Original Article

An Observational Study on Implication of Postoperative Visceral Edema, Assessed by CT Scan, on Complications Following Bowel Resection and Anastomosis, in a Tertiary Care Hospital in Maharashtra, India

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Abstract

Introduction: Surgeries involving bowel resection and anastomosis are quite common. Fluid overload, leading to tissue edema and impaired tissue perfusion, may contribute to anastomotic leak, which is one of the most dreaded complication.

Methods: In our current study, CT scan , done on postoperative day-4, was used to assess visceral edema, and its effect on development of complications post bowel anastomosis and increase in value of cross section of body trunk area ≥20% was taken as an independent risk factor of severe complication.

Results: Twenty three patients were enrolled in the study, 7 of them developed complications. The most common complication observed was wound infection (Clavein Dindo grade II). Only 2 patients (28.57%) had an increase in CT area >20%. Among patients who developed complications, 33.3% had an increase in CT area and 28.6% did not. Various other factors – preoperative albumin level, timing of surgery, duration of surgery – also lead to development of complications. Statistically, no significant association could be derived between the increase in CT area and development of complications.

Conclusion: As per the findings of the current study, higher fluid balance was not reflected by an increase in body surface area on CT Scan. Hence, use of CT scan as a tool to assess visceral edema needs further evaluation.

Keywords: Anastomotic leak; Computed tomography; Fluid balance.

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Introduction

Surgeries involving bowel resection and anastomosis are quite common. The most dreaded complication following an anastomosis is anastomotic leak. Fluid overload causes increased extravascular fluid volume, leading to tissue edema, and accumulation of fluid in other compartments like pleural effusion. This is further enhanced in patients with hypoalbuminemia.[1] Tissue edema decreases muscular oxygen tension, impairs tissue healing and increases postoperative complications including ileus, anastomosis leakage and gastrointestinal dysfunction.[2] Intraoperative fluid administration depends on various complex variables such as operative time, blood loss, insensible transpiration amount and urine output.[3]

Postoperative measurement of body weight is a useful physiological assessment to evaluate fluid overload. However, increased body weight reflects tissue edema along with fluid retained in other body spaces like pleura or peritoneum.[1,2]

CT (Computed Tomography) scan can provide an objective assessment tool for interstitial edema due to fluid overload, reflected by an increased cross sectional body trunk area.[4] Shimizu et al have evaluated whether radiologic imaging could assess the association between tissue edema and severe complications after pancreaticoduodenectomy (PD). They concluded that the increase in value of cross section of body trunk area in postoperative CT≥20%, was an independent risk factor of severe complication.[5]

In this study, we correlated postoperative visceral edema, assessed by CT scan on postoperative day-4, and development of complications.

Methods

This is a prospective study in patients, above 18 years of age, undergoing surgeries involving bowel anastomosis from August 2019 to August 2021, at a tertiary care hospital in Maharashtra. All patients attending surgery clinic during the period stated for bowel anastomosis were included in the study, after taking written informed consent from the same. The study had received prior approval from institutional ethics committee, prior to patient recruitment and data collection.

Preoperative CT Scan done within one month of surgery and a postoperative CT scan done on POD-4 at the Radiology Department were compared. In both these scans, the body trunk area at the level of umbilicus was measured via Diacomm viewer software. The difference in the cross section of the body trunk area (measured in mm^2), between the two CT scan was calculated as follows:

(Body trunk area on POD 4 - Body trunk area preoperatively)/ (Body trunk area on preoperative CT) X 100

Table 1. Basic demographic details

Basic Details	Mean ± SD
Age (Years)	45.68 ± 18.92
Gender	
Male	14 (56.0%)
Female	11 (44.0%)
Comorbidities (Yes)	7 (28.0%)
Type of Procedure	
Elective	19 (76.0%)
Emergency	6 (24.0%)
Diagnosis	
Benign	15 (60.0%)
Malignant	10 (40.0%)
S. Albumin (g/dL)	3.58 ± 0.41
S. Albumin	
<3.5 g/dL	7 (28.0%)
≥3.5 g/dL	18 (72.0%)
Operative Time (Hours)	4.12 ± 1.54
Fluid Input (mL/kg/Hr)- intraoperative	12.28 ± 4.38
Total Fluid Input (mL/kg)	247.34 ± 80.74
Fluid Balance (mL/kg)	116.84 ± 52.53

The total fluid input and output were measured in ml, as per the input output charting done regularly. Intraoperative fluid input was determined by calculating the total amount of fluids administered during surgery. Fluid balance over POD 0 to POD3 was recorded-as the internal milieu returns to normal by POD 3. Fluid balance in the postoperative period was obtained by subtracting the output (urine output and drain output) from the total input (oral and IV fluids). Based on the summative data over 96 hours, fluid administration and balance was divided into low, medium and high tertiles. Association between each fluid tertile and development of complications were recorded and analyzed. Grading of complications was done as per the Clavein Dindo Classification of Surgical Complications.[6] The anastomosis leak was graded as per the modified DULK score.[7] Analysis of the perioperative fluid administration, change in cross section of body trunk area on postoperative CT Scan on POD-4 and occurrence of postoperative complications were done.

Data was entered in MS Excel (Office 365) and analyzed using R. Descriptive data was expressed in percentages for categorical variables, and mean + SD for quantitative variables. Fischer test was applied for analysis of categorical variables. Wilcoxon -Mann -Whitney U test was used for making intergroup comparison, correlation was used for assessing strength of association between quantitative variables. Data was represented in the form of tables.

Results

The study included 25 participants initially. Out of these two had died before post op day 4.

The mean age was 45.68±18.92 years. Majority of participants were male, and 28% of them had comorbidities. 28.0% of the participants had serum albumin: <3.5 g/dL (hypoalbuminemia). The mean of intraoperative fluid input (mL/kg/hr) was 12.28 ± 4.38. The mean of total fluid input was 247.34 ± 80.74 ml/Kg. The mean of total fluid balance was 116.84 ± 52.53 ml/Kg. (**Table 1**)

Based on their perioperative fluid parameters they have been divided into three tertiles and classified as low, medium and high. As per the intraoperative fluid input, mean of low, medium and high tertiles were at 7.95(n=8), 11.28(n=9) and 17.75(n=8) ml/kg/hr respectively. As per the total fluid input, mean of low, medium and high tertiles were at 175(n=8), 227(n=9) and 341(n=8) ml/kg respectively. As per the total fluid balance, mean of low, medium and high tertiles were 77(n=8), 102(n=9) and 173(n=8) ml/kg respectively.

39.1% of the participants had increase in post op CT area and 36.0% of the participants developed complications. Among patients who developed complications, 33.3% had an increase in CT area and 28.6% did not.

Among these, 64.0%(16) of the participants had Grade 0 complication, 20.0%(5) grade 2, 4.0%(1) grade 3A, 4.0%(1) grade 4, and 8.0%(2) had grade 5. The most common complication observed was Grade 2- wound dehiscence.

57.1% (4)of the patients with comorbidities developed complications. The odds ratio was 3.47 and relative risk was 2.06. 42.9%(3) of the patients with hypoalbuminemia had complications. The odds ratio was 1.5 and relative risk was 1.29. In emergency procedure group, 66.7% (4)of the participants developed complications. The odds ratio was 5.6 and relative risk was 2.53.

Intraoperative fluid input is usually high to compensate for intraoperative losses. Hence, longer operative time leads to higher fluid input and more chances of developing complications. The mean intra operative fluid input was 12.28 ml/kg/hr. There was a moderate positive correlation between intraoperative fluid balance (mL/kg) and operative time, and this correlation was statistically significant (p = 0.022).

Among the intraoperative fluid input tertiles, 50%, 22 % and 50% patients had an increase in the post op CT area, in the low, medium and high tertiles respectively, and 12.5 %, 44% and 50 % developed complications respectively.

Among the total fluid input tertiles, 37.5%, 44.4 % and 33.3% patients had an increase in the post op CT area and 25 %, 11% and 75 % developed complications respectively. Fisher's exact test was used to explore the association between 'Increase in CT Area' and 'Complications'. There was no significant difference between the various groups in terms of distribution of Complications (p = 1.000). The factors affecting increase in CT area and development of complications in represented in **Table 2** and **Table 3** respectively.

Table 2. Association of increase in CT area with different variables

Parameters	Increase in CT Area		p value
	Yes (n = 9)	No (n = 14)	
Age (in years)	49.67 ± 13.41	46.79 ± 20.90	0.7771
Gender			
Male	7 (77.8%)	7 (50.0%)	0. 228
Female	2 (22.2%)	7 (50.0%)	
With Comorbidities	3 (33.3%)	2 (14.3%)	0.343
Weight (in kg)	54.22 ± 9.93	55.36 ± 9.52	0.924
Type of Procedure			
Elective	9 (100.0%)	10 (71.4%)	0.127
Emergency	0 (0.0%)	4 (28.6%)	
Diagnosis			
Benign	3 (33.3%)	10 (71.4%)	0.102
Malignant	6 (66.7%)	4 (28.6%)	
S. Albumin			
<3.5 g/dL.	1 (11.1%)	4 (28.6%)	0.611
≥3.5 g/dL	8 (88.9%)	10 (71.4%)	
Operative Time (Hours)	4.33 ± 1.87	4.07 ± 1.44	0.773
Fluid Input (mL/kg/Hr) (Intraoperative)	12.07 ± 4.39	11.64 ± 4.19	0.877
Fluid Input (mL/kg) (Total)	234.13 ± 67.64	228.81 ± 56.80	1.000
Fluid Balance (mL/kg) (Total)	104.16 ± 28.05	105.24 ± 31.80	0.926
Complications (Yes)	3 (33.3%)	4 (28.6%)	1.000

The difference in CT Area was not normally distributed, thus, Wilcoxon-Mann-Whitney U Test were used to make group comparisons. The mean of Percent Difference in CT area with development of complications was 6.07 ± 30.47 and without development of complications was 4.09 ±24.08. This was statistically insignificant. (p = 0.871).

Out of seven patients who developed complications, only 2(28.57%) had an increase in CT area >20%.

Discussion

Studies have shown that less perioperative fluid input leads to decreased tissue edema, leading to reduced morbidity and length of hospital stay and early return of gut function.[3,5,8] Currently, weight measurement and input/output charting are the main indicators of fluid retention. Gullo, quantified interstitial fluid by CT scan during autopsy. Thus suggesting

Table 3. Association of complications with different variables

Parameters	Complications		p value
	Yes (n = 9)	No (n = 16)	
Gender			
Male	4 (44.4%)	10 (62.5%)	0.4342
Female	5 (55.6%)	6 (37.5%)	
Comorbidities (Yes)	4 (44.4%)	3 (18.8%)	0.2052
Type of Procedure			
Elective	5 (55.6%)	14 (87.5%)	0.1422
Emergency	4 (44.4%)	2 (12.5%)	
S. Albumin (g/dL)	3.50 ± 0.39	3.63 ± 0.42	0.3781
Operative Time (Hours)	4.72 ± 2.02	3.78 ± 1.12	0.6231
Fluid Input (mL/kg/Hr) (Intraoperative)	12.92 ± 4.00	11.93 ± 4.66	0.3881
Fluid Input (mL/kg) (Total)	294.90 ± 105.79	220.58 ± 48.39	0.0951
Fluid Balance (mL/kg) (Total)	145.82 ± 74.38	100.53 ± 26.00	0.1081
Percent Difference in CT Area	-6.07 ± 30.47	-4.09 ± 24.08	0.8711
With an increase in CT Area	3 (42.9%)	6 (37.5%)	1.0002

CT scan as an objective measurement of tissue edema.[4] Shimizu et al have demonstrated an increase in post op body trunk area ≥20% as an independent predictor for development of complications.[5]

The sample size of this study was 25. Of these, two were lost to follow up, seven patients developed complications and 16 patients had no complications. The most common complication was grade 2 – surgical site infection. Many factors, such as hypoalbuminemia, low hemoglobin, poor hygiene, intraoperative contamination, breech in aseptic precautions, poor preoperative preparation, could have a contributory role for development of surgical site infection. Hence, no definite conclusion can be derived only on the basis of this complication. The development of complications had a positive association with hypoalbuminemia, emergency procedures and presence of comorbidities (relative risk >1). The common associated comorbidities included diabetes mellitus, hypertension and IHD. The associated microangiopathy might have led to poor wound healing.

Serum albumin is identified as an independent factor in wound healing.[9] The mean fluid balance in the hypoalbuminemia and normoalbuminemia group was 155.77 ± 80.19 and 101.69 ± 27.54 ml/kg respectively. It is expected that patients with low serum albumin will have more fluid retention, and thus higher fluid balance, as has been observed in the study. They are also expected to have a higher post op body trunk area on CT scan However, in our study only 20.0% of the patients with hypoalbuminemia had an increase in post op CT scan area and 44.4% in the group with normoalbuminemia. This may be due to the smaller size, and the study should be performed on a larger sample size to further validate this finding.

The risk of complications is higher in the emergency group.[10] This can be due to already ongoing stress response, along with added stress of surgery, ongoing sepsis, deranged laboratory parameters like anemia, and acute kidney injury, secondary to dehydration. In these conditions, restricting fluid administration can be more harmful. Emergency surgery has already proven to be a risk factor for development of complications.

It was observed that patients with low intraoperative fluid input developed less complication. This data however, wasn not reflected by an increase in CT area. However, no statistical association could be established between fluid input and development of complications. Higher fluid balance was associated with higher risk of complications.

The mean difference in CT area with development of complications was 6.07 ± 30.47 %. Thus, complications are commonly seen in patients with higher fluid balance and thus, more tissue edema. However, it is not related to or reflected by an increase in the CT scan area.

Limitations of the study:
1. Curtailed sample size- due to COVID -19 pandemic leading to decrease in elective cases.
2. A variety of cases were chosen, not specific to one surgery.
3. No protocol for fluid therapy was advocated.
4. The range of complications observed was less. The main complication i.e. anastomotic leak, was not observed in any of the participants.

Conclusion

The visceral edema, as estimated by the body surface area on CT Scan, was not significantly associated with any complications. The development of complications had a positive association with hypoalbuminemia, emergency procedures and presence of comorbidities. Similarly, it was more in patients with higher perioperative fluid input. .

As per the findings of the current study, higher fluid balance was not reflected by an increase in body surface area on CT Scan. Hence, use of CT scan as a tool to assess visceral edema needs further evaluation. A larger sample size with a wide variety of complications might help us to narrow down on the effects of fluid retention on complications.

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