

Emergency presentation of abdominal wall hernias: Factors affecting resections and surgical-site complications in complex acute scenarios

Presentación de emergencia de las hernias de la pared abdominal: factores que afectan las resecciones y las complicaciones del sitio quirúrgico en escenarios agudos complejos

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Abstract

Objective: Abdominal wall hernias (AWH) may turn into a complex condition in terms of emergency. This study aims to evaluate the factors which may lead emergency AWH operation to complex surgery. **Materials and methods:** Univariate and multivariate regression analysis is performed to determine independent factors affecting tissue resection, bowel resection, and surgical-site complications. **Results:** The type of hernia, time, and content of hernia are independent factors for tissue resection. The time elapsed from the onset of complaints to surgery and comorbid diseases are independent factors for bowel resection. Similarly, the time elapsed from the onset of complaints to surgery and bowel presence in hernia is independent risk factors for surgical-site complications. **Conclusion:** Patients who are operated later than 6 h after the onset of complaints and have comorbidity are more complex surgery.

Keywords: Hernia. Emergency. Acute. Complex surgery.

Resumen

Objetivo: Las hernias de la pared abdominal pueden convertirse en un cuadro complejo en términos de urgencia. Este estudio tiene como objetivo evaluar los factores que pueden llevar a una operación de hernia de la pared abdominal de emergencia a una cirugía compleja. **Materials y métodos:** Se realiza un análisis de regresión univariado y multivariado para determinar los factores independientes que afectan la resección de tejido, la resección intestinal y las complicaciones del sitio quirúrgico. **Resultados:** El tipo de hernia, el tiempo y el contenido de la hernia son factores independientes para la resección del tejido. El tiempo transcurrido desde el inicio de las molestias hasta la cirugía y las enfermedades comórbidas son factores independientes para la resección intestinal. Del mismo modo, el tiempo transcurrido desde el inicio de las molestias hasta la cirugía y la presencia de intestino en la hernia son factores de riesgo independientes para las complicaciones del sitio quirúrgico. **Conclusión:** Los pacientes que son operados después de las seis horas del inicio de las molestias y presentan comorbilidad son cirugías más complejas.

Palabras clave: Hernia. Emergencia. Aguda. Cirugía compleja.

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Introduction

Abdominal wall hernia (AWH) is the most commonly diagnosed condition in general surgery wards^{1,2}. Conditions such as constipation, prostatism, coughing due to respiratory diseases, and abdominal wall weakness may play an essential role in developing AWHs³⁻⁵. AWH repair is a fundamental and standard surgical procedure, but the prevalence of patients with hernia who require emergent operation varies between 0.5% and 15%⁶⁻⁹. Even though emergency operations are not preferred, and protocols are being performed to lower for discarding emergent surgery because of high morbidity and mortality of complicated hernia, in most cases emergent surgery is inevitable^{10,11}.

An incarcerated inguinal hernia term is one in which the contents are no longer reducible, and the term strangulation accommodates for ischemic contents¹². Even though we are in an era based on high technology and technological improvement, patient-related factors are still yielding to increased mortality in patients who have strangulated AWH and need emergent surgery like in the past decades regardless of developed and underdeveloped countries^{11,13-16}. There is no alternative treatment of hernia; operation should be held as soon as possible in emergent situations; morbidity and mortality rates of incarcerated AWH are higher than elective surgery¹⁰. Even though most surgeons are familiar with the abdominal wall anatomy, surgeons can struggle with unexpected bowel or other tissue resections in complex acute scenarios. These cases tend to be more complicated due to resections and increased complications after the surgery. This study aims to evaluate factors leading a simple emergency case to a complex acute scenario, which involves resection of tissues and surgical-site complications with demonstrating 5-year experience on the patients admitted to emergency surgery. In the light of these findings, our study intends to guide surgeons to be aware of risk patients for intraoperative and post-operative incidents.

Methods

Human and animal rights

Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects."

Informed consent

Patients were informed in detail and informed consent was obtained from the patients to use the data.

Ethical approval

The study was approved by University of Health Sciences - Antalya Education and Research Hospital's Ethical Committee.

Sample

Medical records of the 103 patients, who were operated in a tertiary hospital's emergency ward for incarcerated AWH in a 5-year period, collected from the hospital's database retrospectively. Indication for the operation was decided by the presence of symptoms such as pain, irreducibility, vomiting, and signs of intestinal obstruction in plain abdominal X-ray. For patients in whom a clinical diagnosis could not be established, imaging studies such as abdominal ultrasound or computerized tomography were performed. Pregnant or cirrhotic patients are excluded from the study.

Anesthesia type was determined according to the patient's choice, co-morbidity, American Society of Anesthesiologists (ASA) score, and surgeons' preference. All patients were given a standard dose of appropriate antibiotics before surgery and an additional dose applied if the operation time exceeds. Patients who were clinically stable, afebrile, has audible bowel sound and could tolerate diet have been discharged. The demographic data consist of age, gender, ASA score, co-morbidity (diabetes mellitus, chronic obstructive pulmonary diseases, coronary artery disease, and hypertension), and type of hernia were recorded. Other information such as type of repair, the content of hernia (whether if there is any intestinal segment, omental tissue or additional intra-abdominal organ), presence of strangulation, total time elapsed from the onset of complaints till to surgery (≤ 6 h or > 6 h), post-operative surgical-site complications, type of anesthesia, all types of tissue resections (ATR) (cases in which any of the omental tissue, intestine, and other tissues were resected), bowel resection (BR) (cases in which bowel resection occurred with or without any additional tissue), intensive care unit needs, and mortality were also recorded for further analysis. All the data collected are documented through Office

365 Excel worksheet version 16.41 (Microsoft Corp, Redmond, Washington).

Statistical analysis

All statistical analysis was carried out using JMP version 15.1 (SAS Institute Inc., Cary, North Carolina, 1989-2019). Descriptive statistical results (mean, standard deviation (SD), standard error of the mean (SEM), frequency, percent, minimum, and maximum) were used to evaluate the study data. Independent samples t-test, Wilcoxon test, and Fisher exact test were used to compare the variables of groups for univariate analysis. Multivariate regression analysis is performed to determine independent factors affecting ATR, BR, and surgical-site complications. $p < 0.05$ was accepted as statistically significant.

Results

A total of 103 patients operated with a diagnosis of incarcerated AWH consisting of 44 ventral and 59 groin hernia. Groin hernias were more common in male patients ($p < 0.001$). Mean \pm SEM (range) age of the patients was 61.5 ± 1.5 (18-89) years. Fifty-five (53%) patients were male and 48 (47%) were female. Among all groin hernias, 50 were inguinal and nine were femoral. Among all ventral hernias, 30 were umbilical, 13 were incisional, and one was Spigelian. Sixty-six (64%) patients underwent surgery in < 6 h and 37 (36%) patients underwent surgery after 6 h since the complaints have started. ATR observed in 21 out of 66 patients (32%) who were operated before 6 h since the symptoms started, and 27 out of 37 (73%) patients operated after 6 h since the symptoms started; and resection was observed significantly more in > 6 h group ($p < 0.001$). Ventral hernias ($n = 36$ (82%)) were more prone to strangulation than groin (23 (39%)) hernias ($p < 0.001$). ATR and BR were more common in ventral hernias ($p < 0.001$). Surgical-site infection was also more frequent in ventral hernias ($p = 0.003$). Two patients (2%) who were diagnosed as ventral hernia (one patient was diagnosed as stage 4 colon carcinoma and the other was metastatic gastric cancer) had transferred to the intensive care unit (ICU) and passed away in ICU after surgery. Other demographic details are shown in table 1.

Among all cases, 48 patients (33 ventral and 15 groin) underwent tissue resection consisting of 27 omental tissue, ten omental tissue and bowel, eight small bowel, two large bowel resection, and an

appendix. Details of the resected tissues are shown in table 2.

Twenty-five patients (17 ventral and 8 groin) had surgical-site related complications presented as nine seroma, ten surgical-site infections, and six hematoma details are also shown in table 3.

According to univariate analysis, gender ($p < 0.001$), type of hernia ($p < 0.001$), the time from the onset of complaints to surgery ($p < 0.001$), and content of hernia ($p < 0.001$) were risk factors that is responsible for ATR. Furthermore, gender ($p = 0.013$), age ($p = 0.046$), the time from the onset of complaints to surgery ($p < 0.001$), and co-morbid diseases ($p = 0.002$) were risk factors for BR. Age ($p < 0.001$), type of hernia (0.003), the time from the onset of complaints to surgery ($p < 0.001$), and co-morbid disease presence ($p < 0.001$) were risk factors for surgical-site complications.

Multivariate analysis revealed that the time from the onset of complaints to surgery was an independent risk factor for ATR ($p < 0.001$), BR ($p = 0.004$), and surgical-site complications ($p = 0.01$). Type of hernia was an independent risk factor for ATR ($p = 0.001$) and surgical-site complications ($p = 0.002$). Co-morbid disease presence was an independent risk factor for BR ($p = 0.007$), and surgical-site complications ($p < 0.001$). The content of hernia was an independent risk factor for ATR ($p = 0.005$). Details of univariate and multivariate regression analysis are shown in tables 4 and 5.

Discussion

Inguinal hernias account for 75% of AWHs, with a lifetime risk of 27% in men, and 3% in women¹. There are plenty of surgical repair modalities, whether laparoscopic or open technique of AWH¹⁷⁻²⁰. The hernia sac may contain different tissues varying from any abdominal tissue to metastasis of any malignant tissue^{21,22}. The literature mentions that an inguinal hernia's incarceration probability is 4.5% for 2 years after diagnosis. The complication risk is higher in femoral hernias with a 22% cumulative probability at 3 months and 45% at 21 months²³⁻²⁵. Painful swelling located on the hernia site, abdominal distension, nausea, and vomiting are the most frequently observed symptoms. European Hernia Society Guideline recommends emergent surgical repair in case of symptomatic inguinal hernia. In contrast, if patients do not complain about any symptoms, surgical repair may be postponed, and early elective treatment may be an option^{2,10}. Postpone of surgery may result in incarceration on some elderly patients; therefore, elective surgical repair is suggested

Table 1. Demographic values of emergency hernias

	All (n = 103)	Ventral (n = 44)	Groin (n = 59)	p
Gender (M-F), n*	55 (53%)-48 (47%)	12 (27%)-32 (73%)	43 (73%)-16 (27%)	< 0.001
Age, years*	61.5 ± 1.5 (18-89)	62.1 ± 2 (36-84)	61.1 ± 2.1 (18-89)	0.87
Type of hernia, n				
Groin				
Inguinal	50	N/A	50	
Femoral	9	N/A	9	
Ventral				
Umbilical	30	30	N/A	
Incisional	13	13	N/A	
Spigelian	1	1	N/A	
Co-morbidity, n	54 (52%)	25 (57%)	29 (49%)	0.44
ASA score, n				
≤ 2	76 (74%)	31 (71%)	45 (76%)	
> 2	27 (26%)	13 (30%)	14 (24%)	
Anesthesia type, n				< 0.001
General	66 (64%)	43 (98%)	23 (39%)	
Regional	37 (36%)	1 (2%)	36 (61%)	
Time elapsed from the onset of complaints to surgery, n				0.09
≤ 6 h	66 (64%)	24 (55%)	42 (71%)	
> 6 h	37 (36%)	20 (45%)	17 (29%)	
Time related tissue resection, n				0.1
≤ 6 h resected cases	21 (32%)	17 (71%)	4 (10%)	
> 6 h resected cases	27 (73%)	16 (80%)	11 (65%)	
Type of repair, n				0.38
Primary	28 (27%)	10 (23%)	18 (31%)	
Mesh	75 (73%)	34 (77%)	41 (70%)	
Content of hernia, n				< 0.001
Bowel	53 (51%)	11 (25%)	42 (71%)	
Bowel+omentum tissue	10 (10%)	8 (18%)	2 (3%)	
Other**	40 (39%)	25 (57%)	15 (25%)	
Strangulated cases, n	59 (57%)	36 (82%)	23 (39%)	< 0.001
Bowel resection (BR), n	16 (16%)	8 (18%)	8 (14%)	0.52
Other** resected tissues, n	38 (27%)	30 (68%)	8 (14%)	< 0.001
All types of tissue resection (ATR),*** n	48 (47%)	33 (75%)	15 (25%)	< 0.001
Post-operative surgical-site complication, n	25 (24%)	17 (39%)	8 (14%)	0.003
Intensive care unit need, n	8 (7.8%)	4 (9%)	4 (7%)	0.67
Mortality, n	2 (2%)	2 (5%)	0 (0%)	0.1

*Continuos data is presented as (mean ± standard error of the mean [SEM] [range]); **Other include omental tissue and appendix; ***ATR includes omentum, bowel and appendix individually or together. *Ventral hernia is female, groin hernia is male dominant. M-F = male-female.

as soon as possible²⁶. Emergent surgery of hernias come up with significantly increased post-operative complications and less favorable outcomes^{8,27}.

According to our data, emergency cases are mostly male. The content of hernia was mostly presented with intestinal tissue in groin hernia and omental tissue in ventral hernias. Ventral hernias are more tend to

strangulate, be resected, and lead to surgical-site complications. In a study carried out with 182 patients operated with the diagnosis of incarcerated AWH by Derici et al. revealed that the rate of intestinal resection in patients with incarcerated incisional and femoral hernias was slightly higher than that in patients with other types of incarcerated AWHs, but there was no

Table 2. Distributions of resected tissues

Tissue	All (n = 48)	Ventral (n = 33)	Groin (n = 15)
Small bowel, n	8 (17%)	3 (9%)	5 (33%)
Colon, n	2 (4%)	-	2 (13%)
Omental tissue, n	27 (56%)	22 (67%)	5 (33%)
Omental tissue + Bowel, n	10 (21%)	8 (24%)	2 (13%)
Appendix, n	1 (2%)	-	1 (7%)

Table 3. Distribution of surgical-site complications

Complication	All (n = 25)	Ventral (n = 17)	Groin (n = 8)
Seroma, n	9 (36%)	6 (35%)	3 (37.5%)
Surgical-site infection, n	10 (40%)	7 (41%)	3 (37.5%)
Hematoma, n	6 (24%)	4 (24%)	2 (25%)

significant difference detected²⁸. In our study, we have reached a similar conclusion for BR in groin hernias, but ATR was significantly higher in ventral cases.

According to univariate analysis, gender (female), type of hernia (ventral), time since the starting of complaints to surgery (after 6 h), and content of hernia (omental tissue) are risk factors for ATR in emergent AWH. In a similar study performed by Ozkan et al. carried out with 190 patient showed that advanced age (≥ 65 years), concomitant disease, strangulation, necrosis, high ASA score (III-IV), time from the onset of symptoms, and time to hospital admission were found to have significant influences on morbidity and mortality²⁹. Even though gender was a risk factor for resection of tissue, it was not an independent risk factor in multivariate regression analysis. Multivariate regression analysis revealed that type of hernia, content of hernia, and the time from the onset of complaints to surgery are the independent risk factors for ATR in emergent AWH.

Factors that affect bowel resection have also been evaluated. BR presence leads surgery to a more complex and risky case for the patient and the surgeon. Gender (female), age (older patients), the time from the onset of complaints to surgery (> 6 h), and co-morbidity were risk factors for BR due to univariate analysis. The time from the onset of complaints to surgery was also an independent risk factor for BR like ATR, whereas co-morbidity presence was an independent risk factor for BR only. We hypothesized

settling of necrosis in intestinal tissue is more likely to occur on chronic disease presence and older ages. Interestingly contrary to our hypothesis, age was not an independent risk factor for the BR; nevertheless, we think 0.06 p-value for age in multivariate analysis supports our hypothesis. A meta-analysis consisting of seven studies published in 2020 which evaluated risk factors for BR among patients with incarcerated groin hernias, pointed out eight factors were significantly related to the risk of BR: female sex, age, femoral hernia, bowel obstruction, duration of incarceration, white blood cell count, and neutrophilic leukocyte count³⁰⁻³².

Surgical-site complications tend to be more observed in emergency cases^{28,33,34}. Older patients, ventral hernia patients, patients who operated after more than 6 h since the onset of complaints, and co-morbidity are risk factors of surgical-site complications due to univariate analysis. Content of hernia was not affecting the surgical-site complications; we think the reason is surgeons more tend to use broad-spectrum antibiotics and try to avoid prosthetic materials in BR cases. According to multivariate regression analysis, type of hernia (ventral hernia) is an independent risk factor for surgical-site complications. We assume that ventral hernias are more likely to have a flap of skin and tend to be larger; so, they are more likely to cause hematoma and seroma. Time was another independent risk factor for surgical-site complication; we assume this is caused by bacterial translocation caused by micro-perforations on ischemic bowel and necrosis of the tissue due to prolonged waiting time³⁵⁻³⁷. Hospitalization should be done immediately to avoid any resection and postoperative complications when incarceration is detected. Similarly to us, some of the papers point out BR will increase postoperative complication³⁸.

According to a study performed by Kurt et al. on 106 patients who underwent emergent surgery for strangulated hernia comparing resection performed cases to unreseected cases shows that resected cases are more tend to be infected, but there was no difference in mortality⁸. In another study performed by Dai et al. on 64 patients who underwent emergent surgery for groin hernias mentions diabetes mellitus was an independent risk factor of postoperative complications for incarcerated groin hernia, along with chronic obstructive pulmonary disease, intestinal necrosis, and general anesthesia associated with incisional complications³⁹. Postoperative complications like surgical-site infection, seroma, and hematoma reduce the patients' comfort. Surgical-site infections may also lead to removal of the mesh or recurrence in some

Table 4. Univariate analysis of complicated hernia affecting factors (p-value)

	All types of tissue resections ATR (*)	Bowel resection (BR)	Surgical-site complications
Gender**	< 0.001	0.013	0.28
Age	0.35	0.046	< 0.001
Type of hernia	< 0.001	0.521	0.003
The time elapsed from the onset of complaints to surgery ($\leq 6 - > 6$ h)	< 0.001	< 0.001	< 0.001
Co-morbidity	0.06	0.002	< 0.001
Content of hernia	< 0.001	-	0.8

*All types of tissue resection (ATR) includes omentum, bowel, and appendix individually or together. **Female.

Table 5. Multivariate analysis of complicated hernia affecting factors (p-value)

	All types of tissue Resections ATR (*)	Bowel resection (BR)	Surgical-site complications
Gender	0.42	0.07	0.15
Age	0.07	0.06	0.46
Type of hernia**	0.001	0.37	0.002
The time from the onset of complaints to surgery ($\leq 6 - > 6$ h)	< 0.001	0.004	0.01
Co-morbidity	0.09	0.007	0.2
Content of hernia	0.005	-	0.47

*All types of tissue resection (ATR) includes omentum, bowel and appendix individually or together. **Ventral hernia.

cases. However, there's no statistical difference in postoperative complications regarding mesh utilization or primary repair in the literature^{33,34,40}.

This research has some limitations. As this is a retrospective study, it naturally has the disadvantages of a retrospective study. Also, patient's complaint is a subjective data, which is based on the patient's feelings of discomfort and commonly may not give the exact time for the start of incarceration due to pain threshold difference in patients. Even though this study is based on 5 years of emergency experience consisting of 103 patients, this data and conclusions may be supported with larger series of patients. The threshold of the total time elapsed from the onset of symptoms to surgery is a debated topic. Many experimental ischemic bowel studies' time threshold for bowel ischemia varies 30 min to 12 h^{35,36,41,42}, but in clinical practice, none of the patients are able to be operated on in under 3-4 h due to patient-related factors. The general teaching is that intestinal infarction can occur within 6 h of mesenteric occlusion⁴³. Therefore, in this study we used 6 h as the threshold for the analysis.

Conclusions

All AWHs should be operated electively as soon as possible, whether cause symptoms or not, to reduce emergency surgery risk. Patient-related factors we studied in this paper (age, type of hernia, the time elapsed from the onset of complaints to surgery, co-morbid disease presentation, and content of hernia) are inevitable risk factors for the surgeon and may cause resection of intra-abdominal tissue and undesired complications. This study demonstrates type of hernia, time elapsed from the onset of symptoms, and content of hernia are independent factors for ATR. Time and comorbid disease presentation are independent factors for BR.

Throughout these findings, the time elapsed from the onset of complaints to surgery and bowel presence in hernia is independent risk factors for surgical-site complications. Patients with these attributes tend to be complicated, so surgeons must take extra caution and be prepared for complex consequences.

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Conflicts of interest

All authors declare that they have no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

References

- Kingsnorth A, LeBlanc K. Hernias: inguinal and incisional. *Lancet*. 2003;362:1561-71.
- Birindelli A, Sartelli M, Di Saverio S, Coccolini F, Ansaldi L, van Ramshorst GH, et al. 2017 update of the WSES guidelines for emergency repair of complicated abdominal wall hernias. *World J Emerg Surg*. 2017;12:37.
- Abrahamson J. Etiology and pathophysiology of primary and recurrent groin hernia formation. *Surg Clin North Am*. 1998;78:953-72.
- Urschel JD, Scott PG, Williams HT. Etiology of late developing incisional hernias-the possible role of mechanical stress. *Med Hypotheses*. 1988;25:31-4.
- Pilkington JJ, Zahid MS, Fullwood C, Boersma D, Van Geffen E, Sheen AJ. Contemporaneous evaluation of inguinal hernia causation: a European perspective. *Hernia*. 2020;24:591-9.
- Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg*. 2004;240:205.
- Alvarez JA, Baldonado RF, Bear IG, Solis JA, Alvarez P, Jorge JI. Incarcerated groin hernias in adults: presentation and outcome. *Hernia*. 2004;8:121-6.
- Kurt N, Oncel M, Ozkan Z, Bingul S. Risk and outcome of bowel resection in patients with incarcerated groin hernias: retrospective study. *World J Surg*. 2003;27:741-3.
- Helgstrand F, Rosenberg J, Kehlet H, Bisgaard T. Outcomes after emergency versus elective ventral hernia repair: a prospective nationwide study. *World J Surg*. 2013;37:2273-9.
- Malek S, Torella F, Edwards PR. Emergency repair of groin herniae: outcome and implications for elective surgery waiting times. *Int J Clin Pract*. 2004;58:207-9.
- Nilsson H, Stylianidis G, Haapamäki M, Nilsson E, Nordin P. Mortality after groin hernia surgery. *Ann Surg*. 2007;245:656.
- Karatas T, Ozbag D, Karlioz M. Retrospective analysis of inguinal femoral hernias. *Med Sci Int Med J*. 2020;9:86.
- Primatesta P, Goldacre MJ. Inguinal hernia repair: incidence of elective and emergency surgery, readmission and mortality. *Int J Epidemiol*. 1996;25:835-9.
- Kulah B, Duzgun AP, Moran M, Kulacoglu IH, Ozmen MM, Coskun MF. Emergency hernia repairs in elderly patients. *Am J Surg*. 2001;182:455-9.
- Musbahi A, Abdulhannan P, Nugud O, Garud T. Inguinal hernia repair in patients under and over 65 years of age: a district general hospital experience. *S Afr J Surg*. 2020;58:22-6.
- Ohana G, Manevitch I, Weil R, Melki Y, Seror D, Powsner E, et al. Inguinal hernia: challenging the traditional indication for surgery in asymptomatic patients. *Hernia*. 2004;8:117-20.
- Sikar HE, Cetin K, EYVAZ K, Altin Ö, Kaya S, Gökceimam M, et al. Lateral sided trocar site hernia following laparoscopic hernia repair: results of a long-term follow-up. *Hernia*. 2019;23:101-6.
- Aiolfi A, Cavalli M, Micheletto G, Lombardi F, Bonitta G, Morlacchi A, et al. Primary inguinal hernia: systematic review and Bayesian network meta-analysis comparing open, laparoscopic transabdominal preperitoneal, totally extraperitoneal, and robotic preperitoneal repair. *Hernia*. 2019;23:473-84.
- Collaboration EH. Laparoscopic compared with open methods of groin hernia repair: systematic review of randomized controlled trials. *Br J Surg*. 2000;87:860-7.
- Sikar HE, Cetin K, EYVAZ K, Gökceimam M, Kaptanoglu L, Küçük HF. Evaluation of the effects of absorbable and nonabsorbable tacks on laparoscopic suprapubic hernia repair: a retrospective cohort study. *Int J Surg*. 2019;63:16-21.
- Topal U, Gok M, Akyuz M, Oz AB, Arikan TB, Solak İ, et al. Is Histopathological evaluation of hernia sacs necessary? *Arch Iran Med*. 2020;23:403-8.
- Gurer A, Ozdogan M, Ozlem N, Yildirim A, Kulacoglu H, Aydin R. Uncommon content in groin hernia sac. *Hernia*. 2006;10:152-5.
- Gallegos NC, Dawson J, Jarvis M, Hobsley M. Risk of strangulation in groin hernias. *Br J Surg*. 1991;78:1171-3.
- List of Elderly Risk Assessment and Surgical Outcome (ERASO) Collaborative Study Group endorsed by SICUT, ACOI, SICG, SICE, and Italian Chapter of WSES, Ceresoli M, Carrissimi F, Nigro A, Fransvea P, Lepre L, Braga M, et al. Emergency hernia repair in the elderly: multivariate analysis of morbidity and mortality from an Italian registry. *Hernia*. 2020;26:165-75.
- Gonzalez-Urquijo M, Tellez-Giron VC, Martinez-Ledesma E, Rodarte-Shade M, Estrada-Cortinas OJ, Gil-Galindo G. Bowel obstruction as a serious complication of patients with femoral hernia. *Surg Today*. 2020;51:738-44.
- Nicholson S, Keane TE, Devlin HB. Femoral hernia: an avoidable source of surgical mortality. *Br J Surg*. 1990;77:307-8.
- Oishi SN, Page CP, Schwesinger WH. Complicated presentations of groin hernias. *Am J Surg*. 1991;162:568-71.
- Derici H, Unalp HR, Bozdag AD, Nazli O, Tansug T, Kamer E. Factors affecting morbidity and mortality in incarcerated abdominal wall hernias. *Hernia*. 2007;11:341-6.
- Özkan E, Yıldız MK, Çakır T, Dulundu E, Eriş C, Fersahoglu MM, et al. Incarcerated abdominal wall hernia surgery: relationship between risk factors and morbidity and mortality rates (a single center emergency surgery experience). *Ulus Travma Acil Cerrahi Derg*. 2012;18:8.
- Ge BJ, Huang Q, Liu LM, Bian HP, Fan YZ. Risk factors for bowel resection and outcome in patients with incarcerated groin hernias. *Hernia*. 2010;14:259-64.
- Chen P, Huang L, Yang W, He D, Liu X, Wang Y, et al. Risk factors for bowel resection among patients with incarcerated groin hernias: a meta-analysis. *Am J Emerg Med*. 2020;38:376-83.
- Chen P, Yang W, Zhang J, Wang C, Yu Y, Wang Y, et al. Analysis of risk factors associated bowel resection in patients with incarcerated groin hernia. *Medicine (Baltimore)*. 2020;99:e20629.
- Bessa SS, Abdel-Razek AH. Results of prosthetic mesh repair in the emergency management of the acutely incarcerated and/or strangulated ventral hernias: a seven years study. *Hernia*. 2013;17:59-65.
- Venara A, Hubner M, Le Naoures P, Hamel JF, Hamy A, Demartines N. Surgery for incarcerated hernia: short-term outcome with or without mesh. *Langenbecks Arch Surg*. 2014;399:571-7.
- Simpson R, Alon R, Kobzik L, Valeri CR, Shepro D, Hechtman HB. Neutrophil and nonneutrophil-mediated injury in intestinal ischemia-reperfusion. *Ann Surg*. 1993;218:444-54.
- Wang F, Li Q, Wang C, Tang C, Li J. Dynamic alteration of the colonic microbiota in intestinal ischemia-reperfusion injury. *PLoS One*. 2012;7:e42027.
- Zhi-Yong S, Dong YL, Wang XH. Bacterial translocation and multiple system organ failure in bowel ischemia and reperfusion. *J Trauma*. 1992;32:148-53.
- Rai S, Chandra SS, Smile SR. A study of the risk of strangulation and obstruction in groin hernias. *Aust N Z J Surg*. 1998;68:650-4.
- Dai W, Chen Z, Zuo J, Tan J, Tan M, Yuan Y. Risk factors of postoperative complications after emergency repair of incarcerated groin hernia for adult patients: a retrospective cohort study. *Hernia*. 2019;23:267-76.
- Mann DV, Prout J, Havranek E, Gould S, Darzi A. Late-onset deep prosthetic infection following mesh repair of inguinal hernia. *Am J Surg*. 1998;176:12-4.
- Kubes P, Hunter J, Granger DN. Ischemia/reperfusion-induced feline intestinal dysfunction: importance of granulocyte recruitment. *Gastroenterology*. 1992;103:807-12.
- Tanaka N, Uchida N, Ogihara H, Sasamoto H, Kato H, Kuwano H. Clinical study of inguinal and femoral incarcerated hernias. *Surg Today*. 2010;40:1144-7.
- Brown CV, Inaba K, Martin MJ, Salim A, editors. *Emergency General Surgery: a Practical Approach*. Cham: Springer International Publishing; 2019.