Factors affecting operating time in resection of Rectal Cancer

Mudasir Sofi M.S.,¹ Fazl Q Parray M.S.,² Feroze Shaheen M.D.,³ Nisar A Chowdri M.S.,⁴ Rauf A Wani M.S.⁵

^{1,2,5} Post Graduate scholar, Professor, Additional Professor, Colorectal Division, SKIMS

³ Professor Department of Radiodiagnosis, SKIMS, ⁴ Prof. General and Minimal Invasive Surgery

ABSTRACT

Background: - Rectal cancer continues to be a challenging disease which most of the time needs proper staging and multimodal management to achieve the best possible cure rates. For operating surgeons many factors may play a role in predicting the technical difficulties while conducting the operation.

Objective: Objective of this study is to understand the relationship between Age, body mass index (BMI), Gender and patients anatomical factors on operating time in resection of mid low rectal cancer.

Methods: This was a prospective observational study conducted over a period of two years from Sept 2015 to Sept 2017. The study was conducted in the department of General and Minimal Invasive Surgery, SKIMS which included 29 patients with mid-lower rectal cancer, who underwent anterior resection. Demographic data, body mass index (BMI), distance of tumor from anal verge and pelvimetry measurements were collected and analyzed with respect to operating time using co- relation coefficient analysis, principal component analysis, and linear regression.

Results: The study included 20 (68.96%) females and 9 (31.03%) males. The mean operating time was 136.72±30.09. Multivariate analysis showed that parameters such as BMI (P=0.05), anatomical transverse distance (IP) (P=0.000), interischial distance (IS) (0.004), intertuberos distance (IT) (P=0.003), angle 5 (the angle of the lower border of symphysis pubis to the upper border of symphysis pubis to the sacral promontory) (p=0.017) and distance of tumor from anal verge (Td) (p=0.001), were statistically significant. Whereas parameters such as Interacetabular distance (IA) (P=0.11) and distance from Pubis to coccyx (COSY) (P=0.674) had no statistical significance.

Conclusion: Gender, BMI, angle 5, tumor distance from anal verge, transverse diameters of the pelvis except IA, and COSY played the most important role in affecting operating time. The equation can be very useful tool for pre-operative assessment. JMS 2018: 21 (2):77-83

INTRODUCTION

Colorectal cancer is one of the common malignancies and a leading cause of cancer death in U.S. and worldwide. [1, 2]

Rectal cancer is on the rise in the valley of Kashmir; however the incidence of colorectal cancer in Kashmir is similar to that reported in the rest of India. [3] Since, we are working in a tertiary care hospital, catering to a population of more than 10 million in the sub-specialty of colorectal division; we get exposed to more volume of rectal cancer when compared with most of the centers in and outside the country. Because of increasing trend in rectal cancers in this part of world, different studies have been conducted with a view to assess the surgical outcome, complications and technical difficulties encountered while performing a sphincter preserving surgery [4]. Surgical resection is

considered a standard of treatment for patients with non-metastatic colorectal cancer which can be performed either by open or laparoscopic technique. Laparoscopic resection has similar short and long term outcomes as conventional open surgery, [5-8] but with more clinical advantages. [5,9]

For analysing the factors affecting operative difficulty, operating time is usually chosen as the primary measure of difficulty as it is objective and well suited to a relatively small sample size in which some operative complications may not occur [10-11]. Pelvimetry and tumor characteristics are expected to be other factors responsible for predicting the operative difficulty. Some factors that have been shown to be associated with operative time and hence difficulty are high body mass index (BMI), narrow pelvic outlet, tumors closer to the anal verge, tumor stage, previous abdominal surgery, and preoperative radiotherapy. [10-13] A deep and narrow pelvis in some patients and the effects of neo-adjuvant chemo-radiation treatment make the operation more demanding. Moreover, there is the need to minimise injury to autonomic nerves that are responsible for postoperative urinary and sexual function. [11,14-20]

Correspondence

Dr. Fazl Q Parray
Professor, Colorectal Division, SKIMS, Srinagar
Email: fazlparray@rediffmail.com

CT and magnetic resonance imaging (MRI) pelvimetry have been coming back into vogue for a lower rectal cancer with or without radiation dose. CT and MRI pelvimetry are also an accurate and reliable technique for obtaining pelvimetric measurements, which have been utilized for patients with rectal cancer. Costs of MRI pelvimetry are obviously greater than those of CT techniques. Finally, financial considerations limit the clinical usage of MRI. Therefore, CT pelvimetry is widely used in patients with rectal cancer because of its relatively inexpensive costs and convenience.^[21]

METHODS

A prospective and observational study was performed in mid low rectal cancer patients from September 2015 to September 2017. The study was conducted in the department of General and Minimal Invasive Surgery, SKIMS. Patients with a tumor located 4-12 cm from anal verge and histologically proven adenocarcinomas were included in the study. All other patients subjected to emergency surgery, patients with a history of additional surgeries in addition to rectal cancer surgery and patients who received neo-adjuvant chemo radiotherapy (NACRT) were excluded from the study.

The study patients were evaluated as per hospital protocol. Preoperative data, including demographic characteristics, history of preoperative neo-adjuvant chemo-radiotherapy (NACRT), history of lower abdominal surgery, BMI, and distance of the tumor from the anal verge (Td), were reviewed from the patient's medical records. Computed tomographic (CT) pelvimetry measurements (table 1) were taken by a same consultant Radiologist and noted down. Operative time was calculated from the electronic record on the anesthesia machine from the start of making a skin incision till the closure of abdominal wound or port site.

Statistical analysis:

Statistical analysis of data were performed using STATA software. Descriptive analyses were used to characterize the study population. We defined Operating time as dependent variable and patient's demographic and pelvic anatomical diameters as independent variables. All statistically significant factors by univariate analysis were then used in multivariate analysis. Pearson's correlation coefficient was used to determine the relationship between factors and operating time. Linear regression was applied for data correlated with operating time. If collinearity existed, principle components analysis was applied to further explore the internal relationship between factors and operating time. A p value of less than 0.05 was considered significant.

RESULTS

A total of 29 patients were studied which included, 20 (68.96%) females and 9 (31.03%) males. The mean operating time was 136.72±30.09 minutes (table 2). Males had longer operating time than females by about 4 minutes which was statistically significant (p 0.001); overall pelvic diameters in females were larger than males (table 3). Univariate analysis showed that BMI (p=0.0000), interacetabular distance (IA) (p=0.0001), Anatomical transverse distance (IP) (p=0.020), Interischial distance (IS) (p=0.0000), intertuberos distance (IT) (p=0.0000), Pubis to coccyx distance (COSY) (p=0.0000), the angle of the lower border of symphysis pubis to the upper border of the symphysis pubis to the sacral promontory (Angle 5) (p=0.0004), distance of tumor from anal verge (Td) (p=0.0000) correlated with operating time. However multivariate analysis showed that BMI (P=0.05), IP (P=0.000), IS (0.004), IT (P=0.003), Angle 5 (p=0.017) and Td (p=0.001), were statistically significant, while as IA (P=0.11) and COSY (P=0.674) had no statistical significance.

Table 1: Pelvimetry measurements used by consultant radiologist

Measurement	Definition
Interacetabular distance (IA)	Distance between the most inner points of right and left femoral heads
Anatomical transverse distance (IP)	Distance between the most outer points of right and left iliopectineal lines
Interischial distance (IS)	Distance between the right and left ischial spines
Intertuberos distance (IT)	Distance between the most inner points of right and left ischial tuberosities
Pubis to coccyx (Cosy)	Distance from the lower border of symphysis pubis to the tip of coccyx
Angle 5	The angle of the lower border of symphysis pubis to the upper border of symphysis pubis to the sacral promontory
BMI (body mass index)	$\frac{\text{weight in Kg}}{\text{Height in meter}^2}$

Table 2:Operating time correlation to pelvimetry

Variable	Number of patients	Mean	Standard deviation	Min	Max
Operation time (OT) (Minutes)	29	136.7241	30.09734	90	200
BMI	29	24.98069	3.231005	21.1	33.8
IA	29	12.50897	0.9768256	11.1	14.4
IP	29	13.6069	1.439477	11.1	16.7
IS	29	12.30345	0.7688037	9.9	13.1
IT	29	11.7569	1.492584	8.9	13.5
COSY	29	11.02069	0.9685701	8.5	12.1
Angle 5	29	23.62069	2.651331	20	28
Distance from anal verge(in cm) (Td)	29	6.448276	1.205233	4	8

Table 3:Statistical significance of pelvimetry measurements

Variables	Mean(males)	Mean (females)	P valve
OT	137.75±25.82	134.444±39.72	0.001
BMI	23.99778±2.96	25.425±3.33	0.002
IA	12.23333±1.212	12.633±0.857	0.006
IP	13.12222±1.300	13.825±1.47	0.010
IS	12.1778±0.916	12.36±0.712	0.001
IT	11.6725±1.57	11.94444±1.377	0.003
COSY	10.67±0.949	11.13333±1.059	0.092
Angle 5	24.11111±2.571	23.4±2.72	0.06
Td	6.666667±1.479	6035±1.089	0.10

Table 4:Correlation coefficient of pelvimetry measurements

	OT	BMI	IA	IP	IS	IT	COSY	Angle 5	Td
OT	1.0000								
BMI	0.7759 0.0000	1.0000							
IA	-0.6498 0.0001	-0.2631 0.1678	1.0000						
IP	-0.2410 0.2079	0.0353 0.8556	0.2996 0.1144	1.0000					
IS	-0.8746 0.0000	-0.7800 0.0000	0.4892 0.0071	0.2849 0.1341	1.0000				
IT	-0.8438 0.0000	-0.7965 0.0000	0.4566 0.0128	-0.1672 0.3861	0.7040 0.0000	1.0000			
COSY	-0.7639 0.0000	-0.5791 0.0010	0.3972 0.0329	0.1964 0.3073	0.7160 0.0000	0.7036 0.0000	1.0000		
Angle 5	-0.6136 0.0004	-0.3269 0.0835	0.4804 0.0083	-0.1266 0.5130	0.2617 0.1702	0.5647 0.0014	0.4260 0.0212	1.0000	
Td	-0.9180 0.0000	-0.6687 0.0001	0.6062 0.0005	0.0167 0.9316	0.7345 0.000	0.8053 0.000	0.6679 0.0001	0.7257 0.000	1.0000

Linear regression with collinearity diagnostics showed collinearity existed within the co-relating factors. Dimension reduction using principal component analysis was applied after the variables were standardized (z score). If more than 75% of the variance can be explained by several components (principal components), it can be regarded as a major factor. Principal component analysis showed that 79.06% of the total variance could be explained by three principal components (table 4). So three principal components (z1, z2, z3) were calculated and linear regression analysis was applied.

Z score OT = 136.72 - 8.38(z1) 8.09 (z2) 11.27(z3)

After operation the final equation could be obtained as

OT = 457.44 + 1.17(BMI) 2.13(IA) - 4.25(IP) 9.43(IS) 4.77(IT) 0.64(COSY) + 1.53(Angle5) 7.72(Td)

DISCUSSION:

The operative time for resection of rectal cancer is influenced by a surgeon's skills^[16, 22], patient's clinical and anatomical factors such as gender, BMI, distance of tumor from anal verge, pelvic size^[23, 24] and different surgical procedure. Many pelvic parameters have been used to determine their predicting role on operative difficulty for sphincter preserving resection of rectal cancer. Results are still inconsistent regarding which pelvic parameter is the best predictor. Smaller pelvic outlet^[14], a less acutely curved sacrum, a narrow transverse intertuberos distance^[10], shorter pubic coccyx axis,^[13] or transverse interspinous distance^[25] and a smaller lower pelvic diameter^[13] related to longer operative time. Wang et al^[26] reported that interacetabular, anatomic transverse, interischial, intertuberos distance, distance between the coccyx and symphysis, the angles of the lower border of the symphysis pubis, upper border of symphysis pubis, and sacral promontory are inversely related to operative time. However, our study showed that IA (p 0.110) and COSY (p 0.674) were not statistically significant. The reason may be a small sample size. However in our study we find a significant relationship between interspinous [IS, P=0.004] and intertuberos [IT, P=0.003] diameters with operating time. These results were conforming with the results of study conducted by Salerno G et al^[27]. The Akiyoshi group has previously published an excellent study identifying patient's factors predicting the difficulty of performing laparoscopic low anterior resection for rectal cancer^[18]. In contrast, in our study all surgeries were performed by the same surgeon, instead of several as in Akiyoshi group. Sphincter preserving resection for rectal cancer 3-4 cm to

anal verge has been associated with increased possibility of positive resection margin and a high chance of recurrence.^[28] Our study includes patients with rectal cancer 4-12 cm from anal verge, whereas patients with rectal cancer 3-8 cm from anal verge are included in Akiyoshi's study. Consequently, both studies reveal that BMI, tumor distance to anal verge and pelvic anatomy are predictors for operative difficulty. Some authors have demonstrated significant differences in pelvic measurements between the sexes.^[23, 29] But there is also considerable variation and overlap between the sexes^[27]. Gender has previously been considered a factor in influencing operative difficulty.^[13, 30] Qiken et al^[31] showed sex differences in factors impacting operative time. BMI (estimate=0.11, P=0.0035), interspinous distance (estimate = -0.04, P=0.0010), and preoperative chemoradiotherapy (estimate=0.90, P=0.0011), were significantly associated with the standardized operative time in males based on multivariate analysis. In females, prior abdominal surgery (estimate=1.12, P=0.0003) and concurrent diseases (estimate=0.81, P=0.0059) were associated with the standardized operative time. However, Our study showed that operative time in males is longer than females because of narrow and deep pelvis in males. Greater mesorectal volume in patients with higher BMI restricts the operative field and increases operative time. The predicting role of BMI for laparoscopic sphincter preserving resection of rectal cancer has been observed in previous studies^[13]; however, other researchers have shown that visceral fat may be a better predictor of operative difficulty than BMI^[17]. Patient's obesity seemed to be a favorable factor for resectability of tumors located in the rectum when the surgical procedures were performed by surgeons with low case volume.^[32] Because the meso-rectum presents a considerable obstacle to the growth of cancers.^[33] Their explanation is the probably smaller volume of peri-rectal fatty tissue in lean patients than in obese counterparts. Small volume of peri-rectal fatty tissue can contribute to the early tumor infiltration of the pelvic wall and/or adjacent organs, which decreased the rate of resectability of rectal cancer and increase in operating time. Wepingchen et al^[34] study showed that BMI is a predictor of operative time for men only. The same result was observed in a previous study; however, no detailed data were presented.^[14] BMI does not consistently reflect body adipose tissue distribution. It has been observed that obese males have more visceral fat, whereas obese females have more subcutaneous fat.^[35, 36] This different distribution of fat in males and females may explain that

BMI is a predictor only for males. Our results show that BMI is a predictor for operative time in females. Relatively smaller male sample in our study may account for the above finding. However, we have found that BMI is an easily obtainable and useful parameter in predicting operative difficulty.

Distance from anal verge is also an important factor effecting operating time in resection of rectal cancer. More the distance from anal verge, more accessible the tumor, less difficulty in dissection and hence less is operating time. Qiken et al^[31] in their study showed that tumor distance from anal verge (estimate=-0.17, $P=0.0355$) is a predictor for standardized operative time. Our study showed similar result.

Based on the equation, BMI, angle 5, transverse diameters of the pelvis, Cosy, Gender and Distance of tumor from anal verge were related to operating time. However none of the factors was the dependent factor affecting operating time. Thus, the frame of the pelvis should be considered as a whole. BMI and angle 5 have positive effects on operating time, while transverse diameters (IA, IP, IS and IT) and CoSy have negative effects on OT. Besides the anatomical factors, BMI, which could reflect the soft tissue volume in the pelvis, was also very important in affecting operating time. This equation can be used as a very useful tool for preoperative assessment of patients undergoing LRC. If calculated or predicted operating time is more than a given time, the technique might not be suitable for junior specialists without extensive training. Further research should be performed to identify the given time.

The strength of our study is that we used three-dimensional measurements to obtain pelvimetry data, which is much more accurate than that of two-dimensional measurements. We described the relationship between factors and operating time more accurate by the equation, which provides the internal relationship among the factors. The small number of patients is the major limitation of the study. In addition, the timings for different steps of the procedure were not recorded, which lead to step-by-step analysis of the procedures impossible. We recognized the limitations, however we believe that this study provides important information for further research.

CONCLUSION

No specific demographic data and any measurement of pelvimetry could be identified as an independent predictor for operating time in our study. Instead, BMI, angle

5, distance of tumor from anal verge, transverse diameters of the pelvis except IA and COSY played the most important role in affecting operating time. The equation reveals the internal relationship among the factors, and it can be a very useful tool in preoperative assessment for predicting operative difficulty.

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