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Original Research Article

Histopathological and Microbiological Evaluation of Chronic Rhinosinusitis in Patients Undergoing Functional Endoscopic Sinus Surgery: A Cross-Sectional Study

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Abstract:

Background: Chronic rhinosinusitis (CRS) is a persistent inflammatory disorder of the nasal and paranasal sinus mucosa lasting more than 12 weeks. Microbial colonization and chronic mucosal inflammation contribute significantly to disease progression and tissue remodeling.

Aim: To evaluate histopathological changes in chronic rhinosinusitis and correlate them with microbiological findings.

Materials and Methods: A hospital-based cross-sectional study was conducted in the Departments of Pathology, Microbiology, and ENT over a period of 18 months. Sixty patients clinically diagnosed with CRS and undergoing functional endoscopic sinus surgery (FESS) were included. Tissue specimens were subjected to histopathological examination using hematoxylin and eosin staining, while microbiological analysis included Gram staining, aerobic culture, and antibiotic sensitivity testing. Statistical analysis was performed using Chi-square test, with $p < 0.05$ considered significant.

Results: The most common age group affected was 21–40 years (56.7%). Male predominance was observed (63.3%). Histopathological findings included epithelial hyperplasia (56.7%), basement membrane thickening (46.7%), edema (41.7%), neutrophilic infiltrate (38.3%), eosinophilic infiltrate (31.7%), and fibrosis (28.3%). The predominant organisms isolated were *Staphylococcus aureus* (30%), *Pseudomonas aeruginosa* (21.7%), and *Klebsiella pneumoniae* (15%). Significant association was observed between *Pseudomonas aeruginosa* and neutrophilic infiltrate ($p=0.03$), while *Staphylococcus aureus* correlated with epithelial hyperplasia ($p=0.04$).

Conclusion: Distinct histopathological changes are associated with specific microbial isolates in CRS. Combined histopathological and microbiological evaluation provides valuable information regarding disease severity and may guide therapeutic management.

Keywords: Chronic rhinosinusitis, Histopathology, Microbiology, Functional endoscopic sinus surgery, Staphylococcus aureus, Pseudomonas aeruginosa

Introduction

Chronic rhinosinusitis (CRS) is defined as inflammation involving the mucosa of the nose and paranasal sinuses persisting for more than 12 weeks despite medical therapy. CRS significantly affects quality of life and contributes to considerable healthcare burden worldwide. The pathogenesis of CRS is multifactorial and includes microbial infection, biofilm formation, mucociliary dysfunction, allergy, immune dysregulation, and environmental factors. Histopathological examination demonstrates chronic inflammatory changes including epithelial hyperplasia, basement membrane thickening, edema, fibrosis, and inflammatory cell infiltrates.[1] Microorganisms such as Staphylococcus aureus, Pseudomonas aeruginosa, and anaerobic bacteria have been implicated in chronic mucosal inflammation and disease persistence. Several studies have suggested that certain bacteria are associated with distinct histopathological patterns. [2]

The present study was conducted to analyze histopathological changes in CRS and correlate them with microbiological findings in patients undergoing functional endoscopic sinus surgery.

Material and Methods

The present hospital-based cross-sectional observational study was conducted over a period of 18 months in the Departments of Pathology, Microbiology, and ENT of a tertiary care teaching hospital. A

total of 60 patients clinically diagnosed with chronic rhinosinusitis (CRS) and undergoing functional endoscopic sinus surgery (FESS) were included in the study. Patients aged above 18 years with symptoms persisting for more than 12 weeks were included, while cases of acute rhinosinusitis, sinonasal malignancy, immunocompromised states, previous sinonasal surgery, and prolonged antibiotic therapy were excluded.

Sinonasal mucosal tissue obtained during FESS was divided into two portions for histopathological and microbiological evaluation. Histopathological examination was performed on formalin-fixed, paraffin-embedded tissue sections stained with hematoxylin and eosin to assess epithelial hyperplasia, basement membrane thickening, edema, fibrosis, inflammatory infiltrates, squamous metaplasia, and fungal elements. Microbiological analysis included culture on Blood agar, MacConkey agar, and Chocolate agar, followed by identification of isolates using standard biochemical methods. Antibiotic susceptibility testing was performed using the Kirby–Bauer disc diffusion method according to CLSI guidelines. Statistical analysis was carried out using SPSS version 22.0, and $p < 0.05$ was considered statistically significant.

Statistical Analysis

Data were analyzed using SPSS version 22. Chi-square test was used for association analysis. $p < 0.05$ was considered statistically significant.

Results

Table 1: Age Distribution of Patients

Age Group (Years)	Number of Cases	Percentage
18–20	6	10%
21–40	34	56.7%
41–60	16	26.7%
>60	4	6.6%

Table 2: Gender Distribution

Gender	Number of Cases	Percentage
Male	38	63.3%
Female	22	36.7%

Table no 1 shows that majority of patients belonged to the 21–40 years age group, indicating higher prevalence of CRS among young and middle-aged adults, and table no2 shows that Male predominance was observed with male-to-female ratio of 1.7:1.

Table 3: Histopathological Findings

Histopathological Feature	Number of Cases	Percentage
Epithelial hyperplasia	34	56.7%
Basement membrane thickening	28	46.7%
Edema	25	41.7%
Neutrophilic infiltrate	23	38.3%
Eosinophilic infiltrate	19	31.7%
Fibrosis	17	28.3%
Squamous metaplasia	11	18.3%
Fungal elements	5	8.3%

Table no 3 demonstrate that Epithelial hyperplasia was the most common histopathological finding followed by basement membrane thickening and edema, suggesting chronic inflammatory mucosal remodeling.

Table 4: Microbial Isolates

Organism Isolated	Number of Cases	Percentage
Staphylococcus aureus	18	30%
Pseudomonas aeruginosa	13	21.7%
Klebsiella pneumoniae	9	15%
Coagulase-negative staphylococci	7	11.7%
Escherichia coli	5	8.3%
No growth	8	13.3%

Table 5: Correlation Between Histopathology and Microbiology

Histopathological Finding	Common Organism	p-value
Neutrophilic infiltrate	Pseudomonas aeruginosa	0.03
Epithelial hyperplasia	Staphylococcus aureus	0.04
Edema	Gram-negative bacilli	0.05
Eosinophilic infiltrate	Fungal isolates	0.02

Table no 4 shows that Staphylococcus aureus was the predominant isolate followed by Pseudomonas aeruginosa, indicating their major role in chronic sinonasal inflammation, and Table no 5 A statistically significant association was observed between Pseudomonas aeruginosa and neutrophilic infiltrate, while Staphylococcus aureus showed significant association with epithelial hyperplasia.

Discussion

Chronic rhinosinusitis is characterized by persistent mucosal inflammation and microbial colonization leading to structural alterations in sinonasal mucosa. In the present study, the majority of patients were between 21 and 40 years of age, similar to findings reported by Heilingoetter et al. [3] Male predominance observed in the present study is comparable with earlier studies evaluating CRS epidemiology. Epithelial hyperplasia and basement membrane thickening were the predominant histopathological findings, indicating chronic mucosal irritation and remodeling. Similar findings have been documented in previous histopathological analyses of CRS. [4] The predominant organisms isolated in this study were Staphylococcus aureus and Pseudomonas aeruginosa. These organisms are known to form biofilms and contribute to chronic inflammation and treatment resistance. [5,6] A significant association between Pseudomonas aeruginosa and neutrophilic infiltrate was identified. This finding correlates with observations reported by Heilingoetter et al., who demonstrated increased neutrophilic inflammation in CRS patients harboring Pseudomonas aeruginosa. [7,8] Similarly, epithelial hyperplasia was significantly associated with Staphylococcus aureus, supporting the hypothesis that bacterial toxins and superantigens may contribute to mucosal remodeling and hyperplastic changes. [9,10] The combined use of histopathological and microbiological evaluation may therefore provide a better understanding of disease severity and guide targeted therapeutic strategies.

Conclusion

Chronic rhinosinusitis demonstrates diverse histopathological alterations associated with specific microbial isolates. Staphylococcus aureus and Pseudomonas aeruginosa were the most common organisms isolated and showed significant correlation with epithelial hyperplasia and neutrophilic infiltrate respectively. Combined histopathological and microbiological assessment is useful in understanding disease pathogenesis and improving patient management.

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