

The Role of Neutrophil Lymphocyte Ratio in Predicting Acute Appendicitis in Adult

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Abstract

Introduction: Acute appendicitis is one of the most common causes of acute abdomen with lifetime occurrence of approximately 7% and with perforation of 17-20%.¹ There are various scoring systems and investigations which are used to ruling in the conditions but none of these are 100% accurate. The aim of this study was to observe relationship between neutrophil lymphocyte ratio (NLR) and simple and complicated acute appendicitis.

Methods: This is a prospective observational study conducted for a period of 12 months. Clinical, laboratory and USG parameters were used to diagnose acute. HPE findings were taken as final diagnosis and the objective of the study compared.

Results: Total of 100 patients were evaluated in this study. The mean age of the patients with acute appendicitis in this study was 30 years. The mean Alvarado score in this study was 7 and the mean NLR was 6.6. In this study, 24% of case who had TLC of more than 10000 per cubic millimeter had complicated appendicitis ($p=0.685$). 16% of total cases had complicated acute appendicitis with neutrophil percentage between 81%-90%, 20% with NLR >8 had complicated acute appendicitis and 20% with NLR >8 had HPE proven complicated acute appendicitis ($p=0.001$)

Conclusion: Both neutrophil percentage and NLR were statistically significant in differentiating complicated acute appendicitis from simple acute appendicitis than total leucocyte count alone as shown by study.

Keywords: acute appendicitis, Alvarado score, neutrophil percentage, NLR ratios

INTRODUCTION

Acute appendicitis is one of the most common causes of acute abdomen with lifetime occurrence of approximately 7% and with perforation of 17-20%.¹ Acute appendicitis is common in childhood and early adult life with a peak incidence between 10 and 30 years of age.² Incidence in males and female are equal before puberty. In teenagers and young adult the male female ratio increases to 3:2 at age 25, thereafter greater incidence in male declines.³ migratory right iliac fossa pain and leukocytosis are classical signs and symptoms but these symptoms are not always constant posing a diagnostic challenge⁴ especially in the elderly and in female patients in whom gynecological pathology may mimic acute appendicitis. The morbidity and mortality rises if the appendix perforates before the surgical interventions. There are various scoring systems and investigations which are used to ruling in the conditions but none of these are 100% accurate. Among these Alvarado is the most used and best known clinical scoring system for estimating risk of appendicitis⁵ and leukocytosis⁶, the most used laboratory parameter. To date, reliable specific marker of acute appendicitis has not yet been identified.

Moreover, the variability in appendicular locations such as in retrocecal appendicitis may not allow patients to exhibit enough peritoneal signs to support the diagnosis of acute appendicitis. To overcome morbidity and mortality of perforation before surgery, a negative appendectomy is somewhat acceptable traditionally but many have considered this unacceptable since the operation itself is a cause of morbidity and mortality.⁷

Despite advances in investigation modalities, the rate of negative appendectomies remains between 15% and 50%.⁷ Neutrophil to lymphocyte ratio (NLR) has been uses frequently in recent years to diagnosis of acute appendicitis⁸ and to differentiate complicated from non-complicated appendicitis thus reducing the rate of negative appendectomy. We conducted a study to evaluate the relationship between neutrophil lymphocyte ratio (NLR) and simple and complicated acute appendicitis.

METHODS

This is a prospective observational study conducted at Bir Hospital, NAMS for a period of 12 months after obtaining approval from institutional review board (IRB) .A total of 100 cases were included in this study using sample size calculation formula

$$N=Z^2 \times P \times Q/D^2$$

Where, N=sample size

Z=confidence interval (1.96 for confidence interval of 95%)

P=reported incidence (here 7% i.e. 0.07)

Q= 1-P=0.93

D=margin of error (here 1% of 7 i.e. 0.07)

After calculation, N= 100.03 i.e. 100 cases.

All cases of appendicitis in the hospital during the study period who presented with right iliac fossa pain with Alvarado score of ≥ 7 or USG showing blind tubular non peristaltic structure measuring >6 mm were included using non randomized convenience sampling technique. All cases admitted and operated with diagnosis of acute appendicitis over a period of 12 months were included in the study. Cases excluded were age <15 years and >80 years, patients with DM, pregnancy, HIV, HBsAg, HCV positive status or taking immunosuppressant, intraoperative finding of other pathology, patients diagnosed with appendicular lump and those managed conservatively and patient who did not give informed consent.

Simple appendicitis was considered if intraoperative finding was acutely inflamed appendix with healthy base and graded as G1. Complicated appendicitis was considered if finding was gangrenous and or perforated and graded as G2.

Procedural details:

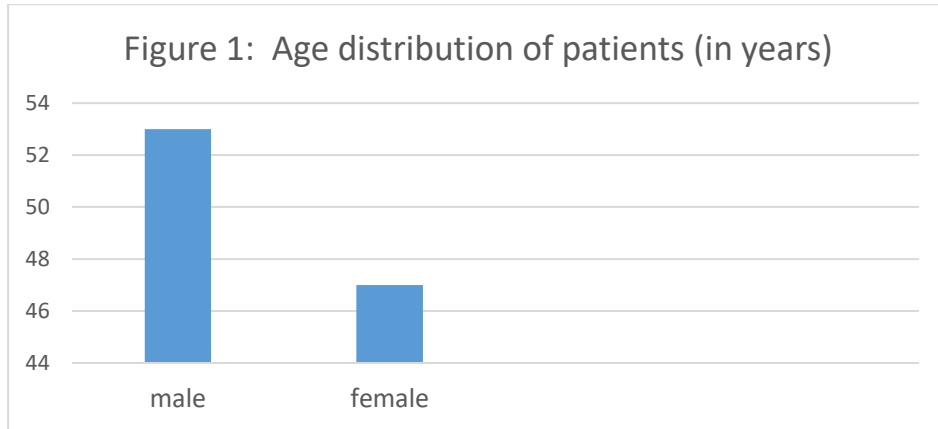
Upon receiving the case fulfilling the inclusion criteria he or she was given adequate explanation about the procedure and about the study. He or she was assured of full confidentiality and timely appendectomy and informed consent was taken subsequently. Data collection was continued until the required sample was attained.

Patients were initially evaluated by surgery resident on call at emergency and detail history, clinical examination were done. Demographic data were collected which included age, sex, and occupation. USG abdomen and pelvis was done in patient with who had equivocal signs. Acute appendicitis was diagnosed in patient with right iliac fossa pain with Alvarado score of ≥ 7 and or USG abdomen and pelvis showing blind tubular peristaltic structure measuring ≥ 6 mm. routine complete haemogram was done on admission to hospital. Leucocyte count and neutrophils percentage were measured by automated hematology analyzer. Neutrophil to lymphocyte ratio was calculated by dividing the percentage value of neutrophils and lymphocyte obtained and data were collected. Leukocytosis was accepted for TLC level of higher than 10000 per cubic millimeter. Intraoperative finding of appendix was noted and graded as G1 for simple appendicitis and G2 for gangrenous and perforated appendix. Pathology reports was used to determine whether appendix was inflamed or not. Retrieved specimen was preserved in 10% formaldehyde containing jar for histopathological examination. The final diagnosis of acute appendicitis was based on histological findings.

The data was entered into computer using SPSS software. Patients were classified into different study groups based on age, sex, TLC, neutrophil percentage, NLR and intraoperative grading of acute appendicitis. Statistical analysis was done using chi-square test. A 95% confidence interval was taken and P value of less than 0.05 was taken as statistical significant. Results were expressed in the form of tables, graphs and diagrams.

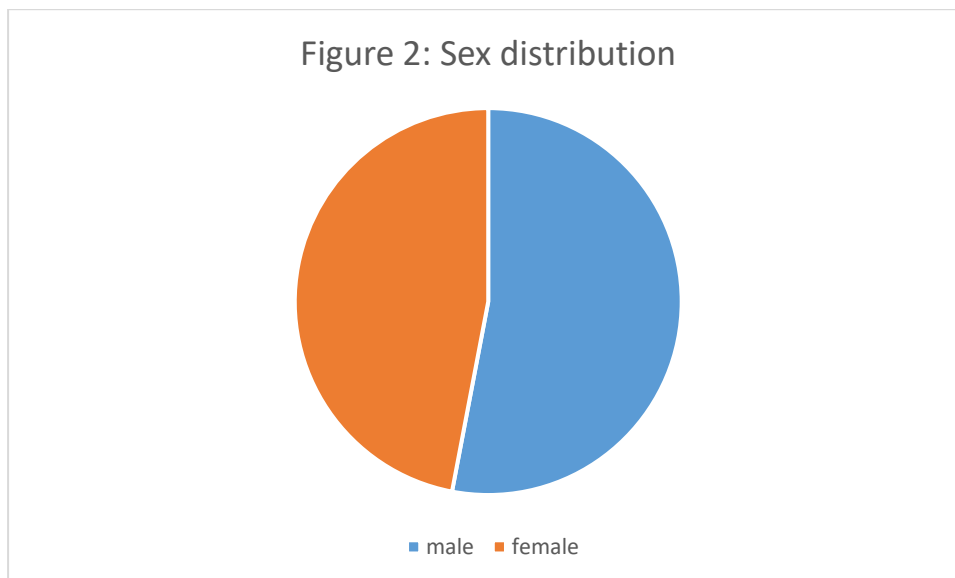
RESULTS

1. Demographics



Out of 100 patients who were operated for acute appendicitis in Bir hospital during duration of 12 months of study period most of them were in the age group of 15-30 years (63%). The mean age of the patients was 30 years. (fig.1)

2. Sex distribution



Out of 100 patients 53% were male and 47% were female. The male to female ratio is 1.12:1 (fig.2)

Table no.1 frequency distribution table of neutrophil percentage

Neutrophil percentage	Frequency	Percentage
60-70	14	14
71-80	29	29
81-90	45	45
91-100	12	12
Total	100	100

Out of 100 patients, majority of patients i.e. 45% had neutrophil percentage of 81-90%, 29% patients had 71-80% of neutrophil, 14% had 60-70% neutrophils and the least i.e. 12% had neutrophil of 91-100%. The mean neutrophil percentage was 82.14.

Table no.2 frequency distribution table for TLC

TLC(mm ³)	Frequency	Percentage
<5000	18	18
5000-10000	9	9
>10000	73	73
Total	100	100

Out of 100 cases, 18 had TLC of <5000 cubic millimeter (18%). 9 patients had TLC of 5000-10000/mm³ (9%). 73 patients had TLC of >10000/mm³ (73%). The mean TLC was 12760/mm³.

Table no.3 TLC and intraoperative grading of acute appendicitis

TLC(mm ³)	Intraoperative grade of acute appendicitis		Total	P value
	Simple appendicitis	Complicated appendicitis		
<5000	11	7	18	0.685
5000-10000	7	2	9	
>10000	49	24	73	
Total	67	33	100	

24 percent of case who had TLC of more than 10000/mm³ had complicated appendicitis and 49 % had simple appendicitis. In group of TLC of 5000-10000/mm³ only 7% had simple appendicitis and 2% had complicated appendicitis. Whereas 11% patients with TLC of less than 5000/mm³ had simple appendicitis and 7% had complicated appendicitis. The p value of this comparison was 0.685 which was also significance.

Table no. 4 neutrophil percentage and intraoperative grading of acute appendicitis

Neutrophil percentage	Intraoperative grade of acute appendicitis		Total	P value
	Simple appendicitis	Complicated appendicitis		
60-70	13	1	14	0.001
71-80	24	5	29	
81-90	29	16	45	
91-100	1	11	12	
Total	67	33	100	

While comparing neutrophil percentage with intraoperative grading of acute appendicitis, 11% of cases with range of 91-100% neutrophil count had complicated appendicitis, 16 cases were of complicated appendicitis with neutrophil of 81-90% whereas 29 cases had simple appendicitis. In group of 71-80% neutrophils 24% had simple appendicitis and 5% had complicated appendicitis. In group of 60-70% neutrophils 13% had simple appendicitis and only 1 case had complicated appendicitis. The p value of this study is 0.001 which was statistically significant.

Table no. 5 NLR and intraoperative grade of acute appendicitis

NLR	Intraoperative grade of acute appendicitis		Total	P value
	Simple appendicitis	Complicated appendicitis		
<3	14	1	15	0.001
3-5	24	3	27	
5.1-8	21	9	30	
>8	8	20	28	
Total	67	33	100	

Out of 100 cases, 20 cases with NLR of more than 8 had complicated appendicitis and 8 were of simple appendicitis. Only 9 cases with NLR of 5.1-8 had complicated appendicitis and 21 cases had simple appendicitis. While in NLR group of 3-5, 24% of patients had simple appendicitis and 3 had complicated appendicitis. Only single patient had complicated appendicitis in NLR group of less than 3 whereas 14 cases had acutely inflamed appendix with healthy base. The p value of this comparison was 0.001. The mean NLR was 6.6.

Table no.6 NLR and histopathological grade of acute appendicitis

NLR	Histopathological grade of acute appendicitis		Total	P value
	Simple appendicitis	Complicated appendicitis		
<3	14	1	15	0.001
3-5	24	3	27	
5.1-8	21	9	30	
>8	8	20	28	
Total	67	33	100	

In NLR of more than 8, 20 cases had complicated appendicitis. In NLR group of 5.1-8, 9 had complicated appendicitis. In the group of 3-5, 3 had complicated appendicitis. Similarly only single case had complicated appendicitis in NLR less than 3. The p value of this comparison is 0.001

Table no.7 Sex and intraoperative grading of acute appendicitis

Sex	Histopathological grade of acute appendicitis		Total
	Simple appendicitis	Complicated appendicitis	
Female	31	16	47
male	36	17	53
Total	67	33	100

Out of 100 patients 16 female and 17 male patients had complicated appendicitis.

DISCUSSION

Emergency open appendectomy even though is one of the commonly performed surgery worldwide for acute appendicitis, clinical diagnosis remain the mainstay for diagnosis of the condition. Various scoring system, laboratory parameters and radiological investigations has been utilized as armamentarium in diagnosis but none is 100% accurate. Because appendicular perforation has significant impact in morbidity, mortality and outcome after surgery, it is very much important to diagnose it early and remove it surgically. This has led to acceptance of negative appendectomy somewhat to overcome morbidity and mortality owing to perforation. However, recently many have considered negative appendectomy unacceptable because of morbidity and mortality associated with surgery itself and various studies challenging the surgical treatment of simple appendicitis with antibiotics alone.

The classical presentation of acute appendicitis with pain periumbilical region which later on migrate and localize to RIF is only present in about 60% cases, many present with atypical

features especially in children, elderly, immunocompromised and female patients owing to position of vermiform appendix and gynecological conditions mimicking acute appendicitis. Various literature shows that 2-7% of all adults on exploration have disease other than appendicitis. A definitive diagnosis of acute appendicitis can only be made at operation and after histopathological examination of the resected specimen.

The incidence of acute appendicitis is most in the second decade of life and the life time risk of having acute appendicitis is about 8.6% for males and 6.7% for females and the lifetime risk of appendectomy is 12.0% for male and 23.1% for females. The highest incidence of appendicitis was found in persons aged 10-19 years. Male had higher rates of appendicitis than females for all age groups (overall ratio 1.4:1).

In this study, the mean age of the patients with acute appendicitis was 30 years of which 53% were male and 47% were female. The male to female ratio in my study was 1.12:1.

Lin, Kai-Biao⁹ found that appendicitis occurred frequently in male patients, with a higher incidence for those aged 15-29 years. After an epidemiological study of 971 cases Pieper R, found the incidence both appendicitis and appendectomies for both sexes occurred in the second decade of life (2.34/1000 and 3.63/1000 per annum, respectively. The peak incidence of acute appendicitis in people of Ghana was 25-29 year age groups in both male and female. Appendicitis was twice as common in male and in all age group. In a study done in patients in Nigeria the authors found that the overall mean age of acute appendicitis was 25.79 years (male 25.94 and female 25.43 years). The highest incidence in male and females occurred in the second and third decades, respectively. Noudeh, YJ¹⁰ in their observation found that incidence of acute appendicitis was highest in males aged 20-29 years whereas in females the highest incidence was observed in 10-19 years age group. Makaju, R in study conducted in Kathmandu university hospital, dhulikhe, kavre, Nepal reported that the mean age of acute appendicitis in Nepalese people was 30 years.¹¹

In this study, complicated appendicitis was associated with age group of 15-30 years which came to be 22 percent out of 100 whereas there was no complication in elderly patient which was totally against many research. This could be because of very less number of patients with age group more than 60 years in the study.

In the study by Teixeira et al¹² finding of perforated appendix was consistent with age \geq 55 yrs. ($p < 0.001$). Similarly, study by Nshuti et al.¹³ showed that complicated appendicitis was associated with age > 45 yrs.

In this study only 17 percent out of total who had complicated appendicitis were male and 16 were female ($p = 0.117$) which was insignificant. In my study, finding of complicated appendix was independent of gender of patient. This is in contrast with the finding of the study by Ditillo et al.¹⁴ In which advanced pathology was associated with the female gender ($p = 0.006$). Study

by Teixeira et al. also related female gender with perforation of appendix ($p=0.024$). in contrast to above studies, study by Khorasani and Pasha¹⁵ showed higher perforated appendix in males($p=0.001$). similar finding of higher complication rate was seen in males in study by Nshuti et al. however, study by korner et al. ¹⁶ showed no relation of perforated appendicitis with gender.

In our study mean TLC was $>12760/\text{mm}^3$, mean neutrophil percentage was 82.14%, mean Alvarado was 7 and mean NLR was 6.6. only 19% cases with Alvarado score >7 had complicated appendicitis($p=0.118$) and 24% cases with TLC $>10000/\text{mm}^3$ had complicated appendicitis($p=0.685$) whereas 16% cases with neutrophil percentage of 81-90 and 11% with neutrophil percentage 91-100 had complicated appendicitis($p=0.001$) and NLR >8 , 20% had complicated appendicitis ($p=0.001$) which were both statistically significant. Similar result of increased total count $>10000/\text{mm}^3$ was seen in 63% of all patients in a study by Abdelkarim et al.¹⁷ In contrast, leukocytosis ($\text{WBC}>10000/\text{mm}^3$) was observed with 92% of non-perforated appendicitis and 95% of perforated appendicitis in a study by khorsani and pasha. Study by chamisa ¹⁸ showed that total count $>10000/\text{mm}^3$ was seen in 33.9% of patients.

In this study, complicated appendicitis was not significantly associated with preoperative total count ($p=0.53$). However, study by Teixeira et al. showed that total count $>16000/\text{mm}^3$ was associated with perforated appendicitis. In a study by Shabaz et al¹⁹, leucocyte count $>18000/\text{mm}^3$ was statistically higher in patients with complicated appendicitis($p<0.05$) and neutrophil ratio was higher in complicated appendicitis though the difference was not statistically significant ($p>0.05$). however, WBC count had no diagnostic value in differentiating between uncomplicated and complicated groups($p=0.086$) in a study by Keskek et al²⁰, Anderson et al²¹ and Shaw et al²² also agree that normal inflammatory markers do not rule out appendicitis. Birchley et al²³ report that raised TLC can differentiate acute appendicitis from not appendicitis. Prof Agrawal et al²⁴ reported sensitivity of 78.6% and specificity of 54.8%.

In the study done by Kahramanca, NLR of 4.68 was associated with acute appendicitis. A NLR of 5.74 was associated with complicated appendicitis.²⁵ Shimizu, Takayuki in his research noted that NLR of >5 was the most useful predictor of severe acute appendicitis with OR 0.421 and $p=0.010$.²⁶ Similarly Goodman, D. A found that 88% of patients with acute appendicitis had neutrophil to lymphocyte ratio of more than equal to 3.5 which was very significant statistically ($p=0.001$).⁸ Another author Ishizuka, Mitsuru conducted a study. In his study he found that NLR of >8 showed a significant association with gangrenous appendicitis in patient undergoing appendectomy with sensitivity of 73% and specificity of 39%.²⁷ Marker, S. R. did a study in 1117 patients to validate NLR in diagnosing acute appendicitis. He included neutrophil lymphocyte ratio, WCC, CRP and NLR x CRP and compared postoperative histology. ROC curve was made which showed NLR of 0.836 compared to 0.779 for WCC , 0.732 for CRP and 0.815 for NLR x CRP showing that NLR has greater diagnostic accuracy

than either WCC or CRP alone with adjunct to clinical examination.²⁸ E. Yavuzi found that 3.93 was cut off value sensitive with 92% and 59.3% specific to diagnose acute appendicitis whereas he found no statistical significance difference between distribution of age, lymphocyte count, and gender. He concluded that preoperatively, the estimated neutrophil/lymphocyte ratio can be accepted as easily available, adjunctive data that contributes to the diagnosis of appendicitis at a lower cost.²⁹ As useful tool in diagnosing acute appendicitis Bialas, M performed a study in 469 patients and found that NLR of more than equal to 3.5 had higher sensitivity (77.5% vs 55%) but lower specificity (73.3% vs 81.6%) than leukocytosis and concluded that NLR has higher sensitivity than leukocytosis, especially in appendicitis phlegmonosa and gangrenous and due to easiness of calculation and still higher rate of false positive and negative diagnoses, NLR is worth using in establishing the diagnosis of appendicitis.³⁰ M. Eroglu in his work used neutrophil and lymphocyte ratio to diagnose acute phlegmonous appendicitis. In 153 patients he compared NLR with WBC and percentage of neutrophil. A threshold NLR value for phlegmonous appendicitis was 8 which had sensitivity and specificity of 100% and 81.6%, respectively.³¹

CONCLUSIONS

Both neutrophil percentage and NLR were statistically significant in differentiating complicated acute appendicitis from simple acute appendicitis than total leucocyte count alone as shown by different study. Since neutrophil and lymphocyte ratio can be easily calculated and this investigation is easily available, this could prove help in decision making preoperatively in regard to diagnosis and differentiating acute simple and complicated appendicitis. However there are certain limitations in our study. Since this is a single institution study and the sample size is small and we have excluded children and a significant portion of elderly population which could have changed the result.

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Conflicts of interest: None

REFERNCES

1. Storm-Dickerson TL, Horattas MC. What have we learned over the past 20 years about appendicitis in the elderly? *Am J Surg.* 2003 Mar 1;185(3):198–201.
2. Addiss DG, Shaffer N, Fowler BS, Tauxe R V. THE EPIDEMIOLOGY OF APPENDICITIS AND APPENDECTOMY IN THE UNITED STATES. *Am J Epidemiol* [Internet]. 1990 Nov 1 [cited 2022 Mar 15];132(5):910–25. Available from: <https://academic.oup.com/aje/article/132/5/910/88731>

3. Surgery PT-AJ of, 2014 undefined. Bailey and Love's Short Practice of Surgery; Edited by NS Williams, CJK Bulstrode and PRO'Connell. Boca Raton, FL: CRC Press, 2013. 1517 pages. infona.pl [Internet]. [cited 2022 Mar 16]; Available from: <https://www.infona.pl/resource/bwmeta1.element.wiley-ans-v-84-i-3-ans12504>
4. McCartan D, Fleming F, surgeon PG-T, 2010 undefined. of right iliac fossa pain–Is timing everything? Elsevier [Internet]. [cited 2022 Mar 16]; Available from: <https://www.sciencedirect.com/science/article/pii/S1479666X09000493>
5. medicine AA-A of emergency, 1986 undefined. A practical score for the of acute appendicitis. Elsevier [Internet]. [cited 2022 Mar 16]; Available from: <https://www.sciencedirect.com/science/article/pii/S0196064486809933>
6. Yang HR, Wang YC, Chung PK, Chen WK, Jeng L Bin, Chen RJ. Role of Leukocyte Count, Neutrophil Percentage, and C-Reactive Protein in the Diagnosis of Acute Appendicitis in the Elderly: <https://doi.org/10.1177/000313480507100414> [Internet]. 2005 Apr 1 [cited 2022 Mar 16];71(4):344–7. Available from: <https://journals.sagepub.com/doi/abs/10.1177/000313480507100414>
7. Schellekens DHSM, Hulsew KWE, Van Acker BAC, Van Bijnen AA, De Jaegere TMH, Sastrowijoto SH, et al. Evaluation of the diagnostic of markers for in suspected for acute appendicitis. Wiley Online Libr [Internet]. 2013 Jul [cited 2022 Mar 16];20(7):703–10. Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1111/acem.12160>
8. Goodman DA, Goodman CB, Monk JS. Use of the neutrophil:lymphocyte ratio in the diagnosis of appendicitis. Am Surg [Internet]. 1995 Mar 1 [cited 2022 Mar 16];61(3):257–9. Available from: <https://europepmc.org/article/med/7887542>
9. Lin KB, Chan CL, Yang NP, Lai RK, Liu YH, Zhu SZ, et al. Epidemiology of appendicitis and appendectomy for the low-income population in Taiwan, 2003-2011. BMC Gastroenterol. 2015 Feb 13;15(1).
10. Noudeh Y, Sadigh N, surgery AA-I journal of, 2007 undefined. Epidemiologic features, variations and false positive rate of acute appendicitis in Shahr-e-Rey, Tehran. Elsevier [Internet]. [cited 2022 Mar 16]; Available from: <https://www.sciencedirect.com/science/article/pii/S174391910600080X>
11. Makaju R, Mohammad A, medical AS-KU, 2010 undefined. Acute appendicitis: of 518 histopathologically diagnosed cases at the Kathmandu University Hospital, Nepal. nepjol.info [Internet]. 2010 [cited 2022 Mar 16];8(2):227–30. Available from: <https://www.nepjol.info/index.php/KUMJ/article/view/3564>
12. Teixeira P, Sivrikoz E, Inaba K, ... PT-A of, 2012 undefined. Appendectomy timing:

waiting until the next morning increases of surgical site infections. journals.lww.com [Internet]. [cited 2022 Mar 16]; Available from: https://journals.lww.com/annalsofsurgery/FullText/2012/09000/Appendectomy_Timing__Waiting_Until_the_Next.16.aspx

13. Nshuti R, Kruger D, Luvhengo TE. Clinical presentation of acute appendicitis in adults at the Chris Hani Baragwanath academic hospital. *Int J Emerg Med.* 2014;7(1).

14. Ditillo M, Dziura J, surgery RR-A of, 2006 undefined. Is it safe to delay appendectomy in with acute appendicitis? ncbi.nlm.nih.gov [Internet]. [cited 2022 Mar 16]; Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/pmc1856602/>

15. Khorasani B, Sciences AP-RJ of B, 2009 undefined. Effects of two new risk factors on perforated and non-perforated appendicitis. cabdirect.org [Internet]. [cited 2022 Mar 16]; Available from: <https://www.cabdirect.org/cabdirect/abstract/20103093838>

16. Körner H, Söndena K, Söreide JA, Andersen E, Nysted A, Lende TH, et al. Incidence of acute nonperforated and perforated appendicitis: Age- specific and sex-specific analysis. *World J Surg.* 1997;21(3):313–7.

17. Omari AH, Khammash MR, Qasaimeh GR, Shammari AK, Yaseen MKB, Hammori SK. Acute appendicitis in the elderly: Risk factors for perforation. *World J Emerg Surg.* 2014 Jan 15;9(1).

18. Surgeons IC-TA of TRC of, 2009 undefined. A clinicopathological review of 324 appendices removed for acute appendicitis in Durban, South Africa: a retrospective. publishing.rcseng.ac.uk [Internet]. 2009 Nov [cited 2022 Mar 16];91(8):688–92. Available from: <https://publishing.rcseng.ac.uk/doi/abs/10.1308/003588409X12486167521677>

19. Şahbaz N, Bat O, Kaya B, Ulukent S, ... Öİ-TJ of, 2014 undefined. The clinical value of leucocyte count and neutrophil in diagnosing uncomplicated (simple) appendicitis and predicting complicated appendicitis. tjtes.org [Internet]. [cited 2022 Mar 17]; Available from: <https://tjtes.org/jvi.aspx?pdire=travma&plng=eng&un=UTD-75044&look4=>

20. Keskek M, Tez M, Yoldas O, Acar A, Akgul O, Gocmen E, et al. Receiver operating characteristic analysis of leukocyte counts in operations for suspected appendicitis. *Am J Emerg Med.* 2008 Sep 1;26(7):769–72.

21. Surgery RA-J of B, 2004 undefined. Meta-analysis of the clinical and laboratory of appendicitis. academic.oup.com [Internet]. [cited 2022 Mar 17]; Available from: <https://academic.oup.com/bjs/article-abstract/91/1/28/6143626>

22. Vaughan-Shaw P, Rees J, Bell E, Hamdan M, Platt T. Normal inflammatory markers

in appendicitis: evidence from two independent cohort studies. *JRSM Short Rep.* 2011 May;2(5):1–8.

23. Birchley D. Patients with clinical acute appendicitis should have pre-operative full blood count and C-reactive protein assays. *Ann R Coll Surg Engl.* 2006 Jan;88(1):27–32.

24. Agrawal CS, Adhikari S, Kumar M. Role of serum C-reactive protein and leukocyte count in the diagnosis of acute appendicitis in Nepalese population.

25. Kahramanca Ş, Özgehan G, Şeker D, ... EG-TJ of, 2014 undefined. Neutrophil-to-lymphocyte as of acute appendicitis. *tjtes.org* [Internet]. [cited 2022 Mar 17]; Available from: <https://tjtes.org/jvi.aspx?pdire=travma&plng=eng&un=UTD-20688&look4=>

26. Shimizu T, Ishizuka M, Kubota K. A lower neutrophil to lymphocyte ratio is closely associated with catarrhal appendicitis versus severe appendicitis. *Surg Today.* 2016 Jan 1;46(1):84–9.

27. Ishizuka M, Shimizu T, surgery KK-I, 2013 undefined. Neutrophil-to-lymphocyte has a close association with gangrenous appendicitis in undergoing appendectomy. *meridian.allenpress.com* [Internet]. [cited 2022 Mar 17]; Available from: <https://meridian.allenpress.com/international-surgery/article-abstract/97/4/299/115739>

28. Markar SR, Karthikesalingam A, Falzon A, Kan Y. The diagnostic value of neutrophil: Lymphocyte ratio in adults with suspected acute appendicitis. *Acta Chir Belg.* 2010;110(5):543–7.

29. Yavuz E, ERÇETİN C, ... EU-T journal of, 2014 undefined. DIAGNOSTIC VALUE OF NEUTROPHIL/LYMPHOCYTE RATIO IN GERIATRIC CASES WITH APPENDICITIS. *search.ebscohost.com* [Internet]. [cited 2022 Mar 17]; Available from: <http://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=13042947&AN=102321972&h=dHHjA1hxU583hdP4dKrH%2FJltBCxdh1JyO3x7zcVUywCy8eh%2FiSFqPMOFW9u%2B3a4HiS2iCAX4kuGpAgo5cvQJ0A%3D%3D&crl=c>

30. Białas M, Taran K, (Warsaw MG-..., 1960 P, 2006 undefined. Evaluation of neutrophil-lymphocyte usefulness in the of appendicitis. *europemc.org* [Internet]. [cited 2022 Mar 17]; Available from: <https://europemc.org/article/med/17338113>

31. Eroglu M, Ozdemir Y, Balta A, ... AY-O journal of the, 2013 undefined. Use of Neutrophil/Lymphocyte Ratio in Diagnosis of Phlegmonous Appendicitis: 620. *journals.lww.com* [Internet]. [cited 2022 Mar 17]; Available from: https://journals.lww.com/ajg/fulltext/2013/10001/use_of_neutrophil_lymphocyte_ratio_in_diagnosis_of.620.aspx