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OBJECTIVE: *The goal of the study is to describe postoperative complications observed after colostomy reversal and to define possible risk factor(s) for complications after colostomy closure*

PATIENTS-METHODS: *Patients who underwent colostomy closure in Department of General Surgery, Dr Lutfi Kırdar Kartal Education and Research Hospital between January 2007 and January 2015 were enrolled. Patients with double-barrel ileo-colostomy, Devine's colostomy and tube cecostomy were excluded from study. Demographics, data regarding the first operation and those regarding the reversal operation were analyzed and compared.*

RESULTS: *Total 168 patients [118 (70.1%) male, average age=52.8±15.6] were included. Most common reasons for stoma formation were malignancy [n=63 (37.5%)] and diverticular perforation [40 (23.8%)]. Index operation was performed under emergency conditions in 142 (84.5%) patients. End colostomy was the most common stoma type in emergent cases and loop sigmoidostomy in elective cases. Postoperative complication was observed in 36 (21.4%) patients. Nine (5.3%) patients developed anastomotic leak. Of those, 8 (4.8%) was necessitated reoperation and 1 (0.6%) was treated conservatively. Postoperative mortality was 5 (2.9%). At multivariate analysis, DM was the independent risk factor for surgical site infection and evisceration ($p<0.01$). DM was present in 6 (66.7%) cases who had had an anastomotic leak and leak was more common compared to non-diabetics ($p<0.05$). Patients waiting more than 3 months before stoma reversal had experienced more anastomotic leak compared to those waiting less ($p<0.05$).*

CONCLUSION: *Closure of colostomy has a significant morbidity and mortality, and the physician should be more careful in postoperative follow-up in patients who had comorbidities, especially diabetes mellitus.*

KEY WORDS: Anastomotic leak, Colostomy, Postoperative complication

Introduction

Intestinal stoma refers to the opening of the intestine through the abdominal wall, and it is essentially an enterocutaneous anastomosis created by the surgeon^{1,2}. Colostomy closure has a much higher morbidity and mortality rates than colostomy creation³. However, currently the mortality of colostomy closure ranges between

0% and 4%, and its morbidity ranges between 6% and 50%⁴. These varying rates are caused by various factors such as the differences in time of colostomy closure, closure technique, primary intestinal pathology, type and location of colostomy, and wound care techniques⁵. Studies have reported that the closure rate of temporary colostomies ranges between 41.7% and 60%⁶⁻⁸. Late complications occurring in permanent colostomies can be observed in unclosed colostomies. The most common complication is parastomal hernia, whereas stomal prolapse, stomal stenosis, bleeding, and disease recurrence are other major complications⁹⁻¹³.

The aim of this study was to evaluate elective stoma closure on 168 patients who underwent emergency or elective stoma creation, in terms of postoperative mortality, morbidity, and factors affecting these rates.

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Methodology

In this study, the inpatient records who underwent colostomy closure at Dr. Lütfi Kırdar Training and Research Hospital General Surgery Clinic between 2007-2015, were retrospectively evaluated.

Patients were compared and evaluated according to age, gender, American Society of Anesthesiologists (ASA) score, comorbidities, cause of stoma opening and stoma type, urgency category, operation time of stoma closure, incision technique, type of surgery, anastomosis type and method, time from initial surgery to stoma closure, days of hospitalization, requirement of intensive care unit (ICU) admission in the postoperative period, discharge type, postoperative complications, follow-up and treatment modality if anastomotic leakage was present.

Gastrointestinal motility problems problem was defined as the absence of gas and stool passage for >5 days in the postoperative period in the absence of anastomotic leakage and need for reoperation.

Perianal and pelvic diseases such as perianal, rectovesical and rectovaginal fistula, spontaneous rectum and rectosigmoid perforation, burns, iatrogenic colonic injuries, and anastomotic stenosis which cause stoma opening were classified as other causes.

End-colostomies, sigmoidostomies (loop-double barrel), and transverse ostomies (loop vs. double barrel) were included in the study. Double-barrel end ileostomy+colonic mucous fistula closure, divine colostomy closure, and tube cecostomy closures were excluded from the study. Manual closures were made in double layers, first layer being absorbable suture material and second layer being nonabsorbable suture material, with continuous or interrupted sutures. After joining the end colostomy, anastomotic integrity was evaluated with methylene blue and air test. The colostomy closures performed with circular incision around the stoma were classified as local incision, whereas closures performed with classical median incision under or above the umbilicus were classified as laparotomy.

Colonoscopy and/or passage gastroenterography were performed in all patients during preoperative preparations for evaluating the distal segment of the bowel; in addition, preoperative bowel preparation was performed and antibiotic prophylaxis appropriate for lower gastrointestinal system surgery was administered.

Statistical Analysis

Statistical Package for Social Sciences for Windows 20.0 software was used in the statistical analyses. In addition to descriptive statistical methods (mean, standard error, frequency), the Mann-WhitneyU-test was used to compare quantitative data. Independent sample t-test and chi-square test were used to compare proportional data of the patient groups. Results were evaluated at a signi-

ficance level of $P < 0.05$ with 95% confidence interval, at a level of $P < 0.001$ with 99% confidence interval.

Results

Of 168 patients operated colostomy closure, 118 (70.1%) were male and 50 (29.8%) were female. The age range of the cases was 20–88 years, and the mean age was 52.8 (SD: 15.6) years. The number of patients who underwent temporary colostomy was 283 and the rate of closure was 59.4%.

All patients underwent preoperative anesthesia examination at the Anesthesia outpatient clinics before the operation. 61 (36%) patients had an ASA score of 3. There were no patients undergoing operation with an ASA score of 4. Of the patients, 48 had DM, 52 had cardiac pathology, and 37 had respiratory pathologies requiring additional treatment as comorbidities.

Sixty-three (37.5%) patients underwent colostomy due to malignancy, 25 (14.9%) patients due to trauma, 40 (23.8%) due to diverticular perforation, 18 (10.7%) due to volvulus, and 22 (13.1%) due to other benign causes. When the first operations of patients who underwent a stoma closure operation were considered, 142 (84.5%) operations had been performed under emergency conditions and 26 (15.5%) had been performed under elective conditions. End-colostomy was the most commonly performed emergency operation, whereas sigmoidostomy was the most commonly performed operation under elective operations.

When patients with sigmoidostomy or transversostomy who underwent only stoma closure operation were compared in terms of incision types as local or laparotomy,

TABLE I - Difference of operation durations between operations performed with local incision and laparotomy

	Operation duration	P value
Laparotomy (n:6)	66.7±9.8	0.036*
Local incision(n:38)	54.1±13.6	

Independent sample t test, * $p < 0.05$

TABLE II - Distribution of end-colostomy closure according to anastomosis style and method

End ColostomY	Side to Side	End to Side	End to End	Unknown	Total
Circular Stapler	1	18	59	19	97
Linear Stapler	6	0	0	0	6
Manually	1	4	7	0	12
Total	8	22	66	19	115

TABLE III - Distribution of sigmoidostomy closure according to anastomosis style and method

SigmoidostomyY	Side To Side	End to Side	End to End	Total
Circular Stapler	0	1	5	6
Linear Stapler	11	0	0	11
Manually	0	1	22	23
Total	11	2	27	40

TABLE IV - Distribution of transversostomy closure according to anastomosis style and method

TransversostomyY	Side to Side	End To Side	End to End	Total
Circular Stapler	0	1	0	1
Linear Stapler	0	0	0	0
Manually	0	2	10	12
Total	0	3	10	13

TABLE V - Multivariate analysis of wound infection/evisceration

Wound Infection/Evisceration	B	P value
Age	-/	,44/56
Sex	-/	,56/54
Dm	4,4/14,8	,008*/0,003*
Cardiac Pathology	-/	,95/33
Respiratory Pathology	-/	,22/86
Additional Malignancy	-/	,72/79
Primer Malignancy	-/	,08/08
Closing Time ,3 Month(nterval)	-/	,85/39
Local Incision-Lapatotomy	-/	,87/96
Operation Time	-/	,57/54

a significant difference was found in terms of operation times and hospitalization periods ($P < 0.05$; Table I). Although stoma closure alone was performed in 146 patients (86.9%), colostomy closure+loop ileostomy was performed in five patients (3.0%), colonic resection+colostomy closure+loop ileostomy was performed in two patients (1.2%), colonic resection+colostomy closure was performed in 11 patients (6.5%), and colostomy closure+hepatic metastasectomy was performed in four patients (2.4%).

In total, end-to-end anastomosis was the most frequently preferred type of anastomosis in all colostomy types; end-to-end anastomosis with circular stapler was performed in end-colostomy, and manual end-to-end anastomosis was performed in sigmoidostomy and transversostomy closures (Tables II-IV). No statistically significant

difference was found between the groups in terms of anastomotic leakage when anastomotic closure method and shape were compared ($P > 0.05$).

In the postoperative period, the mean length of hospital stay was 7.6 (SD: 4.7) days, with a minimum of 4 days and a maximum of 35 days. Sixteen patients were admitted to the ICU for follow-up after surgery, and one patient was transferred to ICU due to pulmonary embolism on postoperative day 2. A total of 17 (10.1%) patients required an ICU follow-up.

Postoperative complications were observed in 36 patients (21.4%) and these complications consisted of wound infections in 27 (16%) patients, evisceration in 14 patients (8.3%), pulmonary complications requiring treatment change or rearrangement in six (3.6%) patients, passage problems in four (2.4%) patients (no stool passage over 5 days without anastomotic leakage), and anastomotic leakage in nine (5.3%) patients. One of the patients with anastomotic leakage was followed up conservatively and discharged after recovery without requiring operation. The other eight patients required reoperation for treatment. Five (2.98%) died in the postoperative period before discharge. The mean age of these patients was 78.2 (min: 65, max: 88, SD: 9.15) years, and all five patients had more than one serious comorbidities. Two of these patients died due to unpreventable septic shock caused by anastomotic leakage, one patient died due to massive pulmonary embolism, and two patients were receiving treatment for chronic cardiac and respiratory pathologies, and died due to acute cardiopulmonary arrest.

When the postoperative complications of colostomy closure operations were evaluated according to colostomy types, only one wound infection was observed in transversostomy closures and no other complications were observed. The most frequent complication both in end-colostomy and sigmoidostomy closures was wound infection (18 and 8, respectively). There was no significant difference between the groups in terms of the rate of complications ($P > 0.05$).

Six patients developed anastomotic leakage after end-colostomy closure, and three patients developed anastomotic leakage after sigmoidostomy closure operations. No statistically significant difference was found between stoma types in terms of the development of post-closure anastomotic leakage ($P > 0.05$).

Factors leading to wound infection after colostomy closure are shown in Table V; distribution and statistical evaluation of the factors causing anastomotic leakage after colostomy closure are shown in Table VI.

Discussion

Many studies have shown that patients undergoing stoma creation suffer from depression of various degrees, and among patients with similar diseases, depression is

TABLE VI - Statistical analysis of the factors that may cause anastomotic leakage (Mann Whitney U, Independent sample t test, ki-kare, *p<0,05)

Parameters	No Anastomotic leakage (n=159)	Anastomotic leakage (n=9)	P value
AGE (Mean±SD)	52,4±15,6	58,9±14,9	,23
Sex(M/F)	111/48	7/2	,46
DM (N,%)	42(%26,4)	6(%66,7)	,017*
Cardiac Pathology (N,%)	49(%30,8)	3(%33)	,87
Respiratory Pathology (N,%)	35(%22,0)	2(%22,2)	,98
Additional Malignancy (N,%)	14(%8,8)	0(%0,0)	,352
Primer Malignancy(N,%)	62(%39,0)	1(%11,1)	,15
Closing Time (Month±Sd)(Interval)	7,2±5,2	5±4,1	,06
Operation Time(minute±sd)	91,2±30,7	85,5±35,7	,62
CLOSURE (>3mounth)	147(%92,5)	6(%66,7)	,035*
Anastomosis Style (stapler)	115(%72,3)	6(%66,7)	,71
Anastomosis (end to end)	96(%68,6)	7(%77,8)	,28

significantly more severe in patients undergoing stoma creation¹⁴. This shows how important colostomy closure is for patients with colostomies. However, it must be remembered that colostomy closure is a colonic anastomosis. Although it is considered as a simple procedure, colostomy closure has been reported to have a very high morbidity and mortality rate. The number of publications reporting a morbidity rate below 15% is limited¹⁵. Mortality rate is reported to be 0%-4%¹⁶. However, complication rate of colostomy closure has been reportedly decreasing. Among the reasons explaining this situation, preoperative bowel preparation and delayed colostomy closure (2-3 months after the first operation) are reported as the most important factors^{15,16}.

In a study by Wheeler et al.¹⁷, the mortality rate of colostomy closure procedure was reported as 2.7%, and this rate was reported as 2.2% in the study of Knox et al.¹⁸, 1% in the study of Yajko et al.¹⁹, and 0% in the study of Pittman et al.²⁰. Mileski et al.²¹ reported that mortality was 4.8% after loop colostomy closure and 3.2% after end colostomy closure, indicating that no significant difference was found between mortality rates of both groups of patients.

In our series of patients, mortality rate is 2.98%, all patients are in the geriatric age group, and all patients are evaluated as ASA 3 in the preoperative examinations. The mean age of the patients is 78.2 years and they have more than one severe comorbidities. Two of these patients died because of unpreventable septic shock caused by anastomotic leakage, one patient had a known AF on therapy and was lost because of massive pulmonary embolism on the postoperative day 2. Two patients were receiving treatment for chronic cardiac and respiratory pathologies and were lost because of deterioration in general condition and subsequent cardiopulmonary arrest during their stay in the ICU and.

Despite the fact that mortality rates of colostomy closure operations, which are major surgical procedures,

tend to decrease with the improvement of surgical techniques, and even though there are studies reporting that this rate is zero, mortality risk should not be overlooked especially in geriatric patients with comorbidities. Although the mortality rate obtained in our study is still within the acceptable limits when compared to previous studies, we should be more selective in patient selection and narrowing the set of operable patients, especially for geriatric patients with comorbidities.

Studies on colostomy closure reveal that the main problem is postoperative morbidity. In the study of 179 patients performed by Knox et al.¹⁸, the rate of local complications was reported as 33%. It was emphasized that 41 (22.9%) patients developed anastomotic leakage, 13 (7%) patients underwent reoperation due to anastomotic leakage, and the rate of wound infection was 10%.

In the study by Yajko¹⁹, morbidity rate was 28%. Wound infection was the most frequently observed complication (10%), followed by transient ileus (7%), fecal fistula (4%), and intra-abdominal abscess (1%). Three of the patients who developed fistula had to undergo reoperation. In the statistical analysis, it was found that transient ileus was not associated with anastomosis technique.

In this study, Pittman²⁰ reported a complication rate of 33%, indicating that complication rates of proximal stoma closures with a primary diverticular disease are high. Pittman stated that there was no difference in terms of surgical complications in patients aged >60 years although the complication rate was high. In our study, there was no correlation between complications and age and gender. Bruns²² indicates that wound infection is more common in end-colostomy closures than in loop colostomies.

In the study by Berne²³ conducted on colostomies performed after trauma, it was stated that the complication rate increased as the duration of stoma closure

operation prolonged. Berne reported a complication rate of 32.5%.

In our series of patients, complications were found in 36 patients (21.4%) and these complications consisted of wound infections in 27 (16%) patients, evisceration in 14 (8.3%), pulmonary complications requiring treatment change or rearrangement in six (3.6%), passage problems in four (2.4%), and anastomotic leakage in nine (5.3%). Reoperation was required in the other eight patients. Our complication rate was lower than those reported by Berne, Pittman, Yajko, and Knox; and our wound infection rate was higher than that in the series of Knox and Yajko. Our anastomotic leakage rate was lower compared to the literature, whereas the requirement for surgical intervention for anastomotic leakage was found to be higher than that in other studies.

We have found that primary disease, stoma type, and stoma closure technique and shape do not affect the occurrence of local complications. This result is consistent with the study of Wheeler, and in contrast with the findings in the series reported by Bruns and Pittman. Bruns states that wound infection is more common in end colostomy closures compared to loop colostomies.

On the basis of the multivariate analysis we performed in our series, DM was found to be an independent risk factor for wound infection and evisceration (chi-square test, $P < 0.01$), and no other independent risk factors were identified ($P > 0.05$). Chu et al.²⁴ found no link between wound infection and DM, and reported that uncontrolled hypertension (HT) and high ASA scores increased the rate of infections. In our study, DM was also associated with anastomotic leakage. The results in regarding DM are not surprising. DM negatively affects both the immune and the cardiovascular system, is seen at a high rate above a certain age in our country, and is accompanied by various diseases such as the metabolic syndrome and HT. DM disrupts wound healing both by disturbing the immune system, and by causing circulatory disturbances and hypoxia because of angiopathy. One of the factors affecting anastomotic leakage was found to be early colostomy closure within 3 months. Pittman states that anastomotic leakage rate is higher when colostomies are closed within 2 months, and Wheeler states that the same is true for colostomies closed within 1 month. Knox reported that the complication rate was higher when colostomies were closed within 3 months in patients with stomas constructed due to a diverticular disease of the colon, and emphasized that the best closure time in these patients was 2-6 months after their creation (Table V).

In our study, colostomies closed by extraperitoneal local incision around the stoma showed a statistical advantage in terms of operation time and hospitalization duration than those closed by laparotomy. However, there was no significant relationship between the duration of operation and the development of complications (Table VI).

Although the risks of colostomy closure operations have already been mentioned, it is difficult to evaluate these patients because of the wide age range of these patients, different reasons for colostomy opening operations, and the use of various closure types and techniques. This sample includes both young trauma patients and elderly patients with malignancies and comorbidities. Considering the fact that all patients died in our study were aged >65 years and all had comorbidities, and that DM was identified as an independent risk factor for the development of complications, patients must be meticulously selected for surgery.

Another important question is the timing of colostomy closure. Studies indicate various intervals in the range of 1-6 months after creation. In our study, the high rate of leakage in anastomoses closed within 3 months indicates that closure should be performed at a later stage. The studies indicate high risk of distal loop atrophy and luminal narrowing with long waiting periods; however, the present study did not encounter such complications with a waiting period of 3 months to 5 years.

Conclusions

On the basis of the results of this study, keeping in mind the effects of colostomies on the psychology of patients, we conclude that opened colostomies should be closed after an appropriate duration without hesitation; however, care must be taken in patient selection, while keeping in mind that colostomy closure is a major surgical operation. Especially if the general condition of the patient allows, we may be able to save these patients from the mortality and morbidity risks associated with colostomy closure by forcing the chance of anastomosis formation during the initial surgery, in geriatric patients with comorbidities.

Riassunto

Lo scopo dello studio è la descrizione delle complicanze postoperatorie che possono osservarsi dopo la chiusura di una colostomia per definire possibili fattori di rischio per tali complicanze.

Sono stati studiati i pazienti sottoposti a colostomia nel Dipartimento di Chirurgia Generale "Education and Research Hospital Dr. Lutfi Kirdar Kartal" tra gennaio 2007 e gennaio 2015. Sono stati esclusi dallo studio i pazienti con ileo-colostomia a doppia canna, con colostomia di Devine e ciecostomia su tubo. Sono stati analizzati e confrontati i dati demografici, quelli relativi alla prima operazione e quelli riguardanti l'operazione di chiusura della colostomia.

Sono stati compresi 168 pazienti in totale, di cui 118 (70,1%) uomini dell'età media di $52,8 \pm 15,6$ anni. Le ragioni più comuni del ricorso alla colostomia erano sta-

te un tumore (n = 63 casi, pari al 37,5%) e la perforazione diverticolare (n=40 casi, pari al 23,8%). L'indicazione all'intervento era stata d'urgenza in 142 casi (84,5%). La colostomia terminale era il tipo più comune nei casi in emergenza, e la sigmoidostomia su bacchetta nei casi in elezione.

Una complicanza postoperatoria è stata osservata in 36 pazienti (21,4%). Nove pazienti (5,3%) hanno sviluppato una deiscenza anastomotica. Di questi in 8 casi (4,8%) è stato necessario un reintervento e in 1 caso (0,6%) la questione è stata risolta in modo conservativo. La mortalità postoperatoria si è avuta in 5 casi (2,9%).

All'analisi multivariata, il diabete mellito è risultato il fattore di rischio indipendente per l'infezione e l'eviscerazione del sito chirurgico (p <0,01). Diabete mellito era presente in 6 casi (66,7%) che avevano avuto una deiscenza anastomotica, la causa più comune rispetto ai non diabetici (p <0,05).

I pazienti restati in attesa della chiusura dello stoma per più di 3 mesi hanno presentato una maggiore incidenza di deiscenza rispetto a quelli in attesa inferiore ai 3 mesi (p <0,05).

Si conclude che la chiusura della colostomia ha una mortalità e una morbilità significative e il medico deve prestare maggiore attenzione nel follow-up postoperatorio nei pazienti che presentavano comorbilità, in particolare il diabete mellito.

References

- Cataldo PA: *Technical tips for stoma creation in the challenging patient*. Clin Colon Rectal Surg, 2008; 21:17-22.
- Erkücüük EV, Alabaz Ö, Karadağ A. et al.: *Stoma*. Alemdaroglu K, Akçal T, Buğra D. Editörler. Kolon Rektum ve Anal Bölge Hastalıkları. İstanbul: TKRCD, 2004; 309-29.
- Polat M, Akçay MN, Ertaş E, Çaldırcı M: *Kolostomi kapatmalarının morbidite ve mortalite yönünde retrospektif analizi*. Atatürk Üniversitesi Tıp Bülteni. 24; 679-86, 1992.
- Kaya E, Özgünç H, Yılmazlar T, Özen Y, Zorluoğlu A: *Ostomi kapatılması komplikasyonları*. Kolon ve Rektum Hast Derg, 4:78-82; 1994.
- Pearce NW, Scott S, Karan SJ: *Timing and method of reversal of Hartmann's procedure*. Br J Surg, 1992; 79:839-41.
- Banerjee S, Leather AJ, Rennin eAJ, Samano N, Gonzalez JG, Papagrigoriadis S: *Feasibility and morbidity of reversal of Hartmann's*. Colorectal Dis, 7; 2005, 454-59.
- Roig JV, Aguado M, Lluís F, García-Calvo R, Aguiló J, Hernandis J, Cantos M, Landete, Juan García-Armengol F: *Restoration of bowel continuity after emergency Hartmann's procedure* JCRC.10.14302/issn.2471-7061.jcrc-14-575.
- Dalmia S, Chan C: *MRCs Merit Research Journal of Medicine and Medical Sciences* (ISSN: 2354-323X) Vol. 3(3)79-83, March, 2015.
- De Ruiter P, Bijnen AB: *Successful local repair of paracolostomy hernia with a newly developed prosthetic device*. Int J Colorectal Dis, 1994; 9:165.
- Leslie D: *The parastomal hernia*. Surg Clin North Am, 1984; 64:407-15.
- Cheung MT: *Complications of an abdominal stoma: an analysis of 322 stomas*. Aust N Z J Surg, 1995; 65:808-11.
- Pearl RK: *Parastomal hernias*. World J Surg, 1989; 13:569-72.
- Husain SG, Cataldo TE: *Late stomal complications*. Clin Colon Rectal Surg, 2008; 21:31-40.
- Yamaner YS: *Stoma, Stoma Komplikasyonları ve Bakımı*. İ.Ü. Genel Cerrahi, Kalaycı G. 132;1453-1470, 2002.
- Keigley MRB, Williams NS: *Surgery of the anus, rectum and colon chapter*. 1993; 8-9.
- Altomare DF, Pannarale OC, Lupo L, et al.: *Protective colostomy closure: The hasards of a minor operation*. Int J Colorectal Dis, 1990; 5:73-78.
- Wheeler MH, Barker J: *Closure of colostomy. A safe Prosedure?* Dis. Colon Rectum. 1977; 20:29-32.
- Knox AJ, Birkett FD, Collins CD: *Closure of colostomy*. Br J Surg, 1971; 58:669-72.
- Yajko RD, Morton LW, Bleomendal L & Eiseman B: *Morbidity of colostomy closure*. Am J Surg, 1976; 132:304-06.
- Pittman DM, Smith LE: *Complications of colostomy closure*. Dis Colon Rectum, 1985; 28:836-43.
- Mileski WJ, Rege RV, Joehl RJ, et al.: *Rates of Morbidity and Mortality after closure of loop and colostomy*. Surg Gynecol Obs, 1990; 171:17-21.
- Bruns BR, DuBose J, Pasley J, Kheirbek T, Chouliaris K, Riggle A, Frank MK, Phelan HA, Holena D, Inaba K, Diaz J, Scalea TM: *Loop versus end colostomy reversal: Has anything changed?* Eur J Trauma Emerg Surg, 2015; 41:539-43.
- Berne JD, Velmahos GC, Chan LS, Asensio JA, Demetriades D: *The high morbidity of colostomy closure after trauma: further support for the primary repair of colon injuries*. Surgery,1998;123(2):157-64.
- Daniel I. Chu & Christopher R. Schlieve & Dorin T. Colibaseanu & Paul J. Simpson PJ, Wagie & Cima RR ,Habermann EB: *Surgical Site Infections (SSIs) After Stoma Reversal AE: Risk Factors, Implications, and Protective Strategies*. J Gastrointest Surg, 2014; 10.1007/s11605-014-2649-3.