologically. All resected specimens were examine for histological grade, degree of fibrosis, resected margin status and nodal status. The primary end poins analyzed were downsizing of tumor, down staging of the tumor, sphincter saving rates, toxicity of chemoradiotherapy, and patients compliance for the regimen. Secondary end points analyzed were the incidence of local recurrence, distal metastasis. Downsizing was defined a reduction in the size of tumor after chemoradiotherapy as determined by physical
examination. Down staging was defined as decreases in TNM stage, as assessed after chemoraditheray in the surgically resected specimen.

**Results**

From March 2012 to February 2014, fifteen patients were enrolled with mean age of 58.4 years (37 – 73) and includes 11 males and 4 females. All patients underwent surgery after neoadjuvant chemoradiotherapy. Part of the tumors extended into anal canal from lower third of rectum into upper anal canal (20%) Nine patients had tumors involving lower rectum and Three had tumor involving middle third of Rectum.14 patients were well or moderately differentiated and one poorly differentiated. Among 15 patients 60% were stage 3B (T3/T4N1M0), 20% of cases stage 2A (T3N0M0), 13%stage 3C (N2M0) and 7% stage 2B (T3N0M0).

Fourteen patients underwent surgery at six weeks after chemoradiotherapy; one patients had surgery after seven weeks in post chemoradiotherapy period. Five patients underwent anterior resection (33%), none of the female patients had uterine or bladder involvement which was noticed in preoperative imaging as well as intra operative assessment. Ten patients (67%) underwent abdominoperineal resection. Patient with growth extension up to pelvic side wall which were inoperable were not included in the study and the patients were offered palliative sigmoid colostomy and they were not included in the study.

**Complications**

- Peraperative complications
  - Bleeding 1
  - Post operative complications
  - Abdominal wound infection 4
  - Perineal wound infection 3
  - Intra abdominal abscess 0
  - Urinary retention 2
  - Chemoradietherapy toxicity 3 (20%)
  - Mild –Skin irritation & Discoloration 2 (13.32%)
  - Vomitting 2(13.32%)
  - Diarrhoea 1 (6.66%)
  - Severe – Anaemia 1 (6.66%)

One patient developed intraoperative bleeding due to injury to sacral plexus. It was controlled by packing. Minor complications occurred in four patients, developed abdominal wound infection which was treated conservatively by Antibiotics after confirming the sensitivity by culture.

**Results of Surgery**

Down sizing of tumor seen in fourteen of fifteen patients who had responded well to neoadjuvant chemoradiotherapy. In twelve of fifteen (12/15) patients down staging occurred. The follow up period ranged from six months to twelve months, with median follow up period being nine months. No patients developed local recurrence. Distant metastases in the form of Liver Metastasis not noted in any of the patients who had disease. Of the twelve patients who had been treated for locally advanced carcinoma Rectum for whom APER was planned, a sphincter conservation surgery was possible in two of them after neoadjuvant chemoradiotherapy and those patients underwent anterior resection. Before neoadjuvant chemoradiotherapy only three anterior resections were planned. After it, five anterior resections were done with covering ileostomy done to protect the anastomosis as well as to reduce leak related complications. Neoadjuvant chemoradiotherapy increased sphincter conservation in 2/15 patients in our study. Fifteen of the fifteen patients had completed the full course of chemoradiotherapy followed by surgery (100%) with minimal toxicities to chemoradiotherapy treatment.

**Postoperative TNM staging**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>(T1, T2, NO, MO) Stage 1</td>
<td>3 (20%)</td>
</tr>
<tr>
<td>(T3, NO, MO) Stage 2 A</td>
<td>6 (20%)</td>
</tr>
<tr>
<td>(T4, NO, MO) Stage 2 B</td>
<td>0</td>
</tr>
<tr>
<td>(T1, T2, N1, MO) Stage 3 A</td>
<td>2(13.2%)</td>
</tr>
<tr>
<td>(T3, T4, N1, MO) Stage 3B</td>
<td>4(26.64%)</td>
</tr>
<tr>
<td>(any T, N2, MO) Stage 3C</td>
<td>0</td>
</tr>
<tr>
<td>(any T, any N, M1) Stage 4</td>
<td>0</td>
</tr>
</tbody>
</table>
Discussion

The rationale for giving preoperative chemoradiotherapy is to improve the survival and the advantage of delivering both the agents preoperatively. These advantages include improved compliance given before a major surgery in well vascularized setting to assist in down staging to enhance the rate of curative surgery, prevents tumor tract seeding at surgery by sterilizing the tumor field and permit sphincter preservation in low lying rectal tumors. Irradiation is more effective if given preoperatively due to better tumor oxygenation. The sphincter conservation rate also doubled after preoperative chemo radiotherapy. Postponing the surgery to six weeks help in shrinkage of tumor and recovery of tissues after treatment before fibrosis sets in. Higher pathological complete response produced by addition of 5 FU to preperative radiotherapy over radio therapy alone.13

No improvement in disease – free survival (DFS) or overall survival but Better loco regional control. About 30% patients develop distant metastases. Due to Better pCR and loco regional control rates, 5-FU-based preoperative chemo radiotherapy followed by total mesorectal excision has become the standard of care in patients with locally advanced rectal cancer.

High levels of normal tissue damage, including small bowel injury, nerve dysfunction rectal bleeding, impaired sphincter function, vaginal stenosis, and sacral fractures with Radical pelvic RT at doses of 55-60 Gy.40-50 Gy in 1.8 to 2.0 Gy fractions lower radiotherapy doses have become established as a standard, because it is associated with a good tumor response and with more acceptable levels of late morbidity.

Downsizing tumor

In this study downsizing occurred. This is almost in accordance with other studies which have shown similar significant regression of the tumor after chemoradiotherapy.

Downsizing is indicator of good response to preoperative chemo radio therapy. This is concurrence with the results of Polish trial the tumor was 1.9 cm smaller in patients after chemo radiotherapy.

<table>
<thead>
<tr>
<th>Study</th>
<th>Down Staging</th>
<th>Percentage of patients down staged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rich et al 20 1995</td>
<td>Present</td>
<td>64% p&lt;0.001</td>
</tr>
<tr>
<td>German Rectal Cancer Trial 12 2004</td>
<td>Present</td>
<td>62 % p&lt;0.001.</td>
</tr>
<tr>
<td>EORTC trial 22921 17 2005</td>
<td>Present</td>
<td>52% p&lt;0.01%</td>
</tr>
<tr>
<td>This study</td>
<td>Present</td>
<td></td>
</tr>
</tbody>
</table>

After preoperative chemoradiotherapy, postoperative histopathology shows downgrading of the tumor. In this study of showed down staging (p<0.0001). A good pathological response is good prognostic indicator, with patients having a good response having fewer incidences of improved overall survival and local recurrence. Chung Wah Lam et al4 in 2005 has shown that 69 % of his patients had decreased tumor stages after chemo radio therapy.

Preoperative TNM Staging Vs Post –Operative TNM Staging This Study

<table>
<thead>
<tr>
<th>Stage</th>
<th>Preoperative TNM</th>
<th>Postoperative TNM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 (T1, T2, NO, MO)</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Stage 2 A (T3, NO, MO)</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Stage 2 B (T4, NO, MO)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Stage 3 A (T1, T2, N1, MO)</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Stage 3B (T3, T4, N1, MO)</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Stage 3C (any T, N2, MO)</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Stage 4 (any T, any N, M1)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

In this study preoperatively around 60% of the tumors were in stage 3 B. Post –Operative, histopathology showed a significant shift towards lower stages stage.

Neoadjuvent chemo radiotherapy helps significant downsizing of tumor as it causes tumor shrinkage.

<table>
<thead>
<tr>
<th>Study</th>
<th>Downsizing</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polish Trial 13 2004</td>
<td>Present</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>German Rectal Cancer study group 12 2004</td>
<td>Present</td>
<td>p&lt;0.001.</td>
</tr>
<tr>
<td>EORTC trial 22921 17 2005</td>
<td>Present</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>This study</td>
<td>Present</td>
<td></td>
</tr>
</tbody>
</table>

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2A in 20% and 20% in stage 1. Due to the tumoricidal effect of chemoradiotherapy the lymph node positively was reduced. Effect of time interval on surgery and down staging.

Long time interval between radiotherapy and surgery led to sphincter preservation because of tumor down staging when the optimum time interval between radiotherapy and surgery was analyzed.

In 1999 Francois et al, conducted a randomized trial to compare short interval outcome with along interval of 6-8 weeks. A long interval between preoperative radiotherapy and surgery was associated with pathologic down staging (10.3% in the SI group v 26% in the LI group, P.005) and a significantly better clinical tumor relapse, and short-term survival noted between the two groups at median follow-up of 33 months.

Sphincter – preserving surgery was performed in 76% of cases in the cases in the LI group versus 68 in the SI group (p<0.27). He concluded that a long interval between preoperative irradiation and surgery provides increased tumor down staging. In questionable sphincter preservation, a long interval may increase the chance of a successful sphincter – saving surgery.

The ideal time interval is 6 weeks (56, 21, 28) for surgery after radiotherapy when there is an optimal tumor response and further delay does not enhance the effect of radiotherapy. When fibrosis sets in, dissection also becomes technically difficult with increased incidence of complications like intra – abdominal sepsis, increased bleeding. In this study, the interval ranged from 6 to seven weeks, median being six weeks.

Sphincter Saving Procedures after neoadjuvant chemoradiotherapy

<table>
<thead>
<tr>
<th>Study</th>
<th>Sphincter Saving</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rich et al 26 1995</td>
<td>Present</td>
<td>66.6%</td>
</tr>
<tr>
<td>NSABP Trial’ 1997</td>
<td>Present</td>
<td>50%</td>
</tr>
<tr>
<td>Polish Trial’ 2004</td>
<td>Present</td>
<td>58%</td>
</tr>
<tr>
<td>German Rectal Cancer Group Trial 12 2004</td>
<td>Present</td>
<td>39%</td>
</tr>
<tr>
<td>Chung Wah Lam et al 4 2005</td>
<td>Present</td>
<td>82%</td>
</tr>
<tr>
<td>This study</td>
<td>Present</td>
<td>13.12%</td>
</tr>
</tbody>
</table>

One of the advantages of prooperative chemoradiotherapy is that tumor downsizing helps sphincter saving procedures. The incidence of sphincter saving procedures range from 39% up to 82%. In this study, preoperatively only three patients were planned for an anterior resection. After neoadjuvant therapy, anterior resection was possible in five patients, sphincter conservation rate were increased. The lower number of sphincter saving procedures is due to the fact that most of the tumors (66.6%) had already extended into the anal canal, necessitating abdominoperineal excision of rectum.

Distal Resection Margin after Neoadjuvant Chemoradiotherapy

Nearly 50% of patients undergo Abdominoperineal excision of rectum despite the increasing use of sphincter preservation for rectal cancers. In may circumstances, for adequate distal margins, Abdominoperineal excision of rectus is performed.

More limited distal margins may be appropriate as per evidence. For low lying rectal tumors doing an abdominoperineal excision does not increase the radicality of the procedure or improve survival. Study by Party et al found that no increase in pelvic recurrence when the distal margin was <2 cm compared with >2cm. 1 cm distal margins are adequate as per recent evidence’22. in the past, distal margins as great as 5 cm were advocated.

Smaller distal margins, even 1 cm, may be adequate, supported by pathological evidence that distal intramural spread rarely exceeds 1 cm. A number of clinical pathological studies22 that examined distal intramural Spread suggest that. When significant distal spread does occur, long term survival is affected adversely, despite abdominoperineal excision of rectum. The presence of distal spread is associated with decreased survival due to recurrence (mainly in lung). The use of centimeter and sub centimeter margins is controversial.

Jose G Guillem et al25 one prospective pathological analysis of whole mount sections of whole mount sections of
rectal cancer following combined modality therapy in 109 patients has shown that intramural extension occurred only in 1.8% patients (<0.95cm). Hence he concluded 1 cm margins are sufficient after preoperative chemo radiotherapy and this increases the chances of sphincter preservation without increasing the chances of local recurrence. Preoperative chemo radiotherapy also reduces circumferential resection margin positively. Circumferential resection margin positively is as high as 25% if no preoperative chemo radiotherapy is used. In this study a distal margin of one cm did not result in margin positively in any of the postoperatively examined specimens.

**Local Recurrence**

<table>
<thead>
<tr>
<th>Study</th>
<th>Duration of follow up</th>
<th>Local Recurrence</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>EORTC Trial ^984</td>
<td>7 Years</td>
<td>Present</td>
<td>15%</td>
</tr>
<tr>
<td>Rich et al 26 1995</td>
<td>2 Years, 3 Months</td>
<td>Present</td>
<td>4%</td>
</tr>
<tr>
<td>Polish Trial 13 2004</td>
<td>4 Years</td>
<td>Present</td>
<td>14.2%</td>
</tr>
<tr>
<td>German Rectal Cancer Group Trial 12 2004</td>
<td>4 Years</td>
<td>Present</td>
<td>6%</td>
</tr>
<tr>
<td>EORTC Trial 22921 17 2005</td>
<td>5.4 Years</td>
<td>Present</td>
<td>8%</td>
</tr>
<tr>
<td>Jean Pierre Gerard et al 19 FFCD 9203, 2006</td>
<td>81 Months</td>
<td>Present</td>
<td>8.1%</td>
</tr>
<tr>
<td>This study</td>
<td></td>
<td>Present</td>
<td>13.12%</td>
</tr>
</tbody>
</table>

**Local recurrence**

**Tumors in the distal rectum**

Locally extensive tumors are far more likely to recur than mobile tumors, which type of procedure is performed does not matter. Local recurrence is significantly higher in patients who have circumferential involvement than those without involvement. Recurrence is also influenced by site of lesion in rectum, lower one third tumors have higher incidence than upper third tumors. Incomplete removal of tumor is a very important cause for local recurrence.

Local recurrence ranges from 5.8% as reported by Kapitijin et al 24 to 15% TME considered as a contributing factor in reducing pelvic recurrence to as low as 5% to 8% in high – risk patients.

Follow up of this study during a ranging from 6 months to 9 months and no evidence of local recurrence is noted. This correlates well with the response of chemo radiotherapy and an adequate TME as evidence by downsizing and down staging.

Quirke et al. demonstrated that radial spread into the mesorectum is a common occurrence. Sharp dissection along the parietal pelvic fascia ensures resection of (5mm) occult nodal metastases which may be left behind and causing local recurrence. Radial margins are a more important predictor of disease recurrence and survival than distal margins.

There is an increased risk of recurrence for patients who undergo have abdominoperineal excision of rectum and reflects the worse prognosis attributed to tumors of the low rectum. The location of the tumor may be a more important prognostic factor.

**Toxicity of Chemo radio therapy**

<table>
<thead>
<tr>
<th>Study</th>
<th>Mild Toxicity</th>
<th>Severe Toxicity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>German Rectal Cancer Group Trial 12 2004</td>
<td>62</td>
<td>27</td>
</tr>
<tr>
<td>EORTC Trial 22921 17 2005</td>
<td>38.4</td>
<td>13.9</td>
</tr>
<tr>
<td>This study</td>
<td>26.66</td>
<td>6.66</td>
</tr>
</tbody>
</table>

About 26.6 % of patients developed toxicity of chemo radiotherapy, Skin irritation and discoloration was the most common toxicity encountered. It was totally reversed after few weeks. This is comparable with other studies showing a range of 11% to 15%. the EORTC 22921 trial showed a very high toxicity of 38.4%.

In this study no patient had a change in the chemo radiotherapy schedule due to toxicity.

**Postoperative complications**

<table>
<thead>
<tr>
<th>Study</th>
<th>Complications (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>German Rectal Cancer Group Trial 12 2004</td>
<td>36</td>
</tr>
<tr>
<td>EORTC Trial 22921 17 2005</td>
<td>22.8</td>
</tr>
<tr>
<td>Jean Pierre Gerard et al 19 FFCD 9203, 2006</td>
<td>20.9</td>
</tr>
<tr>
<td>This study</td>
<td>26.7</td>
</tr>
</tbody>
</table>

There is always a fear that neoadjuvant chemo radiotherapy increases preoperative complica-
tions, delays would healing, and patients may need perineal flap cover to prevent post-operative would disruption. The postoperative complications in this study were 26.7% only. Often patients who underwent only on abdominoperineal excision of rectum only one developed perineal wound complication which was successfully treated conservatively. So preoperative chemoradiotherapy can be given safely with good patient compliance, minimal side effects and less postoperative complications.

**Effect on Survival**

With preoperative radiotherapy alone Randomized controlled studies have not shown any significant survival benefit. Jose G.Guilem et al\(^{(23)}\) analyzed the long term outcome following preoperative combined modality therapy and total mesorectal excision of locally advanced rectal cancer, estimated 10-years overall survival was 58% and 10 year recurrence – free survival (RFS) was 62%. With a median follows-up of 44 months. Lymph vascular invasion and /or perineural invasion (PNI), pathologic response of greater than 95%, and positive lymph nodes were significantly with disease free survival and overall survival. There is always a fear that neoadjuvant chemo radiotherapy increases preoperative complications, delays would healing, and patients may need perineal flap cover to prevent post-operative would disruption. The postoperative complications in this study were 26.7% only. Often patients who underwent only on abdominoperineal excision of rectum only one developed perineal wound complication which was successfully treated conservatively. So preoperative chemoradiotherapy can be given safely with good patient compliance, minimal side effects and less postoperative complications.

**Conclusion**

Neoadjuvant chemoradiotherapy given in stage 2 / middle and low rectal cancers causes significant downsizing, down staging of the tumor, increases the rate of sphincter conservation surgeries. The toxicity of chemoradiotherapy is minimal, patient compliance is good. The postoperative complications are not increased and it helps decrease the incidence of local recurrence. The effect on survival has to be determined on long term follow up only. Hence it is beneficial to administer it to patients with stage 2 /3 middle and low rectal cancers.

**References**


22. Boris Kuvshinoff, Irfan Maghfoor, Brent Miedema, David Ota


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of the Phase III Trial ACCORD 12/0405-prodige 2.

56. ARISTOTLE Trial – ARISTOTLE: a phase III trial comparing standard versus novel chemoradiation treatment (CRT) a pre-operative treatment for magnetic resonance imaging (MRI)-defined locally advanced rectal cancer.