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An observational study of the healing time, associated factors, and complications during non-operative management of patients with blunt abdominal trauma

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Abstract

Background: Non-operative management (NOM) has shown success in the management of cases of blunt abdominal trauma (BAT), especially in hemodynamically stable patients, even if there is a higher grade of injury.

Objectives: The aim of this study was to determine the healing rate with NOM and associated risk factors of non-healing in patients with BAT.

Methods: This prospective study was conducted on 20 hemodynamically stable patients of BAT who were treated in a tertiary care hospital by NOM. Clinical monitoring and biochemical investigations were done. The patients were followed-up for three months. The outcome measures were the average time of healing and complications. A p-value less than 0.05 was considered statistically significant.

Results: The mean age of the patients was 24.5 years with 18 (90%) males and 2(10%) females. Nine patients (45%) had isolated liver injury, 8 (40%) had isolated splenic injury, 1 (5%) had isolated left renal injury, 1 (5%) had combined liver and splenic injury and 1 (5%) had combined liver and right renal injury. At 3 months of follow-up, 16 (80%) cases showed complete healing, 3(15%) showed incomplete healing and 1 (5%) patient with grade 4 splenic injury had failure of NOM. On performing univariate regression analysis, grade 3/4 was an independent risk factor of non-healing with an odds ratio of 5.667.

Conclusion: In conclusion, NOM appears to be a safe and effective management protocol for patients with BAT, provided regular follow-ups and monitoring are done.

Keywords: Blunt abdominal trauma, Complications, Non-operative management.

Introduction

Blunt abdominal trauma (BAT) is a major cause of morbidity and mortality across all age groups.[1] It is one of the most common injuries seen in a patient with road traffic accidents (RTAs), accountable for 45% to 50% of BAT.[1]

Intra-abdominal organs (hollow or solid) are more vulnerable to injuries following BAT as compared to intra-thoracic organs, as they are protected by the sternum and rib cage.[2] Previously, the management (conservative or operative) was based on the grading of injuries and the hemodynamic stability of a patient, but more recently many studies have been undertaken that report the success of non-operative management (NOM), especially in hemodynamically stable patients, even if there is a higher grade of injury.[3,4] Non-operative management has become more and more recommended for the treatment of some blunt abdominal solid organ injuries during the past few years, with the success rate of NOM being reported to be as high as 93.8%.[5] However, regular and vigilant monitoring is required in such patients being managed conservatively to look for the onset of any complication, or need for additional minimally invasive interventions assisting in recovery and to pick up early

signs of failing NOM, to take an operative decision as soon as possible.

Though studies have been done in past documenting the average healing time in different grades of different intra-abdominal solid organ injuries on radiological grounds which include ultrasound (US) and computed tomography (CT) scans,[6] there is seldom data on duration and intensity of restricted activity and return to routine physical work and play after intra-abdominal solid organ injury that have been managed conservatively.

Objectives

The present study was conducted to determine the healing after NOM of patients with BAT after three months of follow-up and the risk factors of non-healing. We also assessed the time of return to physical activities.

Methods

A prospective interventional study was conducted at the Department of Surgery and Department of Radiodiagnosis, at a tertiary care hospital, in New Delhi, from November 2019 to July 2021.

Sample size

For sample size calculation, the study of Brillantino et al.,[7] was chosen as a base study where in splenic injury following BAT, NOM was successful in 82/87(95.4%) patients. A confidence level of 95% and a confidence limit of 10% sample size (n=17) were calculated. To compensate for the margin of error, 20 patients were studied. The study included the hemodynamically stable patients (children, adults and elderly) of BAT with solid organ injury who were planned to be treated by NOM. The study excluded the patients of BAT without solid organ injury, those with BAT with solid organ injury who got operated on at onset due to unstable vital parameters, those with penetrating abdominal injury, patients of BAT with hollow viscus injury, and associated chest trauma requiring thoracotomy, and those with persistently altered sensorium, requiring neurosurgical intervention secondary to head injury.

The enrolled 20 patients of BAT who presented to surgery emergency of the hospital were evaluated and resuscitated according to advanced trauma life support (ATLS) Protocol (cABCDE rule) and hemodynamic stability was ensured. US Extended Focused Assessment with Sonography in Trauma (eFAST) was performed (bedside if possible) along with resuscitation going side by side. All eFAST-positive hemodynamically unstable patients or those in whom it was doubtful that the patient will maintain stability were directly shifted to the operating room. Whereas all patients who were eFAST positive and hemodynamically stable were evaluated further on CT scan to look for the pattern and grade of injuries.[8] The organ injuries were graded as per the American Association for the Surgery of Trauma (AAST) grading of organ injuries.[9]

During NOM, the patient was kept nil per oral for initial 24-48 hours and monitoring was done clinically (for pain, abdominal tenderness & guarding, abdominal distension, and vitals) and biochemically, biochemical investigations as per requirement were done. (hemogram at presentation, 12 hourly for first 48 hours followed by 24 hourly till hospital stay, liver functions tests (LFT) and kidney function tests (KFT) - at presentation, 48 hours and repeated when required, Urine routine microscopy (in cases of hematuria) or radiologically [by the US, Doppler and contrast-enhanced CT Abdomen (if required)] to look for any early complications, such as organ infarction, pseudoaneurysm formation, A-V fistula, etc. and need for minimally invasive interventions like CT agio-embolization, stenting etc. or switching to operative management was considered.

In patients who responded well to NOM, the decision of discharge was taken by the treating surgeon (usually not in less than 5 days), after explaining danger signs, which if present at any time, demand urgent presentation of the patient to hospital emergency. After discharge, patients were followed-up in the outpatient department. During the follow-up visit, patients were reassessed clinically, biochemically, and radiologically by ultrasound and Doppler on the 15th day, first, second & third month and CT scan (whenever required). Reassessing clinician, standards of lab and radiologist performing follow-up ultrasound, Doppler and CT scan remained same, to remove any assessment bias.

Follow-up

Follow-up was done for three months during which healing of solid organs, and the resumption of physical activities were noted. The outcome measures studied were the average time of healing of solid organ injuries, day of allowance of oral feeds, day of passing faeces and flatus, day of clearance of hematuria, day of allowing restricted and full activities in the grade of mild, moderate and strenuous and hospital stay.

Mild physical activities included performing daily personal care works like going to the toilet, bathing, slow walking, and cooking. The patients were started to be allowed mild physical activities 48 hours after the

resolution of the signs of peritonism. Moderate physical activities included brisk walking, climbing up and down stairs, mopping floors, washing clothes, driving four wheelers and gardening. Patients were allowed moderate physical activities only when they were asymptomatic clinically with normal reports of organ-specific blood tests biochemically and showing at least a 10% reduction in size with a change in echogenicity of intra-abdominal solid organ hematomas from hyper to hypoechoic radiologically on ultrasound scans upon follow-up over 3 months. Strenuous physical activities included running, jogging, all contact sports activities and riding a bike. The patients were allowed restoration of strenuous physical activities only after radiological documentation of healing, as has been made evident in literature as well.[4-7] Pain severity score was calculated using the "Numerical Pain Rating Scale" in which the severity of pain was graded between the score of 0 to 10 with 0 being no pain and 10 being the highest pain.

Statistical analysis

The presentation of the categorical variables was done in the form of numbers and percentage (%). On the other hand, the quantitative data with normal distribution were presented as the means±SD and the data with non-normal distribution as median with a range. Univariate logistic regression was used to find out significant risk factors of non-healing. The data entry was done in the Microsoft EXCEL spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, version 25.0. For statistical significance, p-value of less than 0.05 was considered statistically significant.

Ethical considerations

The research complies with the guidelines for human studies and was conducted ethically under the World Medical Association Declaration of Helsinki. The study was conducted after approval by the institute's committee on human research of the university college of medical sciences, Delhi (IEC/HR/2019/41/60, Dated 16/10/2019). All participants provided informed consent for the study.

Results

The median age of the patients included in the study was 24.5 years (range 3-50 years). There were 18 (90%) males and 2(10%) females. The place of injury in the majority of the patients 10(50%) was Delhi, followed by UP (45%). RTA was the most common mode of injury, i.e. in 15(75%) patients, and others fall from height (20%). The chief complaints of the patients were pain abdomen in 20 (100%), abdominal distension in 4(20%), and hematuria in 1(5%) patient. History of chest pain, neck pain/ restricted neck movement, and shortness of breath were present in 6(30%), 2(10%), and 1(5%) patients, respectively. The duration between injury and presentation to the hospital was 4.5 hours [Table 1].

Table 1. Demographic and clinical characteristics of patients

Parameters		**N (%)**
Age (years)	Median (Min-Max)	24.5(3-50)
Gender	Female	2(10%)
	Male	18(90%)
Place of injury	Bihar	1(5%)
	Delhi	10(50%)
	UP	9(45%)
Mode of injury	Fall from height	4(20%)
	Fall of heavy object on the trunk	1(5%)
	RTA	15(75%)
Chief complaints	Pain abdomen	20(100%)
Scale of pain,	Median (Min-Max)	7(6-9)
Abdominal distension		4(20%)
Hematuria		1(5%)
History of chest pain		6(30%)
History of neck pain/ restricted neck movement		2(10%)
History of shortness of breath		1(5%)
Injury to presentation time (hours), Median (Min-Max)		4.5 (1.5-36)

Pain severity score could be assessed in 17 patients only as 3 patients were below 5 years of age and hence the pain score could not be reliably elicited from them. The median pain abdomen severity score was 7 with a range from 6-9.

Examination findings

All patients had patent airways at presentation and were phonating well. Eighteen (90%) patients had cervical spine stability while 2(10%) had restricted neck movement. All 20 patients included in the study were hemodynamically stable at presentation. Spine tenderness was present in 3 patients while restriction of motion of the right wrist joint was there in 1 patient and 1 patient had restricted movement of the right leg. On abdominal examination, localized peritonism was present in all patients, bowel sounds were audible in 18(90%) patients, and abdomen distension and shifting dullness were seen in 3(15%) patients each. Various routine blood investigations were done, the values of which are shown in Table 2.

Table 2. Examination and investigations of findings

Parameters	N (%)
Airway patency	20 (100%)
Vocalizing well	20 (100%)
Cervical spine stable	18 (90%)
Spontaneous breathing	20 (100%)
Bony tenderness/ crepitus	5 (25%)
Air entry	19 (95%)
Subcutaneous emphysema	2 (10%)
Abdominal examination	
Distension	3 (15%)
Rigidity	0 (0%)
Shifting dullness	3 (15%)
Bowel sounds present	18 (90%)
Tenderness and guarding	
Left flank	1 (5%)
Left hypochondrium	9 (45%)
Right and left hypochondrium	3 (15%)
Right hypochondrium	6 (30%)
Right hypochondrium and Right flank	1 (5%)
	Mean±SD
Respiratory rate (per min)	19.9±2.59
SpO_2	98±2.45
Systolic blood pressure (mmHg)	112.25±10.27
Diastolic blood pressure (mmHg)	74±7.28
Pulse rate (per min)	105±10.39
Abdominal girth (cms)	74.35±15.99
Hemoglobin (g/dL)	9.97±2.56
Total leucocyte count (per mm^3)	8665±2951.41
Platelets count (per mm^3)	1.62±0.59
Serum creatinine	0.86±0.25
Serum potassium	3.82±0.32
Direct bilirubin	0.52±0.3
Total bilirubin	1.36±0.65
INR	1.21±0.29
Random blood sugar (mg/dL)	126.1±28.73
Serum sodium	139±4.3
AST	109.35±139.65
ALT	108.35±93.97
ALP	110.8±61.72
PT	18.8±3.8
Blood urea	26.9±7.34

Solid organ injury and management

Out of 20 patients in our study, US eFAST was positive in only 12 patients. Although, 8 patients were US eFAST negative, they on contrast enhanced CT abdomen showed intra-abdominal solid organ injury with no to minimum hemoperitoneum. Overall, out of 20 patients, 9 (45%) had isolated liver injury, 8 (40%) had isolated splenic injury, 1 (5%) had isolated left renal injury, 1 (5%) had combined liver and splenic injury and 1 (5%) had combined liver and right renal injury [Figure 1]. The grade and type of solid organ injury are shown in Table 3. The representative CT images of the patients with spleen and liver injury are shown in Figure 2,3.

Majority of the patients 12(60%) passed faeces and flatus on day 1 of admission, reflecting an absence of ileus while 6 (30%) passed on day 2 and 2 (10%) passed on day 3. The median duration of hospital stay was 11 days with a range of 5-23 days.

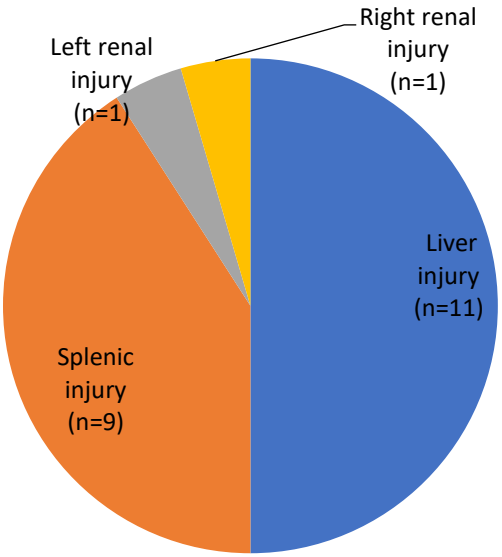

Figure 1. Distribution of pattern of solid organ injury

Figure 2. The figure shows evidence of hypodensity suggestive of splenic laceration with hematoma seen within the spleen extending medially to the hilum and peripherally to the capsule, being labelled as CT grade 3 spleen injury

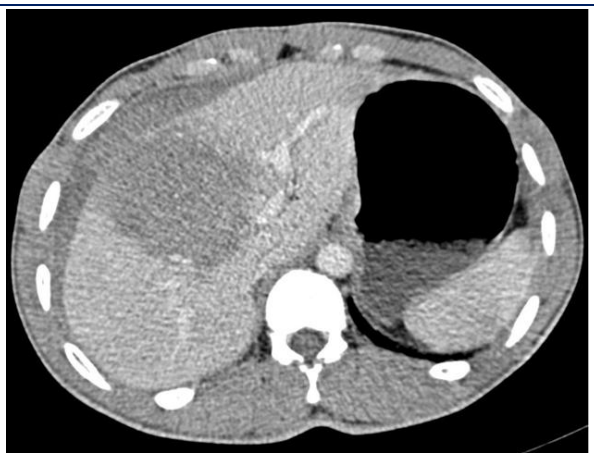

Figure 3. This figure shows evidence of an ill-defined hypodensity within the liver parenchyma suggestive of intra-hepatic hematoma extending up to the liver capsule with associated subcapsular hematoma indicating CT grade 4 Liver injury.

Healing and follow-up

At 3 months of follow-up, 16 (80%) cases showed complete healing, 3(15%) showed incomplete healing and 1 (5%) patient with grade 4 splenic injury had a failure of NOM due to falling a hemoglobin level and increasing abdominal distension and he underwent emergency laparotomy and splenectomy at 72 hours after admission. Average healing in different grades of organ injury is shown in Table 4.

The mean day of resolution of signs of peritonism was 3.89±1.20 days, while the mean day of allowing mild physical activities was 5.89±1.20 days (<1-week, range 4-9 days) and it ranged from admission day 4 to 9. The mean day of allowing moderate physical activities was 3.06±1.61 weeks (range 2 to 8 weeks) and for strenuous physical activities was 6±1.64 weeks (2-8 weeks range). On performing univariate regression analysis, grade 3/4 was an independent risk factor of non-healing with an odds ratio of 5.667 [Table 5].

Out of 20 patients, 6 (30.0%) patients had complications during NOM, including incomplete healing in 3(1.5%) patients, attenuation of right and left hepatic arteries, failure of NOM, and splenic artery pseudoaneurysm in 1(5%) patient each [Figure 4].

Table 3. Distribution of patients in terms of pattern and grades of solid organ injury (n=22)

Organ injured	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Total organs
Spleen	1	4	3	1	0	9
Liver	1	1	6	3	0	11
Right kidney	0	0	1	0	0	1
Left kidney	0	0	0	1	0	1

Table 4. Average healing time in different grades of solid organ injury (n=21)

Organ	Grade 1	Grade 2	Grade 3	Grade 4
Spleen (n=8)	2 weeks	4-5 weeks	3 months	-
Liver (n=11)	2 weeks	1 month	2 months	3 months
Kidney (n=2)	-	-	2 months	1 months

Table 5. Univariate logistic regression to find out significant risk factors of non-healing

Variable	Beta coefficient	Standard error	P value	Odds ratio	Odds ratio Lower bound (95%)	Odds ratio Upper bound (95%)
Age (years) (median with range)	0.008	0.055	0.882	1.008	0.905	1.124
Injury to the presentation time	0.000	0.087	1.000	1.000	0.844	1.185
Hb (g/dl)	-0.585	0.481	0.223	0.557	0.217	1.429
TLC (per mm)	0.000	0.000	0.918	1.000	1.000	1.001
Platelets (per mm)	-1.757	1.744	0.314	0.173	0.006	5.267
Gender (M/F)						
Female				1.000		
Male	0.000	2.386	1.000	1.000	0.009	107.493
Mode of injury						
Fall from height				1.000		
Fall of heavy object on the trunk	-2.233	5.918	0.706	0.107	0.000	11683.250
RTA	-0.900	1.491	0.546	0.406	0.022	7.557

Type of injury						
Liver injury				1.000		
Renal injury	0.000	2.516	1.000	1.000	0.007	138.440
Splenic injury	0.000	1.591	1.000	1.000	0.044	22.608
Grade of injury						
Grade 1/2				1.000		
Grade 3/4	1.735	2.793	0.042	5.667	1.256	125.56

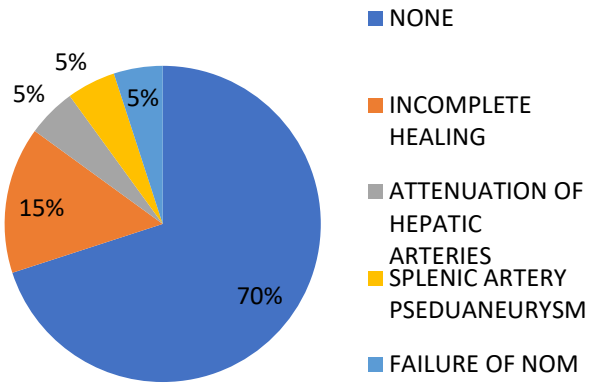

Figure 4. Distribution of the patients in terms of complication during NOM

Discussion

There has been a significant movement in the last three decades from surgical to NOM for traumatic abdominal injuries. NOM is a well-established method now for treating solid organ injuries, such as injuries to the liver, spleen, and kidneys.[10]

The present study showed 80% complete healing by NOM for solid organ injury after three months. This is in line with the findings by Kumar et al.,[1] as the majority of the patients with splenic, liver, and renal injuries (90%) were managed conservatively and showed complete healing. Meena et al.,[11] reported that out of 45 patients with blunt abdominal trauma, 40 (88.88%) were managed conservatively, and out of which 32 (71.11%) patients showed complete healing. In the study by Brillantino et al.,[7] the NOM showed healing in 95.4% of patients. Similarly, Karachentsev[12] found a 90% complete healing rate among 20 patients managed non-operatively. The overall complete healing rate of NOM falls in the range of 70-95%[13,14] making it a safe option for practical clinical use.[15]

Among the 20 cases of BAT, the liver and spleen were the commonest injured organs in our study (n=18) with the kidney being the least (n=2). Literature also portrays the spleen and liver as the commonest injured organs.[16] In a recent Indian study, among 75 cases of BAT, solid organ injury was seen in 54(72%) cases. The most common organ injured was the liver (40%) followed by the spleen (37.33%), and kidney 7(9.33%).[17] In another Indian study, the most common injury was splenic injury (30%) followed by bleeding with no organ injury (20%), and liver injury (10%).[1] Meena et al.,[11] also reported liver was the most common organ injured (44.44%), followed by the spleen (22.2%).

So overall, organs injured remain a constant factor, but the grade of injury may be varied, which may affect the outcomes of NOM. In our study, grade 3/4 organ injury was found to be the sole independent risk factor of non-healing with an odds ratio of 5.667 with the single patient of grade 4 splenic injury reporting failure of NOM. Haan et al.,[18] also found a lower success rate among patients with high-grade injury. On the contrary, Brillantino et al.,[7] found that the success rate was not significantly different among the patients with different splenic injuries' grade, but the success rate was similar among patients with different injury grades. This may be due to heterogeneous patient characteristics like age, gender, and comorbidities. On this aspect, we also assessed the risk factors with demographic profile of the patients but found them statistically insignificant risk factors. In comparison, Hashemzadeh et al.,[5] observed higher age, female gender and injury severity score (ISS) ($P<0.05$) to be significant risk factors for non-healing. Olthof et al.,[19] also found the predictors of NOM failure to be age ≥ 40 years, ISS ≥ 25, and splenic injury grade ≥3. Hemodynamic instability is also reported as one of the reasons for the failure of NOM in the study by Hsieh et al.,[3] as they have lower hemoglobin levels, more hospitalization transfusions, and longer ICU stay. Robinson et al.,[20] found blood transfusion as a predictor of NOM failure. Bhangu et al.,[21] found that the risk factors of NOM failure were American Association for the Surgery of Trauma (AAST) grades 4–5, the presence of moderate or large hemoperitoneum, increasing ISS, and increasing age.

In the present study, the mean healing time with NOM was 6±1.64 weeks with the allowance of mild activities within one-week, moderate activities in up to 3-4 weeks

and strenuous activities in up to 6-7 weeks. Savage et al.,[22] reported that in patients with 97 blunt splenic injuries, the mean healing time values in low-grade and high-grade injuries were 12.5 and 37.2 days, respectively. Tiberio et al.,[23] found that in patients with blunt liver injury, the median healing time of grades I, II and III hematomas were 6, 45.5, and 108 days, and that of lacerations were 29, 34, and 77.5 days, respectively.

Non-operative management helps in spontaneous hemostasis, maintains the formation of a clot, fastens healing, and aids in the preservation of organ functions.[15]

In the present study, complications included attenuation of the hepatic artery and splenic artery pseudoaneurysm. Studies have been done in past which detect incidental findings like solid organ abscess, pseudoaneurysms, segmental organ infarction etc. on following up the patients managed by NOM.[24-26] In Brillantino et al.,[7] study, the minor complications included two cases of pleural effusions, one case of pancreatic fistula, and two cases of splenic abscesses. In Kumar et al.,[1] complications included wound infection, respiratory complications, wound dehiscence and intra-abdominal abscess. Karachentsev[12] found no complications in 20 patients who were managed non-operatively.

The limitation of the study was the small sample size and single-center report, thus limiting the generalization of the results.

Conclusions

Non-operative management provided an 80% complete healing of BAT with an allowance of mild, moderate, and strenuous physical activities in up to 1 week, 3-4 weeks, and 6-7 weeks, respectively, with fewer complications. Grade 3/4 injury was an independent risk factor of non-healing with an odds ratio of 5.667. In conclusion, NOM appears to be a safe and effective management protocol for patients with BAT, provided regular follow-ups and monitoring are done.

Acknowledgment

None

Competing interests

The authors declare that they have no competing interests.

Abbreviations

Non-operative management: NOM;
Blunt abdominal trauma: BAT;
Road traffic accidents: RTAs;
Ultrasound: US;
Computed tomography: CT;
Advanced trauma life support: ATLS;
Extended Focused Assessment with Sonography in Trauma: eFAST;
American Association for the Surgery of Trauma: AAST;
Liver functions tests: LFT;
Kidney function tests: KFT.

Authors' contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Role of the funding source

None.

Availability of data and materials

The data of all the patients in the Excel form is available on request from which the results have been derived.

Ethics approval and consent to participate

The research complies with the guidelines for human studies and was conducted ethically under the World Medical Association Declaration of Helsinki. The study was conducted after approval by the institute's committee on human research of the university college of medical sciences, Delhi (IEC/HR/2019/41/60, Dated 16/10/2019). All participants provided informed consent for the study.

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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