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Efficacy of modified clinical abdominal scoring system (modified CASS) in predicting the necessity of laparotomy in blunt trauma abdomen

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Abstract

Introduction: Although there are many scores to evaluate a patient having trauma, modified CASS is a newer score specifically designed for blunt abdominal trauma which is not adequately studied. The objective was to study the Efficacy of modified CASS by comparing it with conventional experience-based management of Blunt abdominal trauma.

Methods: 146 patients presenting with blunt abdominal trauma between April 2021 to November 2022 were randomly Selected. Patients were treated by conventional experience-based management and it was compared with management Guided by modified CASS by prospective observation. Analysis was done by assessing need for CT scan of abdomen and Laparotomy to check efficacy of modified CASS.

Results: Out of 146 patients, 85 patients underwent CT scan and 25 patients amongst them had to go undergo laparotomy afterwards. The results of the CT scan showed the most commonly injured organ to be Spleen, followed by Liver, Kidney, pancreas and Jejunum.

Of the 52 patients with modified CASS scores of <9, 49 underwent CT scan. Out of these 49 patients, 5 patients underwent laparotomy after the CT scan and 44 patients did not need to undergo laparotomy even after the CT scan. Out of 94 patients with modified CASS score of >9, 36 patients underwent CT scan. Out of these 36 patients, 20 patients underwent laparotomy after a CT scan and 16 patients did not require laparotomy even after undergoing CT scan. A significant association was noted in patients with higher modified CASS scores of equal or more than 9 and those undergoing laparotomy after CT scan compared to patients with a modified

CASS less than 9, indicating that the patients with higher modified CASS scores had an intra-abdominal injury requiring surgery.

Free gas under the diaphragm was noted in 31 patients on an erect abdominal X-ray and required urgent laparotomy. 4 such patients who had free gas under the diaphragm and required laparotomy were missed by the CASS score and 7 such patients were missed by the BATSS score. No patients having free gas under the diaphragm were missed by the modified CASS score as the the erect abdominal X-ray is one of the parameters used in the modified CASS scoring system.

Conclusions: In the present study the proposed modified CASS has better sensitivity than the existing CASS and BATSS. Though it is less specific but the intention of this score is to be usedAs a referral score so for it high specificity will not be mandatory. It is feasible to implement at PHC and its interpretation could be easily done by a medical officer. Thus Modified CASS could be a promising tool for identifying the at risk patients for Laparotomy and referring them from peripheral health centers to a tertiary care center.

Keywords - Blunt abdominal trauma scoring system, CT scan, Laparotomy, Road traffic accident, Focused abdominal Sonogram in trauma

Introduction

Trauma is the leading cause of death and disability in developing countries, particularly in those under 45 years of age.[1] Among organ injuries, abdominal injuries rank third after head and chest injuries, with about 85% being blunt, caused by road traffic accidents, falls, assaults, sports injuries, and industrial or rail accidents. [2] Blunt abdominal trauma has a higher probability of being overlooked [3,4] Therefore early recognition of blunt abdominal trauma remains crucial to identify patients that require laparotomy. [5]

In developing countries with limited resources clinical examination remains the gold standard for the assessment of blunt abdominal trauma. To help categorize patients, a scoring system is necessary for prompt decision-making and urgent operative intervention [6] The Blunt abdominal trauma severity score (BATSS) and the Clinical abdominal scoring system (CASS) were designed.[6,7] A comparison of these two scoring systems by previous researchers showed that the BATSS had higher sensitivity and negative predictive value, while the CASS had higher specificity and positive predictive value.[8] However, the use of FAST scan in BATSS requires skilled manpower and special imaging instruments that may not be available in resource-poor peripheral health centers.

To improve the sensitivity of the Clinical abdominal severity score, we propose adding an abdominal X-ray in the erect position to the original score and calling it the Modified CASS. This modified scoring system can be used in emergency settings to predict the need for laparotomy and be used as a tool for referral at peripheral centers with limited diagnostic facilities.

Methodology

This study was conducted in the Department of General Surgery at Medical College Baroda and SSG Hospital, involving patients admitted to the hospital with blunt abdominal trauma between April 2021 and November 2022. A sample size of 146 patients was taken for this study, based on an average of 2-3 blunt abdominal trauma patients admitted per week during that period.

This study was a prospective observational study.Inclusion criteria for the study included patients aged between 18-55 years with isolated blunt

abdominal trauma due to road traffic accidents, falls, pedestrian strikes, and direct blunt traumas such as assaults and kickbacks. Polytrauma patients with other organ injuries with AIS less than or equal to two were also included. Pregnant women, patients under 18 years of age, patients with penetrating trauma, polytrauma patients having a blunt abdominal injury with other organ injuries with AIS greater than 2, and patients with severe cardiopulmonary and renal disease were excluded from the study.

Patients presenting with history of blunt abdominal trauma and symptoms such as abdominal pain, distension and vomiting were examined for vital signs, general condition, Glasgow coma scale, and chest and pelvic tenderness.

Once the patients were stable, investigations of X-rays of the chest, abdomen, and pelvis with both hip bones and FAST scan were performed. Huang FAST scoring system was used to allocate a score. Depending on the findings of examination and imaging modalities, patients with negative or minimal findings were treated conservatively, while in cases where X-ray of the abdomen showed air under both the domes of the diaphragm, Laparotomy was performed.

CASS, BATSS, and the modified CASS scores were calculated for each patient. The modified CASS score was calculated as shown in Table 1. All patients were categorized as low, moderate and high-risk groups based on the CASS, BATSS, and the modified CASS scores. For the CASS and the modified CASS scores, patients with scores <9 were categorized as low risk, scores between 9-11 were classified as moderate risk and patients who had scores>11 were categorized as high risk. For the BATSS score, patients who had scores ≤8 were categorized as low-risk, scores between 9-11 were categorized as moderate risk and patients who had scores >11 were categorized as high-risk. Management was observed and all patients were kept in follow-up until discharge from the hospital.

Data was analyzed using MedCalc software, and statistical analysis was presented in tables and figures. Receiver-operator characteristic curves were designed for each scoring system to summarize its performance and the internal consistency of three scores was measured using Cronbach's alpha test.

Results

Patients in this study ranged from 18-70 years. Majority of the patients belong to the age group 18-30 years. The most common etiology for sustaining blunt abdominal trauma was road traffic accident. A bulk of patients presented 6 hours after encountering trauma. Patients presented most commonly with abdominal pain and guarding, followed by abdominal tenderness. Spleen was the most commonly injured solid organ and the small intestine was the most commonly injured hollow viscus. The demographic data is presented in detail in Table 2.

The average length of hospitalization was 10.10 days in this study.

Out of the 146 patients included in the study, 18 patients died during treatment. Mortality rate in the study was 12.32%.

Based on the CASS score, 39.04%((57) of patients were in the low-risk group, 46.58%(68) of patients were in the moderate-risk group and 14.38%(21) of patients were in the high-risk group. Based on the BATSS score, 48.63%(71) of patients were in the low-risk group, 31.51%(46) of patients were in the moderate-risk group and 19.86%(29) of patients were in the high-risk group. Based on the modified CASS score, 35.61%(52) of patients were in the low-risk group, 26.71% (39) of

patients were in the moderate-risk group and 37.67%(55) of patients were in the high-risk group.

The mean CASS score was 8.16±1.13 for patients treated conservatively and 10.43±1.81 for those who underwent laparotomy (t-test: 9.23; p-value: <0.0001). The mean BATS score of the patients who were managed conservatively was 6.29±1.93, whereas, for patients who underwent operative management, the BATS score was 10.32±3.28 (t-test: 8.84, p-value<0.0001).

The mean modified CASS score of patients who were managed conservatively was 8.16±1.13, while the mean modified CASS score of those patients who were managed operatively was 14.68±4.07 (t-test:12.70, p-value: <0.0001). Thus, the mean CASS, BATSS, and modified CASS scores of patients who underwent laparotomy were higher than those of the patients who were managed conservatively.

Out of the total 57 patients who had CASS score <9, 10 patients were treated operatively with laparotomy and 47 of them were managed conservatively, and of 89 patients who had CASS score >9, 69 patients were managed operatively with laparotomy and 20 patients were treated conservatively. (Chi-square: 50.3489; P-value<0.0001)

Out of the total 71 patients who had BATSS score <8, 18 patients were treated operatively with laparotomy and 53 patients were treated conservatively. Out of the 75 patients who had BATSS score of >8, 61 patients were managed operatively and 14 patients were managed conservatively. (Chi-square:46.0315; p-value: <0.0001)

Out of the total 52 patients who had a modified CASS score of <9, only 5 patients were managed operatively and 47 patients were managed conservatively. Out of the 94 patients who had a modified CASS score of >9, 74 patients were treated operatively and 20 patients were treated conservatively. (Chi-square:64.3931; p-value: <0.0001)

Table 3 compares the diagnostic performance measures of the modified CASS, CASS, and BATSS scores. From Table 3 we can see that the modified CASS score has a Sensitivity of 98.51% and a PPV of 98.2%. The modified CASS score also demonstrates the AUC of 91.41% for the ROC curve.

Moreover, from Table 4 it can be deduced that the modified CASS score outperforms the CASS and the BATSS scores in predicting the need for laparotomy as the difference between the AUCs of the ROC curves is statically significant for p-value of <0.05. Image 1 shows the ROC curves plotted for the modified CASS, BATSS and the CASS scores.

Cronbach's alpha test was applied to evaluate the internal consistency among the three scores. For CASS, modified CASS, and the BATSS score, the alpha was 0.83. For the BATSS and the modified CASS score, the alpha is 0.79, for CASS and the BATSS score the alpha was 0.81 and for CASS and modified CASS score, the alpha was 0.81. Thus this shows that there exists internal consistency between all three scores.

Out of 146 patients, 85 patients underwent CT scan and 25 patients amongst them had to go undergo laparotomy afterwards. The results of the CT scan showed the most commonly injured organ to be Spleen, followed by Liver, Kidney, pancreas and Jejunum.

Of the 52 patients with modified CASS scores of <9, 49 underwent CT scan. Out of these 49 patients, 5 patients underwent laparotomy after the CT scan and 44 patients did not need to undergo laparotomyeven after the CT scan. Out of 94 patients with modified CASS score of >9, 36 patients underwent CT scan. Out of these 36 patients, 20 patients underwent laparotomy after a CT

scan and 16 patients did not require laparotomy even after undergoing CT scan. A significant association was noted in patients with higher modified CASS scores of equal or more than 9 and those undergoing laparotomy after CT scan compared to patients with a modified CASS less than 9, indicating that the patients with higher modified CASS scores had an intra-abdominal injury requiring surgery.

Free gas under the diaphragm was noted in 31 patients on an erect abdominal X-ray and required urgent laparotomy. 4 such patients who had free gas under the diaphragm and required laparotomy were missed by the CASS score and 7 such patients were missed by the BATSS score. No patients having free gas under the diaphragm were missed by the modified CASS score as the erect abdominal X-ray is one of the parameters used in the modified CASS scoring system.

Discussion

Trauma is the leading cause of death and disability in developing countries and is the most common cause of death for individuals under 45 years old [(1)]. The abdomen is the third most frequently injured organ after the head and chest.[(2).] A prospective observational study was conducted on 146 randomly selected patients with blunt abdominal trauma at Medical College Baroda and SSG Hospital in Vadodara. The study aimed to determine the efficacy of modified CASS in predicting the need for laparotomy in patients with blunt abdominal trauma.

In our study, road traffic accidents accounted for 54.11% of blunt abdominal trauma cases, followed by physical assault i.e. 21%. These findings were consistent with other studies conducted by Sakpal J et.al, Singh M. et al and Shah DK et al.where most common cause of encountering blunt abdominal trauma was RTA.[(11,12,13)] However in the study conducted by Vanitha T et.al fall from height was the major cause of encountering blunt abdominal trauma.[(8)]

In our study, abdominal pain with guarding was the most common presentation after blunt abdominal trauma followed by abdominal tenderness. This finding is similar to the study conducted by Sakpal J et.al. and Shah DKK et.al.[(11,13).]

In our study, the most commonly involved organ was spleen followed by liver and small bowel. These findings were consistent with those of the study conducted by Sakpal J et.al.[(11)] In our study, using BATSS,48.63% patients were classified as low risk (score<8) while 36% patients scored ≥8. Using the CASS score, 39.06% patients were classified low risk (score<9) while 60.95% patients scored ≥9. For modified CASS score, 35.61% patients were classified as low risk (score<9)wile 64.38% of patients scored ≥9. The difference in patient distribution between low risk and intermediate/high risk groups in CASS and modified CASS versus BATSS could be due to the inclusion of time of presentation and GCS in the former two scores and differences in scoring for pulse and blood pressure. CASS and modified CASS scores assign higher scores for pulse rates in the range of 90-110 and more than 110, while BATSS scores only for pulse rates over 100. Similarly, for systolic blood pressure, while BATSS assigns a score of zero for systolic blood pressure over 90, CASS and modified CASS assigns scores of 1 and 2 for systolic blood pressure ranges of 90-120 and >120, respectively. Patients with mild tachycardia (up to 110) due to pain and agitation might receive a higher score in CASS and be categorized as intermediate risk, whereas BATSS would categorize them as low risk. Additionally, since CASS and modified CASS score includes GCS score, patients with head injury will receive a higher

score than those without, leading to a higher risk category. This is particularly relevant in cases of RTA and falls where head injuries are common.

Our study found that modified CASS has a sensitivity of 98.5% in predicting need d for laparotomy with a specificity of 68.54%. Also in this study, CASS had a sensitivity of 70.2% and a specificity of 87.3% in predicting laparotomy, while BATSS had a sensitivity of 79.1% and a specificity of 77.2%.

The differences between the CASS and the modified CASS as well as the BATSS were statistically significant. However, there was no significant difference between the CASS and the BATSS score in predicting the need for laparotomy. Overall, the modified CASS score was found to be more sensitive in predicting the need for laparotomy compared to the CASS and the BATSS scores. Shojaee M et al. designed the BATSS score and reported its sensitivity of 99.3% in detecting an intra-abdominal injury[7]. The study conducted by Erfatinib et al. reported that the CASS score has an accuracy of 94%, sensitivity of 100% specificity of 88%, positive predictive value of 100% in determining the necessity of laparotomy in blunt abdominal trauma patients.[9].-In the study conducted by Vanitha T et al. CASS score had a specificity of 100% and sensitivity of 54% and the BATSS score had a specificity of 100% and sensitivity of 83.5%.[8]

In the study conducted by Khirallah M et al. he proposed that adding a plain erect abominal radiograph to the existing scoring systems would greatly improve the prognostic values of those systems. Also in Khirallah M et al.'s study, 18% of the patients required immediate intervention after adding a plain radiograph in the erect position.[10] The present study found that the modified CASS has greater sensitivity than the existing CASS and BATSS. This may be due to the addition of radiological imaging in the form of plain erect abdominal X-ray. This investigation is easily available at the peripheral health centers and its interpretation for hollow viscus perforation could be done by a medical school graduate or medical officer. Thus, modified CASS may be a promising tool for referral of patients from peripheral health centers.

Conclusion

In the present study the proposed modified CASS score has better sensitivity than the existing CASS and BATSS score. In thai study, patients with higher modified CASS score have a higher probability of having an intra-abdominal injury that requires an urgent laparotomy. Higher modified CASS score was significantly associated with a greater need for laparotomy. In this study the modified CASS score has the highest sensitivity and the positive predictive value. The Area under the ROC curve for the modified CASS score is the highest amongst all the three scores. Thus, the modified CASS score outperforms all the three scores in predicting the necessity of laparotomy in blunt abdominal trauma patients. The proposed modified CASS score has better sensitivity than the existing CASS and BATSS scores. Though it is less specific but the intention of this score is to be used as a tool for referral, so for it high specificity will not be mandatory. So, it is feasible to implement this score at peripheral health centres. Thus, modified CASS score could be a promising tool for identifying high risk patientsrequiring laparotomy and referring them from peripheral health centre to tertiary care centres.

Table 1: Modified CASS Score

Parameters	Score
Time of presentation	
<2 hours	1
2-6 hours	2
>6 hours	3
Pulse rate	
<90 beats per minute	1
90-110 beats per minute	2
>110 beats per minute	3
Systolic blood pressure	
>120 mm of Hg	1
90-120 mm of Hg	2
<90 mm of Hg	3
Glasgow coma scale	
13-15	1
9-12	2
<9	3
Abdominal clinical findings	
Pain	1
Guarding	2
Tenderness and Rigidity	3
Free gas under diaphragm	
Absent	0
Present	7

Table 2: Demographic data

Age groups	
18-30 years	56
31-40 years	33
41-50 years	26
51-60 years	24
61-70 years	7
Gender	
Males	109
Females	37
Etiology of blunt abdominal trauma	
Road traffic accident	79
Fall from height	20
Physical assault	32
Fall on ground while walking/running	12
Hit by an animal	3
Time of presentation after trauma	
<2 hours	10
2-6 hours	44
>6 hours	92
Clinical presentation after blunt abdominal trauma	
Abdominal pain with guarding	72
Abdominal tenderness	43
Shock	24
Hematuria	7
Organs injured in the trauma	

Spleen	53
Liver	43
Small intestine	26
Kidney	10
Pancreas	8
Urinary bladder	3
Colon	2
Mesentery	1

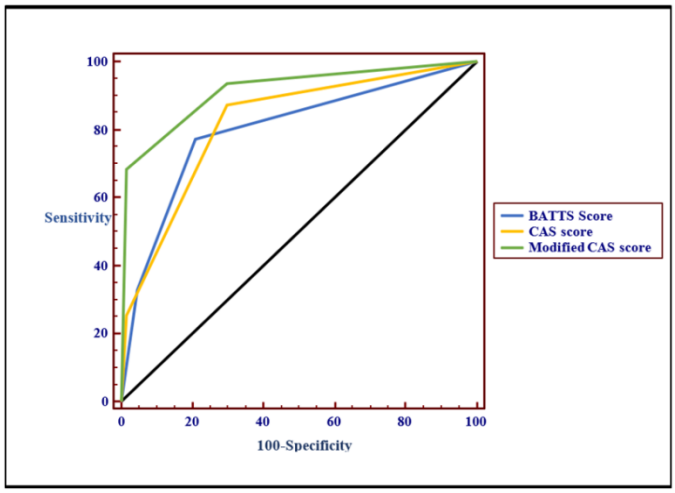
Table 3: Comparison of diagnostic performance measures of CASS, BATSS and the modified CASS scores:

	CASS	BATSS	Modified CASS
Sensitivity	70.15% (CI at 95%: 57.7-80.7)	79.10 (CI at 95%: 67.4-88.1)	98.51 (CI at 95%: 92.0-100.0)
Specificity	87.34 (CI at 95%: 78.0-93.8)	77.2 (CI at 95%: 66.4-85.9)	68.35 (CI at 95%: 56.9-78.4)
PPV	77.5	81.3	98.2
NPV	82.5	74.6	72.5
Positive LR	5.54 (CI at 95%: 3.0-10.1)	3.47 (CI at 95%: 2.3-5.3)	3.11 (CI at 95%; 2.2-4.3)
Negative LR	0.34 (CI at 95%: 0.2-0.5)	0.27 (CI at 95%: 0.2-0.4)	3.11 (CI at 95%: 2.2-4.3)
AUC	81.87%	79.987%	91.41%

Table 4: Comparison for Area under the ROC curves for CASS, BATSS and the modified CASS scoring systems in prediction for Laparotomy

	CASS & BATSS	m CASS &BATSS	m CASS &CASS
Difference between ROC curves	0.020	0.115	0.095
p-value:	0.6661 (not significant at p<0.050	0.0045 (significant at p<0.05)	0.0133 (significant at p<0.05)

Graph 1: ROC curves for the modified CASS, BATSS, and the CASS scores:



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