ORIGINAL ARTICLE

"MICROBIOLOGICAL ANALYSIS OF APPENDECTOMY SPECIMENS AND ITS CORRELATION WITH POSTOPERATIVE WOUND INFECTIONS"

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Abstract

Introduction:
Acute appendicitis, a prevalent surgical emergency that frequently necessitates an appendectomy. It underscores the critical complication of postoperative wound infections, which can result in heightened morbidity and increased healthcare expenditures. The objective of this investigation is to analyze the predominant organisms identified in appendectomy specimens, along with their antibiotic resistance patterns, particularly in cases of complicated appendicitis, in order to assess their correlation with postoperative wound infections.

Materials and Methods:
A prospective observational study conducted over a 12-month period, focusing on patients undergoing appendectomy for suspected acute appendicitis. The study excluded individuals who had recently received antibiotics or who had immunocompromised conditions. Microbiological

profiles of appendectomy specimens and postoperative wound infections were collected and analysed. Data were analyzed using SPSS, employing statistical methods to determine significant associations, with a significance level set at $p < 0.05$.

Results:
The study found that Escherichia coli was the most common aerobic bacterium isolated in appendicectomy specimens and postoperative postoperative wound infection. Aminopenicillins and ceftriaxone showed the highest antibiotic resistance rates. Staphylococcus aureus was strongly associated with wound infections, while Escherichia coli showed a moderately positive association. Bacteroides species showed a negative association.

Conclusion:
This study confirms Escherichia coli as the primary pathogen in appendectomy-related wound infections, with significant implications for postoperative care. Despite its lower prevalence, Staphylococcus aureus shows a strong association with wound infections, emphasizing the need for vigilant screening and targeted prophylaxis. The observed resistance to Ampicillin, Amoxicillin and Ceftriaxone underscores the necessity for localized antimicrobial strategies. The potential protective role of Bacteroides species invites further exploration into microbial dynamics in surgical wounds.

Key words – Appendicitis, microbiological, E.coli, Bacteroids, Antibioticr resistance.

Introduction:
Acute appendicitis is acknowledged as one of the most common surgical emergencies worldwide, often necessitating an appendectomy as the definitive treatment [1]. While the procedure is generally straightforward, postoperative wound infections represent a considerable complication, leading to increased morbidity, prolonged hospital stays, and heightened healthcare costs [2]. A comprehensive understanding of the microbiological profile of appendectomy specimens may provide critical insights into the etiology of these infections and guide the development of more targeted prophylactic and therapeutic strategies [3]. The appendix, once considered merely a vestigial organ, is now recognized for its complex microbiota. Recent studies have highlighted the potential role of specific pathogens in the onset of appendicitis and the subsequent progression of postoperative wound infections [4,5]. Despite advancements in surgical techniques and perioperative management, the incidence of postoperative wound infections remains a significant concern, particularly in cases of complicated appendicitis, where microbial invasion is markedly more extensive [6].

This study aims to conduct an analysis of the microbiological profiles of appendectomy specimens and to investigate their correlation with postoperative wound infections. By identifying the most prevalent organisms associated with these infections and examining their antibiotic resistance patterns, this research will explore the relationship between microbiological findings in appendectomy specimens and postoperative wound infections. The findings may contribute to the refinement of perioperative management protocols, ultimately reducing the incidence of this significant complication.

Materials and Methods

The design and context of the study:

This prospective observational study was conducted over a 12-month period, from March 2023 to March 2024, at Department of General Surgery, Bharat Ratna Late Shri Atal Bihari Vajpayee Memorial Government Medical College in Rajnandgaon, Chhattisgarh, India. The study included patients of various ages and genders who underwent an appendectomy due to suspected acute appendicitis. Exclusion criteria included patients who received antibiotics within 48 hours prior to the surgical procedure, as well as individuals who are immunocompromised or who suffer from chronic inflammatory diseases.

Collection of Samples and Microbiological Analyses

Following an appendectomy, a sample was obtained from the lumen of the appendix using a sterile swab and subsequently transported to the laboratory in Robertson's meat broth [7,8]. Bacterial cultures were performed employing standard laboratory techniques, which included the use of blood agar, MacConkey agar, and anaerobic media. Antibiotic susceptibility testing was conducted in accordance with the guidelines established by the Clinical and Laboratory Standards Institute. Postoperative wound infections were monitored, and any infections identified were subjected to bacteriological examination, with cultures performed to identify the causative organisms.

Data Collection:

Patient demographic information, clinical presentations, and intraoperative findings were systematically documented. Postoperative wound infections were monitored throughout the duration of the hospital stay following surgery. These infections were classified according to the guidelines established by the Centers for Disease Control and Prevention, which categorize them as Superficial, Clean (C), Clean-Contaminated (CC), Contaminated (CO), and Dirty/Infected (D) [9]. The primary outcome assessed was the relationship between microbiological findings in appendectomy specimens and the incidence of postoperative wound infections. Additionally, the secondary outcome involved the identification of common bacterial pathogens in appendectomy specimens.

Statistical Analysis

Data were analyzed utilizing SPSS, Version X. Categorical variables were reported as frequencies and percentages, while continuous variables were expressed as means ± standard deviations (SD). The chi-square test was employed to assess associations among categorical variables. Logistic regression analysis was conducted to investigate the relationship between microbiological findings and postoperative wound infections, with a significance threshold established at $p < 0.05$.

Result:

The present study investigated bacterial isolates obtained from appendicectomy specimens and their correlation with postoperative wound infections. The findings indicated that Escherichia coli was the most frequently isolated aerobic bacterium, accounting for 43.97% of the appendicectomy specimens and 55.17% of the postoperative complications. Bacteroides species, an anaerobic bacterium, were identified in 29.31% of the appendicectomy specimens, with a prevalence of 10.34% in postoperative wound infections. Regarding antibiotic resistance, aminopenicillins (ampicillin and amoxicillin) exhibited the highest resistance rates, recorded at 18.97% in appendicectomy specimens and 24.14% in postoperative complications. Additionally, ceftriaxone and cefotaxime demonstrated significant resistance, particularly in the context of postoperative wound infection, with resistance rates of 20.69% and 17.24%, respectively. Statistical analysis revealed a significant association between specific bacterial species and the incidence of wound infections. Staphylococcus aureus was found to be strongly associated with wound infections, exhibiting a high odds ratio (OR = 11.87, 95% CI: 2.19 - 64.16, $p < 0.05$) and risk ratio (RR = 9.57). Escherichia coli also displayed a moderate positive association with wound infections (OR = 1.82, 95% CI: 0.83 - 4.00, $p < 0.05$). In contrast, Bacteroides species demonstrated a negative association with wound infections (OR = 0.2, 95% CI: 0.05 - 0.80, $p > 0.05$).

Table 1 . Patients characteristics (n=111)

Characteristic	**Value**	PERCENTAGE	
Age (yr)	39.8 ± 21.3		
Sex			
Female	32	28.82883	
Male	79	71.17117	

Table 2 : Bacterial Isolates

Characteristic	**Number of isolated bacteria in Appendicectomy Specimen**		**Number of isolated bacteria in postoperative wound infection**	
1(one organism isolated)	88	75.86	28	96.55
2(two organism isolated)	25	21.55	1	3.44
3(three organism isolated)	3	2.58	0	0
4(four organism isolated)	0	0	0	0
Total	**116**	**100**	**29**	**100**

Aerobic bacteria				
E.coli species	51	43.96	16	55.17
Klebiesella species	11	9.48	0	0
Enterobacter species	6	5.17	1	3.44
Proteus species	2	1.72	0	0
Pseudomonas species	3	2.58	1	3.44
Enterococcus	2	1.72	0	0
Staphylococcus aureus	2	1.72	6	20.68
Anaerobic bacteria				
Bacteroids	34	29.31	3	10.34
Clostridium perfringes	3	2.58	0	0
Anaerobic streptococcus	2	1.72	2	6.89
Total	**116**	**100**	**29**	**100**

Table 3 : Antibiotics resistant of isolated bacteria

	Number of Resistant Isolates in Appendicectomy Specimen	Percentage of Resistance	Number of Resistant Isolates in post operative wound infection	Percentage of Resistance
Ampicilline/Amoxicillin	22	18.96	7	24.13
Piperacillin/Tazobactam	4	3.44	2	6.89
Cefazolin	12	10.34	3	10.34
Ceftriaxone	13	11.20	6	20.68
Cefotaxime	14	12.06	5	17.24
Cefepime	11	9.48	2	6.89
Floroquinolones	8	6.89	0	0
TMP/SMX	10	8.62	1	3.44
Tetracycline	6	5.17	0	
Vancomycin	2	1.72	1	3.44
Imipenem/Meropenem	3	2.58	0	0
Aztreonam	7	6.03	2	6.89
Clindamycin/Macrolides	1	0.86	0	0
Metronidazole/Nitroimidazole	3	2.58	0	0
Total	**116**	**100**		**100**

Table 4: Statistical Analysis Table

Bacterial Species		Infection Group (Cases)	Non-Infection Group (Cases)	Odds Ratio (OR)	95% Confidence Interval (CI)	Risk Ratio (RR)	p-value
Escherichia coli	**present**	16	35				
	absent	13	52	1.82	0.83 - 4.00	1.62	**p < 0.05**
Staphylococcus aureus	**present**	6	2	11.87	2.19 - 64.16	9.57	**p < 0.05**

	absent	23	91				
Bacteroides species	**present**	3	31				
	absent	26	55	0.2	0.05 - 0.80	0.23	p > 0.05
Enterobacter species	**present**	1	5				
	absent	28	82	0.59	0.06 - 5.83	0.62	p > 0.05
Pseudomonas species	**present**	1	2				
	absent	28	85	1.52	0.13 - 18.02	1.52	p > 0.05
Klebsiella species	**present**	0	11				
	absent	29	76	Not calculable (OR = 0)			
Proteus species	**present**	0	2	Not calculable (OR = 0)			
	absent	29	85				
Enterococcus species	**present**	0	2	Not calculable (OR = 0)			
	absent	29	85				
Clostridium perfringens	**present**	0	3	Not calculable (OR = 0)			
	absent	29	84				
Anaerobic Streptococci	**present**	2	0				
	absent	27	87	Not calculable (OR = 0)			

Discussion

The study substantiates the predominant role of Escherichia coli in both appendicectomy specimens and subsequent wound infections, with isolation rates of 43.97% and 55.17%, respectively. This finding is consistent with recent research conducted by Kumar et al. (2022) and Liu et al. (2021), which identified E. coli as the primary etiological agent of postoperative infections following abdominal surgeries [10,11]. The high prevalence of E. coli highlights its adaptability to various host environments, a characteristic facilitated by its extensive array of virulence factors, including adhesins, toxins, and mechanisms for immune evasion[12,13,14].

Staphylococcus aureus exhibited a significant positive correlation with wound infections (odds ratio = 11.87, $p < 0.05$), despite its relatively low prevalence in appendicectomy specimens (1.72%). This correlation aligns with the findings of Martinez et al. (2023), who emphasized the pathogen's contribution to surgical site infections, attributable to its capacity for biofilm formation and the presence of methicillin-resistant strains (MRSA) [15]. The results of this study indicate that even minimal carriage rates of S. aureus can result in considerable postoperative morbidity, thereby underscoring the need for rigorous perioperative screening and targeted prophylactic measures.

The observed high resistance rates to Ampicillin/Amoxicillin (24.14%) and Ceftriaxone (20.69%) in postoperative complications align with the global trends reported by the World Health Organization [16]. The rise in resistance, particularly among Escherichia coli and Staphylococcus aureus, poses a significant challenge to existing treatment protocols. A study conducted by Patel et al. (2022) corroborated this trend, highlighting the necessity for ongoing

surveillance and the development of novel antibiotics or alternative therapies, such as bacteriophage therapy, to address resistant strains[17].

Negative Association of Bacteroides Species with Wound Infections The observed negative association of Bacteroides species with wound infections (odds ratio = 0.2, $p > 0.05$) contrasts with earlier research conducted by Garcia et al. (2019), which identified Bacteroides as a prevalent pathogen in intra-abdominal infections [18]. However, recent findings by Singh et al. (2023) propose that certain strains of Bacteroides may exert a protective effect by outcompeting more virulent bacterial species, or that their presence may serve as an indicator of less severe infections [19]. This observation necessitates further investigation into the intricate interactions within the microbiome during the postoperative recovery process.

The findings of this study emphasize the urgent necessity for targeted antibiotic therapy that is informed by local resistance patterns. The rising prevalence of resistant pathogens, such as Escherichia coli and Staphylococcus aureus, necessitates the incorporation of advanced diagnostic tools, including rapid molecular testing, to facilitate appropriate antibiotic selection. Additionally, the potential protective role of Bacteroides species underscores the significance of comprehending microbial interactions within the surgical wound environment. Future research should prioritize longitudinal studies aimed at monitoring resistance trends and evaluating the effectiveness of novel antimicrobial strategies, such as the application of probiotics and phage therapy, as proposed by Johnson et al. (2024) in their recent review [20].

Conclusion:

This study reaffirms the critical role of Escherichia coli as the predominant pathogen in both appendectomy specimens and subsequent wound infections, consistent with global trends in postoperative infections. The significant correlation of Staphylococcus aureus with wound infections, despite its lower prevalence in specimens, highlights the pathogen's potential for causing substantial postoperative morbidity, emphasizing the need for vigilant perioperative screening and targeted prophylactic measures. The observed antibiotic resistance patterns, particularly to Ampicillin, Amoxicillin and Ceftriaxone, underscore the urgent need for tailored antimicrobial strategies informed by local resistance profiles. The intriguing negative association of Bacteroides species with wound infections suggests a potential protective effect, warranting further investigation into microbial interactions within the surgical wound environment.

Conflict of interest- None

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