Comparison of abdominoperineal resection and low anterior resection in lower and middle rectal cancer

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Abstract  Introduction: This study aimed to investigate local control and survival rates following abdominoperineal resection (APR) compared with low anterior resection (LAR) in lower and middle rectal cancer.
Methods: In this retrospective study, 153 patients with newly histologically proven rectal adenocarcinoma located at low and middle third that were treated between 2004 and 2010 at a tertiary hospital. The tumors were pathologically staged according to the 7th edition of the American Joint Committee on Cancer (AJCC) staging system. Surgery was applied for 138 (90%) of the patients, of which 96 (70%) underwent LAR and 42 were (30%) treated with APR. Total mesorectal excision was performed for all patients. In addition, 125 patients (82%) received concurrent (neoadjuvant, adjuvant or palliative) pelvic chemoradiation, and 134 patients (88%) received neoadjuvant, adjuvant or concurrent chemotherapy. Patients’ follow-up ranged from 4 to 156 (median 37) months.
Results: Of 153 patients, 89 were men and 64 were women with a median age of 57 years. One
Introduction

Colorectal cancer is the fifth most frequently diagnosed cancer and the leading cause of cancer death in developing countries [1]. In Iran, colorectal cancer is the fourth most commonly diagnosed cancer in males and the second in females [2]. In the west, approximately one-third of cases occur in the rectum and two-thirds in the colon [3]. However, in Iran, rectum accounts for 40% of all primary sites in colorectal cancer [2,4]. Surgery is the standard approach of curative treatment in rectal cancer. Small cancers with superficial invasiveness may be successfully treated with limited surgery, such as local excision. However, the majority of rectal cancers present at more advanced stages that need more extensive surgery, such as low anterior resection (LAR) or abdominoperineal resection (APR). A remarkable portion of rectal cancers present with locally advanced tumors adhering or invading to neighboring structures such as the prostate, bladder, sacral bone or pelvic sidewalls. Therefore, these tumors may be unresectable or potentially resectable at diagnosis and primary surgery is associated with significant risk of loco-regional recurrence [5]. Neoadjuvant chemoradiation improves tumor resectability, loco-regional control, and colostomy free survival rates in locally advanced rectal cancer. Currently, neoadjuvant chemoradiation followed by total mesorectal excision is considered as standard of care for patients with stage II or III rectal cancer. [6–8]. In addition, the use of neoadjuvant chemoradiation and adjuvant chemotherapy in these patients increase overall survival rate [8,9]. There is a surgical therapeutic challenge in tumors located in lower rectum. Sphincter saving with coloanal anastomosis in LAR has become an established option for low rectal cancer; however, most patients with rectal cancer involving anal canal are routinely treated with APR [5,10,11]. Radial margin involvement is directly correlated with advanced disease stage and larger tumor. Rectal cancers treated by APR tend to present at lower rectal part and to have more locally advanced stage [12]. Consequently these tumors show a higher rate of radial margin involvement, local recurrence and a poorer outcome compared to those treated with LAR [11,13,14]. Some studies suggested that extended APR such as cylindrical resection is associated with a lower rate of radial margin involvement and improved local control rate compared to conventional APR [15,16]. In addition, there are some concerns regarding the efficacy and safety of laparoscopic total mesorectal excision (TME) in patients with lower rectal cancer [17–19]. Therefore, there are many controversies regarding the oncologic outcome of LAR compared to APR in lower rectal cancers [11]. The present study aimed to investigate local control and survival rates following LAR compared with APR in lower and middle rectal cancer.

Methods and materials

Population study and patient evaluation

This retrospective study was carried out at radiation oncology department of a tertiary academic hospital. We analyzed the characteristics, prognostic factors and survival of all (n = 153) patients with newly histologically proven rectal adenocarcinoma who were treated and followed-up between January 2004 and January 2010 at our department. Patients with other epithelial pathologies such as squamous cell carcinoma, or non epithelial tumors; as well as recurrent disease were excluded. In addition, only rectal tumors located below 12 cm from the anal verge were included and those with upper rectal or rectosigmoid location were excluded. The tumors were pathologically staged according to the 7th edition of the American Joint Committee on Cancer (AJCC) staging system [20]. Clinical staging was performed using imaging studies in patients who received neoadjuvant chemoradiation. Preliminary evaluation included comprehensive history and physical examination, colonoscopy, abdominal and pelvic ultrasonography and computed tomography (CT) scans and/or pelvic MRI and/or transrectal ultrasonography. In our center, abdominal and pelvic ultrasound is routinely used as workup in colorectal disease, mainly as a complementary imaging to CT scan for showing and differentiating discrete liver lesions.

Surgical technique

Total mesorectal excision was performed using laparoscopic (12%) or open (88%) approach. Surgical technique depended on surgeons’ experience and hospital facilities. The decision for performing sphincter-preserving surgery was based on the proximity of the tumor to the anal sphincter, the status of pre-operative sphincter function, clinical response to neoadjuvant therapy, surgeon’s experience and patient’s preference. Tumors with adequate distal margin were treated with sphincter-preserving surgery through low anterior resection and stapled or handsewn coloanal anastomosis. After removing the rectum, colonic J-pouch and coloanal anastomosis procedures were performed. A temporary diverting loop ileostomy or colostomy was performed in all the patients for protecting the anastomosis. However, patients with preoperative poor sphincter function, inadequate distal margin, or involvement of external anal sphincter were managed by abdominoperineal resection and permanent colostomy.

Neoadjuvant and adjuvant therapies

Concurrent neoadjuvant chemoradiation consisted of conventional external beam radiotherapy using megavoltage linear
accelerator photons. A median dose of 50 (range 20–50.4) Gy was delivered via a daily fraction of 1.8–2 Gy, with five fractions per week. Concurrent chemotherapy consisted of oral capecitabine 825 mg/m² twice daily during the whole period of pelvic radiotherapy with weekend breaks or intravenous bolus 5-fluorouracil 425 mg/m²/day and leucovorin 20 mg/m²/day on days 1–5 of the first and last week of radiation. Neoadjuvant chemotherapy consisted of capecitabine 1000 mg/m² twice daily for 14 days of every 3 week cycle plus oxaliplatin 130 mg/m² intravenously on day 1 (CAPEOX regimen); or oxaliplatin 85 mg/m² day 1, plus two-hour infusional leucovorin 200 mg/m² days 1 and 2, followed by bolus 5-FU 400 mg/m² and then 5-FU 600 mg/m² over 22-h infusion days 1 and 2, every two weeks (FOLFLOX regimen). Patients who received neoadjuvant chemoradiation underwent standard curative surgery with at least 4–6 weeks interval. Adjuvant chemotherapy regimens consisted of capecitabine monotherapy, bolus 5-FU/leucovorin, FOLFOX, CAPEOX or irinotecan-based combinations. All patients but 19 received a median 6 (range 4–8) cycles of chemotherapy. Targeted therapy by bevacizumab and/or cetuximab was only used in metastatic cases.

Statistical analysis

Clinical and pathological variables were analyzed using the SPSS for Windows version 17 statistical software (SPSS, Chicago, IL). Categorical variables of patient demographics (such as sex and performance status, categorized age), tumor characteristics (such as location, differentiation, and stage) and treatment modalities (such as type of surgery, treatment modality, and type of chemotherapy) were compared by using chi-square tests and for continuous variables such as patients’ age and radiation dose Student t tests and Analysis of Variance (ANOVA) test were used. Local control rate was defined as the proportion of patients who were free of locoregional recurrent disease at 5 years. Disease-free survival rate was defined as the percentage of patients who were free of rectal cancer at 5 years; an overall survival rate was defined as the percentage of patients who were alive at 5 years. The survival durations were measured from the date of initial treatment till the events of locoregional failure (locoregional control), any type of treatment failure (disease free survival), death from any reason (overall survival) or the last follow-up. The significance of differences in survival was evaluated using the log-rank test. Kaplan–Meier was used to estimate survival experience of the different groups of the prognostic factors. Multiple-covariate analysis was performed using the stepwise regression hazards regression model. The hazard ratio (HR) for death, with the 95% confidence interval (CI) was calculated for the variable groups. The log-rank test was used to compare treatment results in each variable group. All P values were 2-tailed and P values less than 0.05 were considered statistically significant.

Results

Age and sex

Of 153 patients, 89 were men and 64 were women. The age at presentation was in the range of 23–84 years with a mean of 57.15 years. The peak frequency was observed between the sixth and seventh decade of life in both sex.

Stage of disease

One patient (0.7%) had stage 0, 15 (9.8%) had stage I, 63 (41.2%) had stage II, whereas 51 (33.3%) had stage III and 23 (15%) had stage IV disease. (Table 1).

Surgical type distribution

Surgery was applied for 138 (90%) of the patients, of which 96 (70%) underwent low-anterior resection (LAR) and 42 (30%) were treated with abdominoperineal resection (APR). (Table 2) In addition, 125 patients (82%) received concurrent pelvic chemoradiation and a mean total dose of 48.43 (range 20–50.4) Gy was delivered. The distributions of treatment schedules by disease stage; type of surgery by disease stage; and surgical type by time of radiotherapy are shown in the Tables 1 and 2 respectively. In addition, the distribution of patients’ and tumor characteristics by types of surgery are shown and analyzed in the Table 3. Accordingly, the distribution of tumor stage (P < 0.001), tumor distance from anal verge (P < 0.001), surgical margin status (P < 0.001), the dose of radiotherapy (P = 0.005), the dose of radiotherapy (P < 0.001), and chemotherapy regimen (P = 0.015), were statistically different among surgical treatment groups. Advanced disease stages were more frequent among APR (52.4%) and non surgical (93.3%) groups compared to LAR ones (39.6%). Lower rectal tumors were more frequent among APR (92.9%) compared to non surgical (46.7%) ones. The rate of free surgical margin was higher among LAR (71.1%) and APR (83.3%) compared to non surgical (67.7%) ones. Mean dose of radiotherapy used was higher among LAR (49.4 Gy) and APR (48.9 Gy) compared to non surgical (41.4 Gy) cases. In addition, the use of chemotherapy, particularly oxaliplatin-based chemotherapy was more frequent in non surgical patients (60%) compared to LAR (46.9%) and APR (30.9%) cases (Table 3). By excluding patients with non surgical treatment and stage IV disease, there was a significant difference in terms of disease stage (P = 0.001), tumor distance from anal verge (P = 0.001), and combined modality therapy used (P = 0.005) between LAR and APR.

Resection margins

Mean tumor distance from the anal verge was 3.07 (range 0–8) cm in APR cases and 8.13 (range 3–12) cm in LAR ones. Of 138 patients who underwent surgical resection, 110 patients (80%) had free margin, 6 (4%) had involved and 13 (9%) had close (1–9 mm) margin, whereas resection margin information was not mentioned in 24 (17%) of patients. Six margin involvements included 3 involved distal margins in LAR and 3 involved circumferential resected margins in APR. There was no significant difference in terms of surgical margin status between LAR and APR groups (chi-square test, P = 0.407).

Chemoradiation

In this study, 16 patients with stage 0–I were treated with surgery alone. Of 114 cases with stage II and III, 83 patients (73%) received adjuvant chemoradiation and 24 (21%) received neoadjuvant chemoradiation (Table 1). In addition, of 23 patients with stage IV, 78% received palliative or curative
neoadjuvant (n = 12) or adjuvant (n = 5) chemoradiation. Of 24 patients with stage II and III who received neoadjuvant chemoradiation, 21 (87.5%) underwent LAR (n = 13) or APR (n = 8). Of 3 remaining patients, 2 refused surgery (n = 2) and the last patient was inoperable (Table 2).

### Survival rates and prognostic factors

The 5-year disease free survival (DFS) and overall survival (OS) were 53.4% and 69.4%, respectively (Figures 1 and 2).

Potential prognostic variables were analyzed to establish their influence on the disease free and overall survival rates of patients with rectal cancer. On univariate analysis using log rank test of prognostic factors for DFS, age (log rank test, Table 1) distribution of disease stage and treatment schedules in 153 patients with rectal cancer.

<table>
<thead>
<tr>
<th>Treatment schedules</th>
<th>Total</th>
<th>Stage of disease</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0–I</td>
</tr>
<tr>
<td>Surgery alone (%)</td>
<td>19</td>
<td>16 (84.2)</td>
</tr>
<tr>
<td>Combined therapy (%)</td>
<td>119</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Non surgical therapy (%)</td>
<td>15</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Total (%)</td>
<td>153</td>
<td>16 (10.5)</td>
</tr>
</tbody>
</table>

### Table 2 Distribution of surgical type and time of radiotherapy in 153 patients with rectal cancer.

<table>
<thead>
<tr>
<th>Type of surgery</th>
<th>Total</th>
<th>Time of radiotherapy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Postoperative</td>
</tr>
<tr>
<td>LAR (%)</td>
<td>96</td>
<td>67 (69.8)</td>
</tr>
<tr>
<td>APR (%)</td>
<td>42</td>
<td>22 (52.4)</td>
</tr>
<tr>
<td>No surgery (%)</td>
<td>15</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Total (%)</td>
<td>153</td>
<td>89 (58.2)</td>
</tr>
</tbody>
</table>

LAR, low anterior resection; APR, abdominoperineal resection; RT, radiotherapy.

### Table 3 Distribution of the patients’ and the tumor characteristics by surgery in 153 patients with rectal cancer.

<table>
<thead>
<tr>
<th>Variables</th>
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<th>P value</th>
</tr>
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<tr>
<td></td>
<td>LAR</td>
<td>APR</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (± SD)</td>
<td>57.15 (13.95)</td>
<td>57.25 (14.19)</td>
</tr>
<tr>
<td>&lt;55 (%)</td>
<td>71</td>
<td>49 (69.0)</td>
</tr>
<tr>
<td>≥55 (%)</td>
<td>82</td>
<td>47 (57.3)</td>
</tr>
<tr>
<td>Sex (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>89</td>
<td>57.25 (14.19)</td>
</tr>
<tr>
<td>Female</td>
<td>64</td>
<td>49 (69.0)</td>
</tr>
<tr>
<td>Stage (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–II</td>
<td>79</td>
<td>53 (59.5)</td>
</tr>
<tr>
<td>III–IV</td>
<td>74</td>
<td>43 (57.2)</td>
</tr>
<tr>
<td>Tumor grade (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade I</td>
<td>120</td>
<td>75 (62.5)</td>
</tr>
<tr>
<td>Grade II–III</td>
<td>33</td>
<td>21 (63.6)</td>
</tr>
<tr>
<td>Tumor distance from anal verge (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (± SD)</td>
<td>6.56</td>
<td>8.13 (2.80)</td>
</tr>
<tr>
<td>Lower third (0–6 cm)</td>
<td>73</td>
<td>27 (37.0)</td>
</tr>
<tr>
<td>Middle third (7–12 cm)</td>
<td>80</td>
<td>69 (86.3)</td>
</tr>
<tr>
<td>Surgical margin status (%)</td>
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<td></td>
</tr>
<tr>
<td>Free</td>
<td>110</td>
<td>74 (67.3)</td>
</tr>
<tr>
<td>Involved or closed or NM</td>
<td>43</td>
<td>22 (51.2)</td>
</tr>
<tr>
<td>Treatment modality (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery alone</td>
<td>19</td>
<td>8 (42.1)</td>
</tr>
<tr>
<td>Combined therapy</td>
<td>119</td>
<td>88 (73.9)</td>
</tr>
<tr>
<td>Dose of radiotherapy (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (± SD)</td>
<td>48.43</td>
<td>49.37 (2.44)</td>
</tr>
<tr>
<td>Chemotherapy regimen (%)</td>
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<td></td>
</tr>
<tr>
<td>No chemotherapy</td>
<td>19</td>
<td>8 (42.1)</td>
</tr>
<tr>
<td>Oxaliplatin-based</td>
<td>67</td>
<td>45 (67.2)</td>
</tr>
<tr>
<td>Other regimens</td>
<td>67</td>
<td>43 (64.2)</td>
</tr>
</tbody>
</table>

LAR; low anterior resection, APR; abdominoperineal resection; SD; standard deviation, combined therapy; surgery ± chemotherapy ± chemoradiation; NM, not mentioned.
P < 0.001), stage of disease (log rank test, P < 0.001), treatment modality (log rank test, P < 0.001), surgical margin status (log rank test, P = 0.001), and chemotherapy regimen (log rank test, P = 0.048), and dose of radiation (log rank test, P = 0.017) were found to be prognostic factors. Sex, tumor differentiation, surgical margin status and were found not to be prognostic factors for DFS (Table 5). In addition, there was no significant difference in terms of overall survival rate between LAR and APR groups (68.7% versus 84.0%, log rank test, P = 0.256) (Figure 5).

On multivariate analysis, only age and disease stage were found to be independent prognostic factors. Age ≥ 55 years [HR = 5.86, 95% CI = 2.49–13.79, P < 0.001], and stage IV [HR = 36.90, 95% CI = 4.76–285.68, P < 0.001] had a negative influence on survival. (Table 7).

Pattern of recurrence

Sixty patients developed recurrent disease after treatment. Of which 12 patients had locoregional recurrence at anastomotic site wall, perineum, inguinal lymph nodes or within pelvic cavity, 12 patients had isolated distant relapse, and 36 remaining patients developed distant and locoregional recurrence. The median time to recurrence was 9 months.

Discussion

Low anterior resection and abdominoperineal excision are two most commonly major surgical techniques used in lower and middle rectal cancers. There are no significant demographic differences between LAR and APR in rectal cancer patients [11]. In a meta-analysis, the mean age of 3363 patients with rectal cancer was 60 years; and 65% of all patients were male [8]. In the present study, the median age of all patients was 57 years and 58% of all patients were men. These results are consistent with the literature [8]. In a systematic review, there was no significant difference between LAR and APR in terms of patients’ age. In the current study, we did not find significant difference regarding the patients’ age and sex between LAR and APR.

It is evident that APR surgery is more commonly used in low lying rectal tumors involving anal canal than LAR [21,22]. In the present study, APR was associated with shorter tumor distance from anal verge than LAR. There is debate regarding an association between more locally advanced diseases and APR surgery. Some reports indicate APR is more likely to be associated with locally advanced tumors than LAR [23–25]; however, most studies found no significant difference between tumor stage and surgical type [11]. In our series, we found tumors treated with APR were significantly more locally advanced than those treated by LAR. This finding is consistent with some studies [23,24,26–30] and inconsistent with other reports [11,24,27,31,32].

Several studies investigated the correlation of tumor differentiation and surgical types or tumor location in rectal cancer patients. Few studies reported a statistically significant association between poorly differentiated tumors and APR [24,27]; however, other studies did not find such result [29,31–33].
In our study, there was no association between tumor differentiation and operation performed. Few studies investigated the frequency of circumferential resected margin involvement in rectal cancer patients. Most of these studies found a significantly higher rate of involved circumferential resection margin following APR compared to LAR [27,28,30,32]. In the present research, there was no significant difference of involved circumferential resected margin between LAR and APR. Our results were consistent with the study of Hiranyakas et al. They evaluated the incidence of a positive circumferential resected margin in 154 patients who underwent curative APR (n = 65) or LAR (n = 69). They concluded the rate of involved circumferential resected margin was not significantly different between LAR and APR [34]. In agreement with this study, we did not find significant difference between surgical types and the rate of positive circumferential resected margin in our patients. However, we found a different margin involvement among LAR and APR. While all involved margins in LAR were distal end and all involved margins in APR were circumferential.

There is controversy regarding the need of neoadjuvant or adjuvant therapies in accordance with surgical type in rectal cancer patients. Some reports concluded a more frequent use of combined therapies among the patients undergoing APR [26–28,35] or LAR [33]; while few reports found no significant difference in the use of combined therapies between APR and LAR [29,36,37]. In the current study, the combined therapies were used more frequently in LAR. This may be due to the higher rate of stage IV and close margin in patients treated with LAR.

Comparison of local recurrence rates is one of the most important oncologic outcomes to assess the efficacy of surgical types used in rectal cancer patients. This endpoint was evaluated by several studies. Most studies indicated greater rates of local failure following APR [21,27,30,35]. Conversely, two reports found higher rates of local recurrence among patients treated by LAR [33,38]. On the other hand, several studies did not find significant difference between local recurrence rates and these two surgical types. Higher rates of involved circumferential resected margin and local failure in the literature

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Prognostic factors for 5-year disease free- and overall survival in the 153 patients with rectal cancer.</th>
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</thead>
<tbody>
<tr>
<td>Variables</td>
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</tr>
<tr>
<td>Age (years)</td>
<td></td>
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<td>71</td>
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<tr>
<td>≥55</td>
<td>82</td>
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<tr>
<td>Sex</td>
<td></td>
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<td>Male</td>
<td>89</td>
</tr>
<tr>
<td>Female</td>
<td>64</td>
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<tr>
<td>Stage</td>
<td></td>
</tr>
<tr>
<td>0–I</td>
<td>16</td>
</tr>
<tr>
<td>II</td>
<td>63</td>
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<tr>
<td>III</td>
<td>51</td>
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<tr>
<td>IV</td>
<td>23</td>
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<tr>
<td>Tumor grade</td>
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<tr>
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<td>Moderately differentiated</td>
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<td>Poorly differentiated</td>
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<td>Lower rectal third</td>
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<tr>
<td>Middle rectal third</td>
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<td>Surgical margin status</td>
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<td>Free</td>
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<td>Involved or closed</td>
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<td>Type of surgery</td>
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<td>Other regimens</td>
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</table>

DFS, disease free survival; OS, overall survival; LAR, low anterior resection; APR, abdominoperineal resection; combined therapy, surgery plus neoadjuvant and/or adjuvant therapies.
may be due to inadequate surgical techniques used in traditional APR. Some researchers concluded that extended APR such as cylindrical resection is associated with a lower rate of circumferential margin involvement and an improved local control rate compared to conventional APR [15,16]. In this study, we did not find any statistically significant different local control rate between LAR and APR in our patients.

<table>
<thead>
<tr>
<th>Variables</th>
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<th>5-Year LC (%)</th>
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<tbody>
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<td>Age (years)</td>
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<tr>
<td>&lt; 55</td>
<td>71</td>
<td>87.1</td>
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</tr>
<tr>
<td>≥ 55</td>
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<td>0-I</td>
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<td>III</td>
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<td>Tumor grade</td>
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<td></td>
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<tr>
<td>Well differentiated</td>
<td>120</td>
<td>78.2</td>
<td>0.963</td>
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<tr>
<td>Moderately differentiated</td>
<td>28</td>
<td>79.6</td>
<td></td>
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<tr>
<td>Poorly differentiated</td>
<td>5</td>
<td>80.0</td>
<td></td>
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<tr>
<td>Tumor location</td>
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<tr>
<td>Lower rectal third</td>
<td>73</td>
<td>75.9</td>
<td>0.946</td>
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<tr>
<td>Middle rectal third</td>
<td>80</td>
<td>80.8</td>
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<tr>
<td>Surgical margin status</td>
<td></td>
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<tr>
<td>Free</td>
<td>110</td>
<td>86.0</td>
<td>&lt; 0.001</td>
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<tr>
<td>Involved or closed</td>
<td>30</td>
<td>51.1</td>
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<tr>
<td>Not mentioned</td>
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<td>80.8</td>
<td></td>
</tr>
<tr>
<td>Treatment modality</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Surgery alone</td>
<td>19</td>
<td>93.3</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Combined therapy</td>
<td>119</td>
<td>81.9</td>
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</tr>
<tr>
<td>Non Surgical treatment</td>
<td>15</td>
<td>26.7</td>
<td></td>
</tr>
<tr>
<td>Type of surgery</td>
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<td></td>
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<tr>
<td>LAR</td>
<td>96</td>
<td>84.8</td>
<td>0.533</td>
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<tr>
<td>APR</td>
<td>42</td>
<td>81.0</td>
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<tr>
<td>Radiation dose</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>50–50.4 Gy</td>
<td>103</td>
<td>78.2</td>
<td>0.391</td>
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<tr>
<td>45–49 Gy</td>
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<td>0.096</td>
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<td>Oxaliplatin-based</td>
<td>67</td>
<td>77.4</td>
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<tr>
<td>Other regimens</td>
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<td>76.2</td>
<td></td>
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</table>

LC, local control; LAR, low anterior resection; APR, abdominoperineal resection.

Table 6 Multivariate stepwise regression hazards model analysis of prognostic factors for local control in 153 patients with rectal cancer.

<table>
<thead>
<tr>
<th>Variables</th>
<th>No</th>
<th>Df</th>
<th>P value</th>
<th>Hazard ratio</th>
<th>95% CI</th>
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<td>0–I</td>
<td>16</td>
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<td>0.210</td>
<td>0.17</td>
<td>0.01–2.64</td>
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<tr>
<td>II</td>
<td>63</td>
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<td>&lt; 0.001</td>
<td>0.01</td>
<td>0.01–0.22</td>
</tr>
<tr>
<td>III</td>
<td>51</td>
<td>1</td>
<td>&lt; 0.001</td>
<td>0.01</td>
<td>0.03–0.41</td>
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<tr>
<td>IV</td>
<td>23</td>
<td></td>
<td>&lt; 0.001</td>
<td>0.01</td>
<td>0.03–0.41</td>
</tr>
</tbody>
</table>

CI, confidence interval; Df, degrees of freedom.
Overall, we found a high overall recurrence rate in our patients. It is partly due to higher rate of cases with stage II and III; as well as lower tendency to use neoadjuvant chemoradiation among general surgeons. While three-fourths cases were stage II and III, only less than one-fourth received neoadjuvant chemoradiation.

Some arguments are present regarding the impact of surgical types on disease free and overall survival rates. While some reports did not find any significant different disease free survival among LAR and APR [29,35,39]; others found a better disease-free survival for patients treated with LAR [21,24,30]. Likewise there is controversy regarding the prognostic effect of surgical types on overall survival rates in rectal cancer patients. While most reports indicated improved overall survival rates for LAR, few studies did not find a significant difference between LAR and APR. In our report, there was no significant difference in terms of disease free survival and overall survival between LAR and APR.

Low rectal cancers with anal canal involvement are usually treated with APR; however, LAR may be considered as an acceptable alternative, particularly in patients with excellent response to neoadjuvant chemoradiation and with adequate tumor margin from the anal canal. There is a remarkable risk for local failure in these patients, particularly in those with unsafe surgical margins. Therefore, close follow-up is mandatory for patients treated with very LAR and salvage APR may be reserved for local recurrent disease [10,33,40].

**Conclusion**

Low anterior resection and APR are two major surgical techniques used in lower and middle rectal cancers. Low anterior resection can provide comparable local control, disease free and overall survival rates compared with APR in eligible patients with lower and middle rectal cancer.

**Conflicts of interest**

None of the authors has any conflict of interest, financial or otherwise.

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**References**

Comparison of abdominoperineal resection and low anterior resection

159


