ORIGINAL ARTICLE

Splenic lacerations: a retrospective analysis of management strategies and clinical outcomes

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ABSTRACT

BACKGROUND: Splenic injuries are among the most frequently encountered conditions in abdominal trauma. In such cases, the treatment approach must be carefully determined based on the patient's hemodynamic stability, the severity of the injury, and the presence of associated intra-abdominal pathologies, typically requiring a choice between non-operative management (NOM) and surgical intervention. The decision-making process is primarily guided by hemodynamic status, injury grade, and imaging findings. This study evaluates clinical outcomes and the factors influencing treatment decisions in patients with splenic rupture who were referred from the emergency department to the general surgery unit.

METHODS: A retrospective cohort study was conducted on 42 patients diagnosed with splenic injury between June 2023 and February 2025. Patients were divided into two groups: those who received NOM (n=29, 69.0%) and those who underwent operative management (OM) (n=13, 31.0%). Demographics, mechanisms of injury, hemodynamic status, laboratory results, imaging findings, transfusion requirements, length of hospital stay, and mortality rates were analyzed. Statistical comparisons were made using appropriate tests, with significance set at $p<0.05$.

RESULTS: The mean age of patients was 38.3±19.4 years, with 76.2% being male. The leading cause of injury was vehicular accidents (47.6%), followed by falls (21.4%) and penetrating trauma (11.9%). Operative management was more common in sharp object penetrating injuries (SOPI) (15.4%) and gunshot wounds (7.7%). Hemodynamic instability was more frequent in the OM group compared to the NOM group (30.8% vs. 10.3%, p=0.149). Splenectomy was performed in 76.9% of surgical cases (p=0.003). Computed tomography (CT) imaging revealed that Grade 1 injuries (55.2%) were predominant in the NOM group, while Grade 2 injuries (38.5%) were more common in the OM group (p=0.531). The OM group required more blood transfusions (2.6±3.0 units vs. 0.9±1.9 units, p=0.053) and had longer hospital stays (10.3±6.9 days vs. 5.7±4.9 days, p=0.042). Overall mortality was low (9.5%), with no significant difference between the groups (p=0.819).

CONCLUSION: Non-operative management is the preferred approach for hemodynamically stable patients, offering favorable outcomes and shorter hospital stays. However, penetrating trauma and hemodynamic instability are strong predictors for surgical intervention. Early risk stratification and close clinical monitoring are essential in determining the most appropriate treatment strategy for splenic injuries.

Keywords: Splenic injury; trauma; non-operative management; splenectomy; emergency surgery.

INTRODUCTION

Splenic injuries are the most common solid organ injuries in blunt abdominal trauma, accounting for up to 32% of abdominal injuries.[1] Traditionally, the primary treatment for splenic trauma was splenectomy, aimed at preventing hemorrhagic complications.[2] Non-operative management (NOM) is

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a treatment approach that involves managing splenic injuries without surgery, particularly in patients who are hemodynamically stable, that is, those whose blood pressure and heart rate are within normal ranges. This approach seeks to avoid the risks associated with surgical intervention while ensuring careful monitoring of the patient's condition. However, growing awareness of the spleen's role in immune function and the risk of infection following splenectomy has shifted the focus toward NOM.[3]

Current guidelines recommend NOM for hemodynamically stable patients, with reported success rates ranging from 80% to 90%.[4,5] The American Association for the Surgery of Trauma (AAST) grading system, along with computed tomography (CT) imaging, plays a key role in assessing injury severity and guiding treatment decisions.[6,7] However, the presence of vascular injury, pseudoaneurysms, or the need for blood transfusions are among the main predictors of NOM failure.[8,9]

Despite advances in trauma care, delayed surgical intervention may still be required in 20%-30% of patients initially managed non-operatively.[10] Additionally, splenic artery embolization (SAE) is increasingly utilized to enhance the success rate of NOM, although its efficacy across different trauma settings is a topic of debate.[11,12] This study evaluates the clinical outcomes of patients with splenic rupture referred from the emergency department to the general surgery unit and identifies factors influencing treatment decisions.

MATERIALS AND METHODS

Study Design and Population

This retrospective cohort study included 42 patients diagnosed with splenic injury and treated at our institution. Patients were divided into two groups based on the treatment approach: non-surgical treatment (n=29, 69.0%) and surgical treatment (n=13, 31.0%). Data were collected from medical records, including demographics, mechanism of injury, laboratory findings, imaging results, and clinical outcomes.

The inclusion criteria were adult patients (aged 18 years and older) admitted through the emergency department with a radiologically confirmed splenic injury on computed tomography, who were subsequently managed by the general surgery team. Patients were excluded if they were under the age of 18, had incomplete or missing medical records, sustained additional major injuries requiring immediate surgical intervention unrelated to splenic trauma, or were referred from another hospital after receiving initial treatment elsewhere.

The study was approved by the Scientific Research Evaluation and Ethics Committee of Ankara Etlik City Hospital (Approval No: 2024-1082; Date: 11/12/2024). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data Collection and Variables

The study variables included age, gender, mechanism of injury (pedestrian, vehicular, fall, sharp object penetrating injury [SOPI], gunshot wound, and iatrogenic), baseline hemoglobin and hematocrit levels, prothrombin time, need for blood product transfusion (fresh frozen plasma and erythrocyte suspension), hemodynamic stability, and physical examination findings. Imaging parameters such as sonography results and computed tomography injury grade were also recorded. Clinical outcomes included changes in hemoglobin and hematocrit levels, transfusion requirements, follow-up imaging, length of hospital stay, mortality, and splenectomy rates.

Imaging and Management Approach

All patients underwent initial evaluation by sonography and CT for classification of splenic injury. Based on hemodynamic stability and imaging findings, patients were managed either conservatively (NOM) or surgically (operative management, including splenectomy).

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation (SD) and compared between groups using the independent samples t-test. Categorical variables were presented as frequency (percentage) and analyzed using the chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant. Statistical analysis was performed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Box plots were created to visualize differences in length of hospital stay and changes in hematocrit between the management groups.

RESULTS

A total of 42 patients with splenic injuries were included in the study, with 29 patients (69.0%) managed non-operatively and 13 patients (31.0%) undergoing operative intervention. The analysis compared baseline demographics, injury characteristics, imaging findings, and clinical outcomes between the two groups.

The mean age of the cohort was 38.3±19.4 years, with no significant difference between the non-operative (37.7±17.9 years) and operative groups (39.8±23.2 years; p=0.743). Males comprised the majority of both groups (76.2% overall), with no significant gender difference between the non-operative (82.8%) and operative (61.5%) groups (p=0.527). In-vehicle accidents were the most common mechanism of injury (47.6% of all cases), followed by falls (21.4%), pedestrian accidents (11.9%), and penetrating trauma (SOPI: 7.1%, firearm injuries: 4.8%). While the overall distribution of injury mechanisms did not significantly differ between the groups (p=0.297), operative management was more frequently associated with SOPI (15.4% vs. 3.4% in non-operative) and firearm injuries (7.7% vs. 3.4%) (Table 1).

Table 1. Baseline demographic and clinical characteristics

Variable	Total (n=42)	Non-Operative (n=29)	Operative (n=13)	p-value
Age (mean ± SD)	38.3±19.4	37.7±17.9	39.8±23.2	0.743
Gender, n (%)				
Male	32 (76.2)	24 (82.8)	8 (61.5)	0.527
Female	10 (23.8)	5 (17.2)	5 (38.5)	
Cause of Injury, n (%)				
Pedestrian accident	5 (11.9)	4 (13.8)	1 (7.7)	0.297
In-vehicle traffic accident	20 (47.6	14 (48.3)	6 (46.2)	
Fall from height	9 (21.4)	6 (20.7)	3 (23.1)	
Sharp object penetrating injury (SOPI)	3 (7.1)	1 (3.4)	2 (15.4)	
Firearm injury	2 (4.8)	1 (3.4)	1 (7.7)	
Other (iatrogenic)	3 (7.1)	3 (10.3)	0 (0)	
Initial hemoglobin (mean±SD)	14.0±2.1	14.2±2.1	13.4±2.1	0.340
Initial hematocrit (mean±SD)	42.2±6.2	42.9±6.2	40.7±6.0	0.323
Prothrombin time (mean±SD)	10.1±0.9	10.2±1.1	10.0±0.4	0.630
Need for fresh frozen plasma (mean±SD)	0.5±1.4	0.2±0.8	1.1±2.1	0.124
Need for erythrocyte suspension (mean±SD)	1.4±2.4	0.9±1.9	2.6±3.0	0.053
Hemodynamic stability, n (%)				
Stable	35 (83.3)	26 (89.7)	9 (69.2)	0.149
Unstable	7 (16.7)	3 (10.3)	4 (30.8)	
Positive physical examination findings, n (%)				
Normal	16 (38.1)	13 (44.8)	3 (23.1)	0.188
Positive	26 (61.9)	16 (55.2)	10 (76.9)	

SD: Standard deviation; n (%): Number (percentage); p-value: Statistical significance level.

Initial hemoglobin levels (14.2±2.1 g/dL in non-operative vs. 13.4±2.1 g/dL in operative; p=0.340) and hematocrit levels (42.9±6.2% vs. 40.7±6.0%; p=0.323) were comparable between groups at presentation. Prothrombin time also showed no significant difference (10.2±1.1 vs. 10.0±0.4; p=0.630). Hemodynamic instability was more prevalent in the operative group (30.8% vs. 10.3%; p=0.149), although the difference was not statistically significant. Positive physical examination findings (e.g., abdominal tenderness, guarding) were observed in 76.9% of operative patients compared to 55.2% of those in the non-operative group (p=0.188) (Table 2).

Sonographic findings were positive in 60.0% of operative patients compared to 20.0% of non-operative patients (p=0.414), although ultrasound use was limited (total n=35). Computed tomography grading showed that Grade 1 injuries were the most common in the non-operative group (55.2% vs. 30.8% in the operative group), while Grade 2 injuries were more frequent in operative patients (38.5% vs. 17.2% in the non-operative group; overall p=0.531). High-grade injuries (Grades 4-5) were rare, accounting for 9.5% of the total cohort. Non-operative patients underwent significantly more follow-up imaging studies during hospitalization (1.9±1.4 vs. 0.8±1.0 in the operative group; p=0.036), reflecting a protocol of close radiographic monitoring in conservative management.

The operative cohort demonstrated higher transfusion requirements, with a near-significant trend toward greater erythrocyte suspension use (2.6±3.0 units vs. 0.9±1.9 units; p=0.053) and fresh frozen plasma administration (1.1±2.1 units vs. 0.2±0.8 units; p=0.124). Hemoglobin and hematocrit declines during hospitalization were comparable between groups (Δ hemoglobin: 2.0±1.9 vs. 2.3±3.0 g/dL; p=0.664; Δ hematocrit: 4.8±6.4% vs. 5.9±9.1%; p=0.628).

Operative management was associated with significantly longer hospital stays (10.3±6.9 days vs. 5.7±4.9 days; p=0.042) and a markedly higher splenectomy rate (76.9% vs. 24.1%; p=0.003). Mortality rates were low overall (9.5%) and did not differ between groups (7.7% in the operative group vs. 10.3% in the non-operative group; p=0.819) (Table 3).

Non-operative management was predominantly utilized in hemodynamically stable patients (89.7% stable in the non-operative group vs. 69.2% in the operative group; p=0.149), with fewer requiring surgical intervention. In contrast, op-

Table 2. Splenic injury grade and imaging results

Variable	Total (n=42)	Non-Operative Management (n=29)	Operative Management (n=13)	p-value
Sonography, n (%)				0.414
Negative	24 (57.1)	20 (80.0)	4 (40.0)	
Positive	11 (26.2)	5 (20.0)	6 (60.0)	
CT Grade, n (%)				0.531
Grade 1	20 (47.6)	17 (58.6)	3 (23.0)	
Grade 2	10 (23.8)	5 (17.2)	5 (38.5)	
Grade 3	8 (19.0)	5 (17.2)	3 (23.1)	
Grade 4	3 (7.1)	2 (6.8)	1 (7.6)	
Grade 5	1 (2.4)	0 (0)	1 (7.6)	
Follow-up Imaging, mean±SD	1.6±1.4	1.9±1.4	0.8±1.0	0.036

n (%): Number (percentage); SD: Standard deviation; CT: Computed tomography; p-value: Statistical significance value.

Table 3. Clinical outcomes and follow-up

Variable	Total (n=42)	Non-Operative Management (n=29)	Operative Management (n=13)	p-value
First Hemoglobin (g/dL), mean±SD	14.0±2.1	14.2±2.1	13.4±2.1	0.340
Last Hemoglobin (g/dL), mean±SD	11.9±2.2	12.3±2.2	11.1±2.1	0.250
Hemoglobin Change (g/dL), mean±SD	2.1±2.3	2.0±1.9	2.3±3.0	0.664
First Hematocrit (%), mean±SD	42.2±6.2	42.9±6.2	40.7±6.0	0.323
Last Hematocrit (%), mean±SD	37.1±6.2	38.1±5.9	34.8±6.5	0.133
Hematocrit Change (%), mean±SD	5.1±7.2	4.8±6.4	5.9±9.1	0.628
Prothrombin Time (PT), mean±SD	10.1±0.9	10.2±1.1	10.0±0.4	0.630
Erythrocyte Suspension Replacement (units), mean±SD	1.4±2.4	0.9±1.9	2.6±3.0	0.053
FFP Replacement (units), mean±SD	0.5±1.4	0.2±0.8	1.1±2.1	0.124
Follow-up Imaging, mean±SD	1.6±1.4	1.9±1.4	0.8±1.0	0.036
Length of Stay (days), mean±SD	7.1±5.9	5.7±4.9	10.3±6.9	0.042
Exitus, n (%)				0.819
No	38 (90.5)	26 (89.7)	12 (92.3)	
Yes	4 (9.5)	3 (10.3)	1 (7.7)	
Splenectomy, n (%)				0.003
No	25 (59.5)	22 (75.9)	3 (23.1)	
Yes	17 (40.5)	7 (24.1)	10 (76.9)	

SD: Standard deviation; g/dL: Grams per deciliter; PT: Prothrombin time; FFP: Fresh frozen plasma; n (%): Number (percentage).

erative patients exhibited higher rates of instability, positive imaging findings, and greater injury heterogeneity, necessitating procedural intervention. Despite comparable injury severity grades, the clinical trajectory of the operative group was marked by increased resource utilization, including blood transfusions, extended hospitalization, and splenectomy (Figures 1, 2, and 3).

DISCUSSION

Our findings are consistent with previous studies demonstrating the efficacy of non-operative management for hemodynamically stable splenic injuries, with success rates exceeding 80% in selected patient populations.[13,14] The high splenectomy rate in the operative cohort (76.9%) reflects

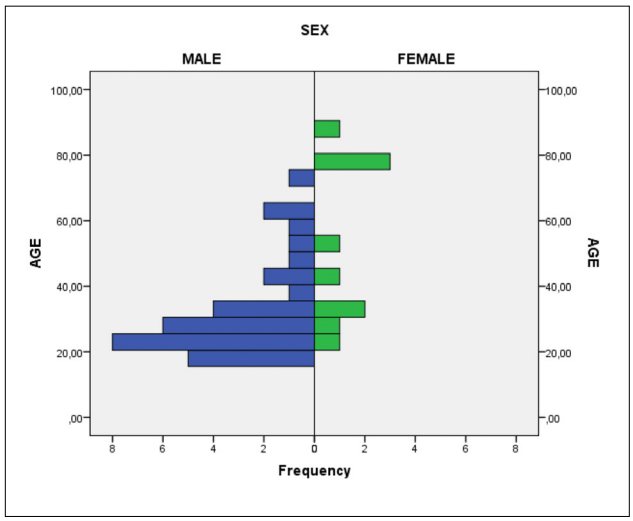

Figure 1. Population pyramid.

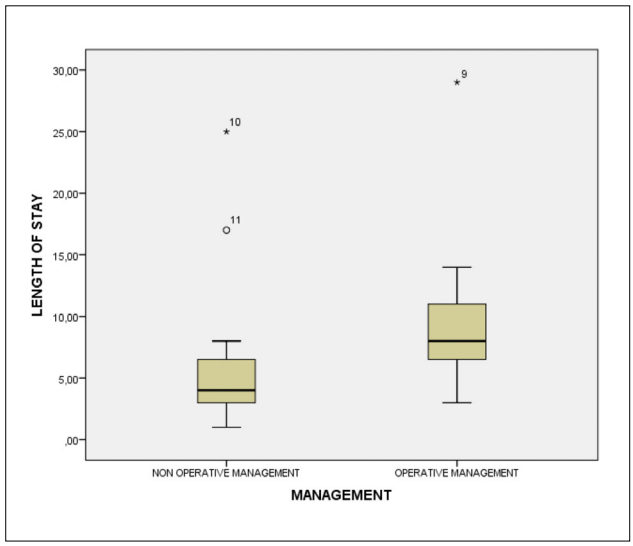

Figure 2. Length of hospital stay according to management strategy (presented as a box plot).

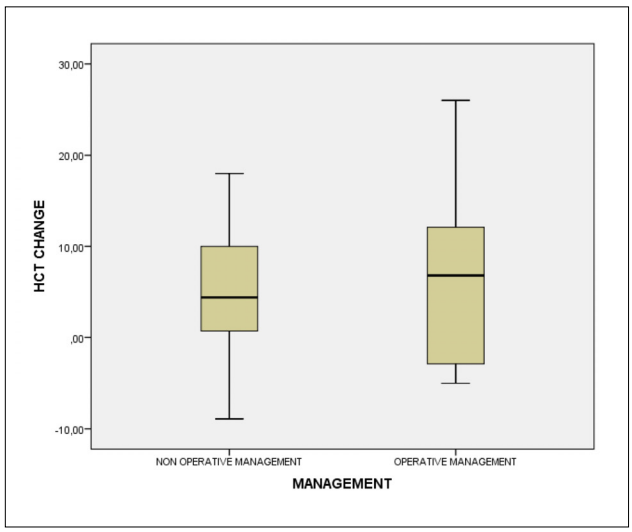

Figure 3. Change in hematocrit (HCT) levels according to management strategy (presented as a box plot).

the severity of injury presentations, in line with literature showing that penetrating trauma and hemodynamic instability remain the strongest predictors for surgical intervention.[15,16] Moreover, AAST Grade IV-V injuries have been identified as independent risk factors for NOM failure, reinforcing the need for accurate grading and close monitoring.[17]

The Role of Hemodynamic Status in Treatment Decisions

Hemodynamic stability plays a critical role in determining the appropriate management approach. Several studies emphasize that patients with persistent hypotension despite resuscitation require urgent surgical intervention.[18] Our findings support this, as hemodynamic instability was more common in the operative group (30.8% vs. 10.3%, p=0.149), although the difference was not statistically significant. However, the decision to proceed with surgery should also consider factors beyond vital signs, such as active contrast extravasation on CT, which has been associated with increased NOM failure rates.[19]

Splenic Artery Embolization and NOM Success Rates

The increasing use of splenic artery embolization has improved NOM success rates, particularly in patients with high-grade injuries.[20] Recent meta-analyses show that SAE reduces NOM failure by nearly 50%, making it an essential adjunct in trauma centers where available.[21] Despite its benefits, SAE is not universally implemented, and its role in low-resource settings is a topic of debate. Our study did not include SAE as a standardized intervention, highlighting a potential area for future research. Developing and adopting standardized protocols for SAE selection criteria may enhance patient outcomes and reduce unnecessary splenectomies.[22]

Recent guidelines from the World Society of Emergency Surgery (WSES) and the Eastern Association for the Surgery of Trauma (EAST) emphasize the importance of non-operative management in hemodynamically stable patients, including those with high-grade injuries, when proper monitoring and interventional radiology resources are available.[1,23] These guidelines recommend the use of splenic artery embolization as a key adjunct to NOM in the presence of vascular injuries or contrast blush on CT imaging. Furthermore, the EAST guidelines highlight the importance of institutional algorithms, early risk stratification, and rapid hemodynamic assessment in improving the success rate of NOM.[1] Although SAE was not implemented in our cohort, the predominance of NOM among stable patients and the favorable clinical outcomes observed align with these evidence-based recommendations.

Delayed Splenectomy and Associated Morbidity

Despite the widespread adoption of NOM, delayed splenectomy remains a clinical concern. Several studies have reported that patients initially managed non-operatively who later require surgery tend to have higher morbidity, including secondary hemorrhage, infection, and increased transfusion requirements.[24] In our study, the operative group re-

quired significantly more blood transfusions (2.6±3.0 units vs. 0.9±1.9 units, p=0.053) and experienced longer hospital stays (10.3±6.9 days vs. 5.7±4.9 days, p=0.042), reinforcing the resource-intensive nature of surgical intervention

Future Directions and Limitations

Advances in trauma management, including machine learning-based predictive models, are being developed to assess the risk of NOM failure and to optimize early decision-making.[25] Future research should focus on improving risk stratification tools, evaluating the long-term outcomes of SAE compared to surgery, and exploring minimally invasive alternatives.

A limitation of our study is its retrospective nature, which may introduce selection bias. Additionally, the relatively small sample size (n=42) limits the generalizability of our findings. Prospective, multicenter studies are needed to confirm these results and establish comprehensive criteria for NOM failure.

Recent Evidence and Trends in Splenic Trauma Management

Recent studies have reinforced the efficacy of non-operative management for blunt splenic injuries, even in high-grade cases, provided that patients are hemodynamically stable and have access to appropriate monitoring and interventional radiology services. A nationwide analysis demonstrated a significant decrease in splenectomy rates and an increase in the use of splenic artery embolization from 2013 to 2019, highlighting a shift toward less invasive management strategies.[26] Additionally, a multicenter retrospective study reported a 20% failure rate of NOM in Grade I–II splenic injuries with contrast blush, emphasizing the need for careful patient selection and close monitoring.[27] These findings underscore the importance of individualized treatment plans and the potential benefits of incorporating SAE into NOM protocols to enhance patient outcomes.

CONCLUSION

Our findings reaffirm that non-operative management is the preferred strategy for hemodynamically stable patients with splenic trauma, offering favorable outcomes and shorter hospital stays. However, penetrating trauma, hemodynamic instability, and higher AAST grades remain strong predictors for surgical intervention. The growing role of SAE highlights its potential to improve NOM success and warrants further research into optimal protocols for its use. Future studies should explore advanced predictive models and risk stratification tools to refine treatment pathways and improve patient outcomes.

Ethics Committee Approval: This study was approved by the Ankara Etlik City Hospital Research Evaluation and Ethics Committee (Date: 11.12.2024, Decision No: 2024-1082).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Dalak laserasyonları: Yönetim stratejileri ve klinik sonuçların retrospektif analizi

AMAÇ: Dalak yaralanmaları, en sık görülen karın travmaları arasında yer alır ve cerrahi dışı tedavi (NOM) ile cerrahi müdahale arasında bir denge gerektirir. Karar verme süreci, hemodinamik stabilite, yaralanmanın şiddeti ve görüntüleme bulgularına bağlıdır. Bu çalışma, acil servisten genel cerrahi birimine sevk edilen dalak rüptürlü hastalarda klinik sonuçları ve tedavi kararlarını etkileyen faktörleri değerlendirmektedir.

GEREÇ VE YÖNTEM: Haziran 2023 ile Şubat 2025 arasında dalak yaralanması tanısı alan 42 hasta üzerinde retrospektif bir kohort çalışması yapıldı. Hastalar, cerrahi dışı tedavi (n=29, %69.0) ve cerrahi tedavi (n=13, %31.0) gruplarına ayrıldı. Demografik özellikler, yaralanma mekanizmaları, hemodinamik durum, laboratuvar sonuçları, görüntüleme bulguları, transfüzyon ihtiyacı, hastanede kalış süresi ve mortalite oranları incelendi. İstatistiksel karşılaştırmalar, anlamlılık düzeyi p<0.05 olacak şekilde uygun testler kullanılarak yapıldı.

BULGULAR: Ortalama yaş 38.3±19.4 yıl olup, hastaların %76,2'si erkekti. Yaralanmaların en yaygın nedeni trafik kazaları (%47.6), bunu düşmeler (%21.4) ve penetran travmalar (%11.9) izledi. Cerrahi tedavi, bıçak yaralanmalarında (%15.4) ve ateşli silah yaralanmalarında (%7.7) daha sık uygulandı. Hemodinamik instabilite, cerrahi tedavi grubunda daha yaygındı (%30.8'e karşı %10.3, p=0.149). Cerrahi vakaların %76.9'unda splenektomi yapıldı (p=0.003). BT görüntülemede, cerrahi dışı tedavi grubunda en sık evre I yaralanmalar (%55.2) görülürken, cerrahi tedavi grubunda evre 2 yaralanmalar (%38.5) daha yaygındı (p=0.531). Cerrahi tedavi alan grupta daha fazla kan transfüzyonu gerekti (2.6±3.0 üniteye karşı 0.9±1.9 ünite, p=0.053) ve hastanede kalış süreleri daha uzundu (10.3±6.9 güne karşı 5.7±4.9 gün, p=0.042). Mortalite oranı düşüktü (%9.5) ve gruplar arasında anlamlı fark yoktu (p=0.819).

SONUÇ: Hemodinamik olarak stabil hastalarda tercih edilen yaklaşım cerrahi dışı tedavi (NOM) olup, bu yöntem olumlu klinik sonuçlar ve daha kısa hastanede kalış süreleri sağlamaktadır. Bununla birlikte, penetran travma ve hemodinamik instabilite cerrahi müdahale için güçlü belirteçlerdir. Dalak yaralanmalarında optimal tedavi stratejisinin belirlenmesi için erken risk sınıflandırması ve yakın takip kritik öneme sahiptir.

Anahtar sözcükler: Dalak yaralanması; travma; cerrahi dışı tedavi; splenektomi; acil cerrahi.

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