

## ORIGINAL RESEARCH

## Laboratory predictors of strangulation in patients with inguinal hernia

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### Abstract

**Objective:** The diagnosis of strangulated hernias cases prior to surgery remains to be a challenging issue. Various diagnostic tests can be used in these patients. Hence, we aimed to evaluate the diagnostic value of leukocytosis, left shift, and ABG in the diagnosis of strangulated cases with incarcerated inguinal hernia.

**Materials and Methods:** 107 males and 2 females were enrolled in the study. Medical records of emergency hernia operation cases from March, 2016 up to March, 2021, have been evaluated. Preoperative data such as blood tests, medical history, and surgical outcomes were recorded.

**Results:** Age was higher in the strangulated and incarcerated group. The rate of involvement of the small intestine, the duration of more than 6 hours from the onset of symptoms to surgery, and enlarged prostate size in patients in the strangulated group were higher. Evaluation of WBC, neutrophils, platelets count, and neutrophil to lymphocyte ratio blood levels showed that, except for platelets blood levels, other biomarkers were significantly higher in the strangulated-incarcerated group. The sensitivity of the tests were 0.84, 0.85, and 0.84, respectively. Also, the diagnostic value cut-off points of each of the tests were 9150-9250, 81-84, and 4.71-4.94, respectively.

**Conclusion:** The results of the present study showed that, the ratio of neutrophils to lymphocytes, neutrophils, and WBC count can be good predictors of strangulated hernia.

**Keywords:** Hernia, Inguinal, Leukocytosis, Neutrophils, Lymphocytes.

## Introduction

Inguinal hernia is reported in 16% of men during lifetime and inguinal hernia surgeries are among the most common types of surgery performed with the rate of more than 800,000 in a year in the US (1-3). Finding the patients with strangulated hernia prior to the surgery for the patients with incarcerated hernia is of importance which may improve the outcomes of the surgery (4). It is mainly due to the difference in surgical approaches and clearer discussion about treatment plan with the patients with strangulated hernia, who should undergo bowel resection associated with higher rates of post operative morbidity (5, 6). Clinical suspicion by the surgeon plays a major role in finding such cases however, it is highly subjective and dependent on the proficiency of the examining surgeon (7, 8). Thus, introducing laboratory tests which may predict strangulation prior to the surgery for the patients with incarcerated hernia is highly recommended (9, 10).

Several studies have been conducted and some biomarkers have been shown to play some roles in prediction of strangulated cases among the patients with incarcerated inguinal hernia. It has been reported that neutrophil-to-lymphocyte ratio (NLR), white blood cell (WBC) count, mean platelet volume and platelet distribution width may be the laboratory predictors of strangulation in patients with incarcerated inguinal hernia (5, 6, 11, 12). However, up to now, there are no reliable laboratory tests for prediction of strangulation in patients with incarcerated inguinal hernia (13).

Thus, in our study we aimed to investigate the diagnostic values of laboratory tests including WBC, neutrophil and platelet counts, NLR and analysis of arterial blood gas (ABG) tests for the prediction of strangulation among our patients who undergo urgent surgery due to the inguinal hernia.

## Materials and Methods

The patients with the diagnosis of incarcerated inguinal hernia who were admitted to the emergency ward of the Shohadaye Tajrish Hospital, Tehran, Iran from March 2016 up to March, 2021, were enrolled in to the study. Our study was approved by the Human Research Ethics committee of the Shahid Beheshti University of Medical Sciences (Ethics approval number for the study is SBMU. MSP.

REC. 1398. 461.). All patients were explained about the aims of the study and a written informed consent was taken from each patients before enrolment.

The inclusion criteria were the patients with incarcerated inguinal hernia, which is described as trapping of the contents in the hernia sac which were failed to reduce back into the abdomen. If ischemia and necrosis of the contents develop, this is known as strangulation which was observed during the surgery. The exclusion criteria were any recent infection which could influence inflammatory biomarkers, or recent history of taking anti-inflammatory medications.

A 10-cc peripheral blood sample test was taken from each patient prior to the surgery and was tested for WBC, neutrophil, and platelet counts, NLR, and ABG. Body temperature was recorded using mercury-based thermometer and higher than 37.2 ° Celsius core temperature was recorded as high. The location and type of hernia (direct or indirect) was recorded using physical examination and also with the help of ultrasound. Onset of symptoms was recorded as unreducible painful bulging expressed by the patients. All the preoperative information, serological data, past medical history, and hernia surgical outcomes of the patients were recorded prospectively.

The data were analyzed using SPSS software version 16 (SPSS Inc., Chicago, IL, USA). The quantitative data are presented as mean and standard deviation, and the qualitative data are presented as frequency and percentage. Chi-squared test was used to compare qualitative variables and for quantitative variables, independent t-test was used. The correlation was measured using Binary Regression test and diagnostic cut-off points were determined using ROC curve.  $P < 0.05$  was considered as the significant level.

## Results

During the study period 109 patients with the mean age of  $53.93 \pm 22.57$  (range=17-93) including 107 (98.2%) males were enrolled in the study. 59 patients with non-strangulated and non-incarcerated (NSNI) inguinal hernia were considered as NSNI group, 23 patients with strangulated hernia were considered as strangulated group, and the rest with incarcerated hernia were considered as incarcerated group.

There was one female in each of NSNI and strangulated groups, while all patients in incarcerated group were males. Comparison of the mean ages between the groups showed no significant difference. The data about laboratory tests in each group are shown in Figure 1. WBC in the strangulated and incarcerated groups were significantly higher than the NSNI group. In addition, the neutrophils counts and NLR in the strangulated and incarcerated groups were significantly higher than the NSNI group. However, there were no significant differences between the strangulated and incarcerated groups regarding the WBC, neutrophils and platelet counts, respectively.

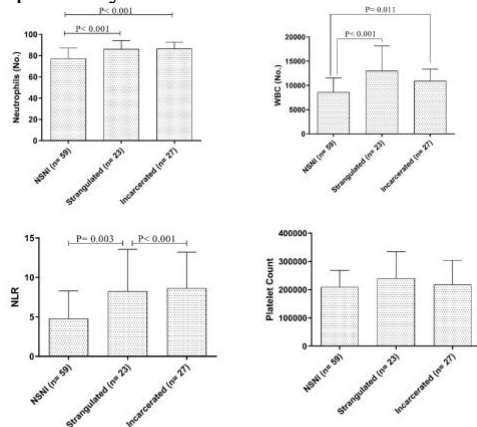


Fig. 1. Comparison of WBC, neutrophil, and platelet counts, and NLR between the three groups.

Data are reported as mean  $\pm$  SD. NSNI: Non strangulated and non-incarcerated; NLR: neutrophil to lymphocyte ratio.

The perioperative and operative data in addition to surgical history of the patients in each group are shown in Table 1. The variables such as direct or indirect hernia, the history of laparotomy, and the involvement of the left or right side hernia were not associated with strangulated hernia.

The results of body temperature between the groups showed the percentage of people who had a body temperature above 37.2 °C in strangulated and incarcerated inguinal hernia groups was significantly higher than the NSNI group. The ABG pH results showed no significant difference between different groups. As shown in Table 1, history of enlarged prostate size increases the risk of strangulated hernia. The rate of small intestine involvement in the hernia sac was significantly higher in the strangulated group. Moreover, the results

showed that there is no significant relationship between small intestine incarceration and the risk of developing strangulated hernia.

Table 1. Medical history, perioperative and operative data.

|                     |                           | Incarcerated (n=27) (%) | Strangulated (n=23) (%) | Group1* (n=59) (%) | P-value      |
|---------------------|---------------------------|-------------------------|-------------------------|--------------------|--------------|
| Hernia sac contents | Omentum                   | -                       | 3 (13)                  | 21 (35.6)          | <b>0.001</b> |
|                     | Small bowel               | 21 (77.8)               | 17 (74)                 | 25 (42.2)          |              |
|                     | Colon                     | 6 (22.2)                | 3 (13)                  | 13 (22.2)          |              |
| Type of hernia      | Indirect                  | 27 (100)                | 22 (95.7)               | 56 (94.9)          |              |
|                     | Direct                    | -                       | 1 (4.3)                 | 3 (5.1)            |              |
| Laparotomy history  | Positive                  | 5 (18.5)                | 6 (26.1)                | 14 (23.7)          |              |
|                     | Negative                  | 22 (81.5)               | 17 (73.9)               | 45 (76.3)          |              |
| Time of onset       | >6h                       | 18 (66.7)               | 21 (91.3)               | 35 (59.3)          | <b>0.020</b> |
|                     | <6h                       | 9 (33.3)                | 2 (8.7)                 | 24 (40.7)          |              |
| Hernia surgery      | Positive                  | 4 (14.8)                | 0                       | 19 (32.2)          | <b>0.004</b> |
|                     | Negative                  | 23 (85.2)               | 23                      | 40 (67.8)          |              |
| Hernia side         | Left                      | 7 (25.9)                | 10 (43.5)               | 22 (37.3)          |              |
|                     | Right                     | 20 (74.1)               | 13 (56.5)               | 37 (62.7)          |              |
| Enlarged prostate   | Yes                       | 14 (51.9)               | 16 (69.6)               | 20 (33.9)          | <b>0.013</b> |
|                     | No                        | 13 (48.1)               | 7 (30.4)                | 39 (66.1)          |              |
| Temperature         | $\geq 37.2^\circ\text{C}$ | 10 (43.4)               | 11 (47.8)               | 11 (18.6)          | <b>0.019</b> |
|                     | $< 37.2^\circ\text{C}$    | 12 (44.4)               | 10 (43.5)               | 40 (67.8)          |              |

\* NSNI: Non Strangulated-Non Incarcerated.

As shown in the Table 2, no significant differences in the incidence of past medical history of the patients were observed between the three groups.

Table 2. History of chronic diseases in the groups

| Variables                | Incarcerated (n=27) (%) | Strangulated (n=23) (%) | Group1* (n=59) (%) | P-value |
|--------------------------|-------------------------|-------------------------|--------------------|---------|
| Diabetes                 | 3 (11.1)                | 3 (13)                  | 3 (5.1)            | 0.169   |
| Congestive heart disease | 4 (14.8)                | 7 (30.4)                | 9 (15.3)           | 0.225   |
| Blood pressure           | 4 (14.8)                | 5 (21.7)                | 7 (11.9)           | 0.264   |
| Stroke                   | 0                       | 1 (4.3)                 | 1 (1.7)            | 0.709   |
| Cirrhosis                | 0                       | 0                       | 1 (1.7)            | 0.541   |
| Rheumatoid Arthritis     | 0                       | 1 (4.3)                 | 0                  | 0.459   |
| Neurofibromatosis        | 1 (3.7)                 | 0                       | 1 (1.7)            | 0.709   |
| Chronic heart disease    | 0                       | 0                       | 1 (1.7)            | 0.541   |
| Undescended testis       | 0                       | 0                       | 2 (3.4)            | 0.291   |

\* NSNI: Non Strangulated-Non Incarcerated. Chi-Square test was performed for data analysis.

Evaluation of WBC, neutrophils, platelets count, and neutrophil to lymphocyte ratio blood levels showed that, except for platelets blood levels, other biomarkers were significantly higher in the strangulated-incarcerated group. The sensitivity of the tests were 0.84, 0.85, and 0.84, respectively. Also, the diagnostic value cut-off points for each of the tests were 9150-9250, 81-84, and 4.71-4.94, respectively (Fig 2).

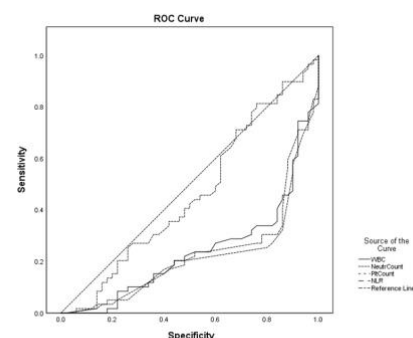


Fig. 2. Evaluation of WBC, neutrophils, platelets count, and neutrophil to lymphocyte ratio blood levels using ROC curve.

## Discussion

Some of the studies in the literature has only investigated the percentage of strangulated hernias while others have determined the diagnostic value of biomarkers and their cut-off point. Alvarez et al. showed that 13% of incarcerated hernia required removal of necrotic tissue (14). According to a report by Kurt et al., the need to remove necrotic tissue in incarcerated hernia was 15% (15). The incidence of strangulated hernia in the present study was 21.1%. The results of the present study has been close to the study results of Kurt et al. who reported a rate of 15 per cent (15).

In a similar study, Zhou et al. evaluated 263 emergency inguinal hernia operation cases. The blood levels of neutrophils count, WBC, and NLR in patients with strangulated and incarcerated hernia were compared. Among them, 128 patients had incarcerated hernia and 135 patients had strangulated hernia. They showed that the blood levels of neutrophils, WBC and NLR in patients with strangulated hernia were significantly higher than incarcerated hernia group. Also, the diagnostic sensitivity for NLR, WBC and neutrophils count were 75, 65.5 and 68%, respectively. They reported a cut-off point of 6.41 for NLR, with sensitivity and specificity of 75 and 69% (6). Also, Xie et al. investigated NLR and the risk of strangulated hernia. 95 patients were examined, among them, 36 patients had strangulated hernia and 59 patients had incarcerated hernia. The study results showed that NLR levels, intestinal obstruction and the duration of onset of symptoms until surgery (more than 26 h) could estimate strangulation of hernia before surgery. Considering the cut-off point of 11.5 for NLR, these researchers reported the sensitivity and specificity of this cut-off point 44 and 92% respectively (16). In our study, the cut-off point for NLR was 4.825,

with sensitivity and specificity of 84 and 69.5%.

In a cross-sectional study conducted by Peng et al., who examined 323 patients requiring emergent hernia surgery, NLR and gastrointestinal obstruction were regarded as strangulation indicators (17). Kahramanca et al. showed NLR levels above 4.68 to be diagnostic for acute appendicitis and levels above 5.74 for differentiation between simple and complicated appendicitis (12). In this regard, Alimoglu et al. showed that NLR can be much more important for diagnosing the type of appendicitis than variables such as WBC, neutrophils count and CRP (18). Lee et al., showed that NLR levels above 3 could predict severe cholecystitis in patients with cholecystitis (19). Koksall et al. showed that, the probability of intestinal necrosis in hernia is increased significantly when NLR level increased above  $7.72 \pm 5.69$  (20). Although the study of some of these researchers differs in terms of the type of disease with the present study, the NLR cut-off points presented are very close to the cut-off points obtained from the present study.

Although the present study has attempted to use all the data possible for a 5-year period of emergency inguinal hernia operations in a tertiary referral hospital, the low volume and less biomarkers used, is some of important limitations in this study. Therefore, it is suggested to use larger sample size, evaluate diagnostic values of other indicators such as ESR and CRP and other hernias such as femoral hernia in future studies.

The ratio of neutrophils to lymphocytes, neutrophils and WBC counts could be good predictors of strangulated inguinal hernia.

## Conflict of interest

Author declares no conflict of interest.

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