ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 04 | April - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

CLINICOPATHOLOGICAL PROFILE OF MICROCYTIC AND MACROCYTIC ANEMIA

General Medicine

Dr. Thakkar Karan Ramyank* Junior Resident, Department of Medicine, Byramjee Jeejeebhoy Government Medical College and Sassoon General Hospital, Pune. *Corresponding Author

Dr. Borse Rohidas Tanku Professor and Head, Department of Medicine, Byramjee Jeejeebhoy Government Medical College and Sassoon General Hospital, Pune

ABSTRACT

Introduction: Anemia is prevalent globally with high rates in India, is caused by deficiencies of iron, vitamin B12, and folate. Dimorphic anemia involves both microcytic and macrocytic cells. Upper GI endoscopy and duodenal biopsy are essential for diagnosing underlying gastrointestinal disorders, ensuring effective management of these anemias. **Methodology:** A cross-sectional observational study was conducted between February 2023 and August 2024 with 74 anemic patients. After taking informed written consent medical history was taken, physical examination was done, laboratory tests and imaging studies were done and an upper gastrointestinal endoscopy followed by duodenal biopsy was done. Observations were noted and IBM SPSS 25 was used for statistical analysis. **Results:** The study included 74 participants, with 31 (41.89%) having microcytic anemia, 26 (35.13%) macrocytic anemia, and 17 (22.97%) dimorphic anemia. Gender, age, and comorbidity distribution showed no significant differences across anemia types. Alcohol, tobacco use, and certain clinical features like knuckle pigmentation and bald tongue varied across anemia types. Hematological findings, including RBC size and RBC color, differed significantly across anemia types. The study found no significant differences in gastrointestinal endoscopy findings across anemia types except for duodenal fissuring. **Discussion:** The study highlights the clinicopathological profiles of microcytic, macrocytic, and dimorphic anemia, emphasizing the need for a systematic diagnostic approach. Upper GI endoscopy and duodenal biopsies are crucial for identifying gastrointestinal causes and guiding effective management strategies in India. **Conclusion:** The study revealed significant associations between clinical features, hematological parameters, Upper gastrointestinal endoscopy findings and histopathological findings across various anemia groups.

KEYWORDS

Anemia, Clinical profile, Upper Gastrointestinal endoscopy, Duodenal biopsy

INTRODUCTION

Anemia is characterized by low haemoglobin (Hb) concentrations and/or red blood cell (RBC) counts, insufficient to meet an individual's physiological requirements. [1] It affects approximately one-third of the global population.[2] According to WHO estimates, India has the highest prevalence of anemia among South Asian countries. Approximately half of the global maternal deaths attributed to anemia occur in South Asia, with India accounting for about 80 percent of these deaths. [3]

Microcytic and macrocytic anemia are the two main subtypes of anemia. Microcytic anemia can be caused by iron deficiency, anemia of chronic disease, thalassemia, lead poisoning, celiac disease, and X-linked sideroblastic anemia. Iron deficiency anemia (IDA) is the most common cause of microcytic hypochromic anemia worldwide. [4] [5] Chronic blood loss leading to iron deficiency can occur due to lesions in both the upper and lower gastrointestinal tract and absorptive disorders. [6] Macrocytic anemia can result from vitamin B12 deficiency, folic acid deficiency, chronic alcohol consumption, hereditary spherocytosis, chronic liver disease, hypothyroidism, and marked reticulocytosis due to conditions of excessive red blood cell consumption, such as hemolytic anemias and pregnancy. Typically, common cause of macrocytic anemia is nutritional deficiency, typically due to inadequate intake or malabsorption of cobalamin and/or folate, as seen in conditions like tropical sprue. [7] Dimorphic anemia, characterized by a peripheral blood picture showing both microcytic hypochromic and macrocytic normochromic cells. While myelodysplastic syndrome is an important differential diagnosis, a concomitant deficiency of both iron and vitamin B12 and/or folate is one of the most common causes of this type of anemia. [8]

Upper GI endoscopy detects bleeding sources and gastrointestinal disorders that impair nutrient absorption, such as peptic ulcers and celiac disease in microcytic anemia, and tropical sprue or atrophic gastritis in macrocytic anemia. Duodenal biopsy confirms malabsorptive disorders like celiac disease and tropical sprue, which can cause iron, vitamin B12, and folate deficiencies. In dimorphic anemia, these tools identify mixed causes and concurrent deficiencies. [9]

Existing literature, with IDA, indicates that gastrointestinal lesions are present in 40–70% of cases. [10] [11] IDA can signal asymptomatic colonic and gastric carcinoma, particularly in elderly. Research indicates that malabsorption, often due to celiac disease (CD), Giardia lamblia infection, poor dietary intake, use of non-steroidal anti-inflammatory drugs (NSAIDs), and gastric conditions such as corpus atrophic gastritis or Helicobacter pylori infection, are predictors of endoscopic lesions in patients with IDA, regardless of the presence of GI symptoms. [12] [13] Studies have concluded that the prevalence of endoscopic lesions in patients with IDA without GI symptoms ranges from 48-71 %. [14] Recognizing cause of iron deficiency anemia is important for diagnosis and management, most of which can be identified through conventional upper gastrointestinal endoscopy and colonoscopy. [15] However, it remains unclear which procedure should be prioritized. [16] Numerous studies have concluded that most lesions related to IDA are in the lower gastrointestinal tract. Thus, they recommend beginning the evaluation with a lower GI examination. [17] [18]

Recent AGA guidelines, based on moderate-quality evidence, recommend bidirectional endoscopy over no endoscopy for asymptomatic postmenopausal women and men with IDA Anemia is a common presentation of celiac disease (CD), found in up to 50% of patients at diagnosis. [19] [20] The incidence of CD in individuals over 60 years old has increased significantly from 4% to between 19-34%. [21] The necessity of routine duodenal biopsies in IDA patients remains debated. The most recent guidelines from the British Society of Gastroenterology on diagnosing and managing CD suggest, with low-quality evidence, that duodenal biopsies should be considered for individuals undergoing upper-GI endoscopy for malabsorption. [20]

Megaloblastic anemia is typically caused by a nutritional deficiency or malabsorption of cobalamin (vitamin B12) and/or folate. Malabsorption can arise from conditions such as gastrectomy, tropical and nontropical sprue, intestinal resection, and certain medications. [22] While pernicious anemia is commonly reported as the primary cause of megaloblastic anemia in Western countries, dietary deficiency and malabsorption are the predominant causes in India. [23] Duodenal biopsies are routinely performed in patients with megaloblastic anemia to detect any signs of malabsorption, as tropical sprue (TS) is reported to be more prevalent in India. [24]

Upper gastrointestinal endoscopy and duodenal biopsy in patients with microcytic, macrocytic, and dimorphic anemia is essential for accurate diagnosis and effective management, particularly those linked to malabsorption. Since the necessity of routine Upper Gastrointestinal endoscopy and duodenal biopsies in anemia patients is debated. Therefore, this study aims to elucidate the endoscopic and histopathological findings in these anemic conditions in a tertiary care center to enhance diagnostic accuracy and patient management.

Aims and Objectives

i. To study hematological profile of patients with Microcytic and macrocytic anemia.
ii. To study the clinical presentation of patients with microcytic and macrocytic anemia.
iii. To study the Upper Gastrointestinal endoscopy findings of microcytic and macrocytic anemia.
iv. To study duodenal biopsy finding of patients with Microcytic and macrocytic anemia

MATERIAL AND METHODOLOGY

After obtaining approval from Institutional Ethics Committee (IEC) a cross-sectional observational study with a sample size of 74 was done in Department of Medicine in a Tertiary Care Centre and Teaching Institute between February, 2023 and August, 2024 in a metropolitan city. Among the available cohort of anemic patients, the following were the inclusion and exclusion criteria:

1. Inclusion Criteria
o Age>12 years of age of either male or female gender.
o Males with Hb < 13 with MCV < 83 fL or > 100 fL.
o Females with Hb < 12 and MCV < 83 fL or MCV > 100 fL.
o Patients giving informed written consent for the study.
2. Exclusion Criteria
o Age<12years.
o Males with Hb < 13 but MCV between 83 – 100 microns.
o Females with Hb < 12 but MCV between 83 – 100 microns.

Study Procedure:

Among the patients having a clinical diagnosis of nutritional anemia randomized sampling was done and Informed written consent was obtained from all participants or their guardians, adhering to ethical standards and protocols approved by the institutional review board. A detailed medical history was obtained from each participant and a thorough physical examination was conducted. Blood samples were collected to assess hematological and Biochemical profiles, including:

- Complete Blood Count (CBC)
- Renal Function test
- Liver Function test
- Prothrombin Time (PT) and International Normalized Ratio (INR)
- Retic count
- Peripheral Blood Smear

Electrocardiogram (ECG), Chest X-Ray PA view (CXR), Ultrasonography of abdomen and pelvis (USG- A+P), Upper Gastrointestinal Endoscopy and Duodenal Biopsy were done of each participant.

Statistical Analysis

Primary data was collected using paper-based forms and entered in Microsoft Excel spreadsheets (2016). Statistical analysis was performed using IBM SPSS Statistics Version 25. Categorical variables were represented as frequencies and percentages, with distributions visualized through pie charts or bar graphs. Continuous variables were expressed in descriptive statistics tables as means and standard deviations. A p-value of less than 0.05 was considered statistically significant, with p-values below 0.001 indicating highly significant results.

RESULTS

Total population of study was 74 with 31 (41.89 %) in microcytic anemia, 26 (35.13 %) in macrocytic anemia and 17 (22.97 %) with dimorphic anemia.

Gender Distribution

Males made up 58.1% of the total population, while females comprised 41.9%. In microcytic anemia, 45.2% were male, in macrocytic anemia, 69.2% were male, and in dimorphic anemia, 64.7% were male. This shows a higher prevalence of macrocytic and dimorphic anemia in males compared to females, but the result was not statistically significant (p=0.15).

Age Distribution

The mean age for patients with microcytic anemia was 44.3 ± 19.1 years, for macrocytic anemia it was 42.4 ± 15.8 years, and for dimorphic anemia, it was 41.4 ± 13.8 years. The p-value of 0.833 indicates no statistically significant difference in mean ages across the different anemia types.

In under 30-years age group, the most common anemia was macrocytic (34.6%), followed by dimorphic (23.5%) and microcytic (22.6%). For those aged between 31 and 40 years, dimorphic anemia (29.4%) was most prevalent, followed by microcytic (25.8%) and macrocytic (11.5%). In the 41 to 50 years group, microcytic and macrocytic anaemias were equally common at 25.8% and 26.9%, with dimorphic anemia at 17.6%. In the 51 to 60 years age group, macrocytic anemia was most frequent (15.4%), followed by dimorphic (11.8%) and microcytic (3.2%). In those over 60 years of age, microcytic and dimorphic anaemias were nearly equal at 22.6% and 17.6%, with macrocytic anemia at 11.5%. Overall, the distribution of anemia types across age groups was not statistically significant (p=0.587).

Comorbidities

Among patients with diabetes mellitus (DM), 4 (12.9%) had microcytic anemia, 2 (7.7%) had macrocytic anemia, and 1 (5.9%) had dimorphic anemia, with a total of 7 patients (p=0.68).

In patients with hypertension (HTN), 3 (9.7%) had microcytic anemia, none had macrocytic anemia, and 2 (11.8%) had dimorphic anemia, totalling 5 patients (p=0.23).

For ischemic heart disease (IHD), 2 (6.5%) patients had microcytic anemia, none had macrocytic or dimorphic anemia, making a total of 2 patients (p= 0.2).

Additionally, 1 patient (2.94%) with dimorphic anemia had a history of seizures, while no cases were seen in the other anemia types.

Addictions

Among those with microcytic anemia 8 (25.8%) consumed alcohol, 2 (6.5%) consumed tobacco, while none smoked cigarette. Among those with macrocytic anemia 13 (50%) consumed alcohol, 7 (26.9%) consumed tobacco while 3 (11.5%) smoked cigarette. Among those with dimorphic anemia 6 (35.3%) consumed alcohol, 6 (35.3%) consumed tobacco and 1 (5.9%) smoked cigarette.

The p-value for alcohol consumption was 0.167, showing no significant association with anemia types. Tobacco use had a significant association (p=0.034), most common in macrocytic anemia. Cigarette smoking showed no significant association (p=0.158).

Menstrual History

Among female participants, 74.19% were menstruating and 25.81% were postmenopausal. Most menstruating women started their periods at ages 12 (39.1%) or 13 (47.8%). Menstrual cycle lengths varied, with 47.8% having cycles of 28 days or fewer, 17.4% with 29-30 days, and 21.7% with 31-35 days. Fewer had cycles of 36-40 days (8.7%) or 41-45 days (4.3%). Regarding cycle regularity, 60.9% had regular cycles, 69.6% experienced menstrual clots, and 65.2% reported painful menstruation.

Dietary Habits:

Egg consumption was reported in 15 (48.4%) with microcytic anemia, 11(42.3%) with macrocytic anemia, and 6 (35.3%) with dimorphic anemia (p = 0.677).

Red meat consumption was seen in 15 (48.4%) with microcytic anemia, 11 (42.3%) with macrocytic anemia, and 7 (41.2%) with dimorphic anemia, (p = 0.345).

Fish consumption was noted in 8 (25.8%) with microcytic anemia, 2 (7.7%) with macrocytic anemia, and 1 (5.9%) with dimorphic anemia, with a near-significant association (p = 0.079), indicating higher fish consumption in microcytic anemia.

Symptomatology:

General Weakness (GW) was noted in 22 (71.0%) of the microcytic anemia, 20 (76.9%) of the macrocytic anemia, and 13 (76.5%) of the dimorphic anemia (p = 0.854).

Dyspnea on Exertion (DOE) was noted in 18 (58.1%) of the microcytic anemia, 20 (76.9%) of the macrocytic anemia, and 12 (70.6%) of the dimorphic anemia (p = 0.303).

Anorexia was noted in 4 (12.9%) of the microcytic anemia, 8 (30.8%) of the macrocytic anemia, and 4 (23.5%) of the dimorphic anemia (p = 0.258).

Malena was noted in 7 (22.6%) of the microcytic anemia, 5 (19.2%) of the macrocytic anemia, and 3 (17.6%) of the dimorphic anemia (p = 0.908).

Abdominal Pain was noted in 5 (16.1%) of the microcytic anemia, 3 (11.5%) of the macrocytic anemia, and 3 (17.6%) of the dimorphic anemia (p = 0.831).

Per rectal Bleeding was noted in 4 (12.9%) of the microcytic anemia, 3 (11.5%) of the macrocytic anemia, and 3 (17.6%) of the dimorphic anemia (p = 0.841).

Pedal oedema was noted in 5 (16.1%) of the microcytic anemia, 4 (15.4%) of the macrocytic anemia, and none in the dimorphic anemia (p = 0.216).

Hematemesis was noted in 5 (16.1%) of the microcytic anemia, 1 (3.8%) of the macrocytic anemia, and none in the dimorphic anemia (p = 0.09).

Loose Stools were present in 3 (11.5%) of the macrocytic anemia and 2 (11.8%) of the dimorphic anemia, with none in the microcytic anemia (p = 0.145).

Fever was present in 2 (6.5%) of the microcytic anemia, 3 (11.5%) of the macrocytic anemia, and none in the dimorphic anemia (p = 0.336).

Cough with Expectoration was present in 2 (6.5%) of the microcytic anemia, 1 (3.8%) of the macrocytic anemia, and 1 (5.9%) of the dimorphic anemia (p = 0.906).

Jaundice was reported in 1 (3.2%) of the microcytic anemia, 2 (7.7%) of the macrocytic anemia, and 2 (5.9%) of the dimorphic anemia (p = 0.755).

Headache occurred in 1 (3.2%) of the microcytic anemia and 2 (7.7%) of the macrocytic anemia, with no cases in the dimorphic anemia. (p = 0.437).

Body Ache was present in 1 (3.2%) of both the microcytic and 1 (3.8 %) macrocytic anemia, and none in the dimorphic anemia (p = 0.728).

Burning Sensation in lower limbs was reported in 1 (5.9%) of the dimorphic anemia, with no cases in the other anemias (p = 0.183).

Hematuria was reported in 1 (3.8%) of the macrocytic anemia, and no cases were observed in the other anemias (p = 0.392).

Cough without Expectoration was observed in 1 (3.2%) of the microcytic anemia, with no cases in the other anemias (p = 0.495)

Vital Parameters:

Tachycardia was seen in 8 (25.8%) of microcytic anemia, 6 (23.1%) of macrocytic anemia and 2 (11.8%) of dimorphic anemia.

Normal pulse rate was seen in 22 (71.0%) of microcytic anemia, 20 (76.9%) of macrocytic anemia and 14 (82.4%) of dimorphic anemia.

Bradycardia was seen in 1 (3.2%) of microcytic anemia and 1 (5.9%) of dimorphic anemia and none in macrocytic anemia. The difference between various heart rates and anemia groups was not statistically significant (p = 0.626).

Hypotension was seen in 9 (29.0%) of microcytic anemia, 3 (11.5%) of macrocytic anemia and 4 (23.5%) of dimorphic anemia.

Normal Blood Pressure (BP) was seen in 21 (67.7%) of microcytic anemia, 23 (88.5%) of macrocytic anemia and 13 (76.5%) of dimorphic anemia.

Hypertension seen in only 1 (3.2%) of microcytic anemia and was not seen in macrocytic or dimorphic anemia. The difference between blood pressure and various anemia groups was not statistically significant (p=0.378).

Normal SPO2 was seen in 29 (93.5%) of microcytic anemia, 25 (96.2%) of macrocytic anemia and 17 (100.0%) of dimorphic anemia.

Low SPO2 was seen in 2 (6.5%) of microcytic anemia and 1 (3.8%) of macrocytic anemia and was not seen in dimorphic anemia. The difference between SpO2 and various anemia groups was not statistically significant (p = 0.6).

Normal Glycemia was seen in 24 (77.4%) of microcytic anemia, 20 (76.9%) of macrocytic anemia and 16 (94.1%) of dimorphic anemia cases.

Hyperglycemia was seen in 7 (22.6%) of microcytic anemia, 5 (19.2%) of macrocytic anemia and 1 (5.9%) of dimorphic anemia.

Hypoglycemia was seen in 1 (3.8%) of macrocytic anemia and was not seen in microcytic and dimorphic anemia. The difference between blood sugar levels and various anemia groups was not statistically significant (p = 0.4).

General Examination:

Pallor was seen in all anemia types, with 74 (100%) of patients in each group indicating it was a consistent feature regardless of anemia type.

Knuckle Pigmentation was significantly more common in the macrocytic anemia, 14 (53.8%) compared to 7 (41.2%) in the dimorphic anemia and none in the microcytic anemia (p = 0.0001).

Icterus was seen in 5 (16.1%) of microcytic anemia, 7 (26.9%) of the macrocytic anemia and 4 (23.5%) of dimorphic anemia (p = 0.601).

Platynychia was seen in 9 (29.0%) of microcytic anemia, none in the macrocytic anemia and 4 (23.5%) in the dimorphic anemia. This difference was statistically significant (p = 0.012).

Pedal Oedema was seen in 5 (16.1%) of microcytic anemia, 4 (15.4%) of the macrocytic anemia and 4 (23.5%) of the dimorphic anemia (p = 0.761).

Bald Tongue was significantly more common in macrocytic anemia, 9 (34.6%) compared to 3 (17.6%) in dimorphic anemia and none in the microcytic anemia (p = 0.002).

Anasarca was seen in 2 (6.5%) of microcytic anemia, 1 (3.8%) of the macrocytic anemia and none in dimorphic anemia (p = 0.555).

Koilonychia was seen in 2 (6.5%) of microcytic anemia, none of macrocytic anemia and 1 (5.9%) of the dimorphic anemia (p = 0.427).

Red Beefy Tongue was seen in 1 (3.8%) of the macrocytic anemia with no cases in the other groups (p = 0.392).

Systemic Examination

Bilateral basal crepitations were present in 8 (25.8%) of microcytic anemia, 6 (23.1%) of macrocytic anemia, and 3 (17.6%) of dimorphic anemia (p = 0.813).

Hemic murmur was detected in 5 (16.1%) of microcytic anemia, 4 (15.4%) of macrocytic anemia and 2 (11.8%) of dimorphic anemia (p = 0.917).

Palpable hepatomegaly was present in 5 (16.1%) of microcytic anemia, 3 (11.5%) of macrocytic anemia and 5 (29.4%) of dimorphic anemia (p = 0.31).

Palpable splenomegaly was present in 3 (9.7%) of microcytic anemia, 2 (7.7%) of macrocytic anemia and 2 (11.8%) of dimorphic anemia (p = 0.31).

Proprioception and vibration sense were absent in 2 (7.7%) of macrocytic anemia and 1 (5.9%) of dimorphic anemia and were present in all participants with microcytic anemia (p = 0.31).

Gait disturbance was noted only in 1 (5.9%) of dimorphic anemia (p = 0.183).

Hematological Profile

Haemoglobin Concentration:

The mean and median of haemoglobin concentration for total population was 4.67 ±1.44 g/dL, 4.75 g/dL while that for microcytic anemia was 4.84 ±1.54 g/dL, 4.8 g/dL, for macrocytic anemia was 4.73± 1.56 g/dL, 4.5 g/dL and for dimorphic anemia was 4.28± 1.03 g/dL, 4.3 g/dL (p=0.428).

MCV
The mean and median of MCV was 63.9±4.3 fL, 58 fL in microcytic anemia, 101.9 ±13.1 fL, 100 fL in macrocytic anemia and 92.1± 23.7 fL, 87.9 fL in dimorphic anemia.

Low MCV was seen in 33 (44.6%) of total population, 28 (90.3%) of microcytic anemia, 5 (29.4%) of dimorphic anemia and none in macrocytic anemia.

Normal MCV was seen in 20 (27%) of total population, 3 (9.7%) of microcytic anemia, 12 (46.2%) of macrocytic anemia and 5 (29.4%) of dimorphic anemia.

High MCV was seen in 21 (28.4%) of total population, 14 (53.08%) of macrocytic anemia and 7 (41.2%) of dimorphic anemia with none seen in microcytic anemia.

This difference in MCV values was statistically significant (p=0.0001) between various groups of anemia with a low MCV being common in microcytic anemia.

MCH
The mean and median of MCH was 25.2 ± 8.6 pg, 25 pg in total population with 20.0± 6.0 pg, 19 pg in microcytic anemia, 30.1± 8.9 pg, 31.6 pg in macrocytic anemia and 27.2 ±6.9 pg, 26 pg in dimorphic anemia.

Low MCH was seen in 45 (60.8%) of total population, 26 (83.9%) of microcytic anemia, 9 (34.6%) of macrocytic anemia and 10 (58.8%) of dimorphic anemia.

Normal MCH was seen in 9(12.2%), 4 (12.9%) of microcytic anemia, 3 (11.5%) of macrocytic anemia and 2 (11.8%) of dimorphic anemia.

High MCH was seen in 20 (27%) of total population, 1 (3.2%) of microcytic anemia, 14 (53.8%) of macrocytic anemia and 5 (29.4%) of dimorphic anemia.

The difference in the MCH values was statistically significant between various groups of anemia (p = 0.001).

RDW
The mean and median RDW of the total population was 20.1 ± 5.2 %, 19.3 %, of microcytic anemia was 19.3 ±5.1 %, 19 %, of macrocytic anemia was 20.6 ± 5.8 %, 19.1 % and of dimorphic anemia was 20.7 ± 4.7 %, 19.3 %.

Low RDW was seen in 2 (6.5%) of microcytic anemia, none in macrocytic anemia and 2 (2.7%) in dimorphic anemia.

Normal RDW was seen in 12 (16.2%) of the total population, 3 (9.7%) of microcytic anemia, 6 (23.1%) of macrocytic anemia, and 3 (17.6%) of dimorphic anemia.

High RDW was seen in 60 (81.1%) of the total population, with 26 (83.9%) of microcytic anemia, 20 (76.9%) of macrocytic anemia and 14 (82.4%) of dimorphic anemia.

The difference in RDW among various types of anemia was not statistically significant (p = 0.348).

WBC Count
Leukopenia was seen in 31 (41.9%) of the total population, with 3 (9.7%) of microcytic anemia, 16 (61.5%) of macrocytic anemia, and 12 (70.6%) of dimorphic anemia.

Normal Leucocyte Number was seen in 39 (52.7%) of the total population, with 25 (80.6%) of microcytic anemia, 10 (38.5%) of macrocytic anemia, and 4 (23.5%) of dimorphic anemia.

Leucocytosis was seen in 4 (5.4%) of the total population, with 3 (9.7%) of microcytic anemia, none in macrocytic anemia, and 1 (5.9%) in dimorphic anemia.

This difference in WBC count and various anemia groups was statistically significant (p = 0.001).

Differential Count:

Neutropenia: 6.8% of the total population. For microcytic anemia, none (0%); for macrocytic anemia, 2 (7.7%); for dimorphic anemia, 3 (17.6%).

Normal Neutrophils: 36.5% of the total population. For microcytic anemia, 9 (29.0%); for macrocytic anemia, 13 (50.0%); for dimorphic anemia, 5 (29.4%).

Neutrocytosis: 56.8% of the total population. For microcytic anemia, 22 (71.0%); for macrocytic anemia, 11 (42.3%); for dimorphic anemia, 9 (52.9%).

The difference in neutrophil count in various types of anemia was not statistically significant (p = 0.056)

Lymphocytopenia: 17.6% of the total population. For microcytic anemia, 7 (22.6%); for macrocytic anemia, 2 (7.7%); for dimorphic anemia, 4 (23.5%).

Normal Lymphocytes: 68.9% of the total population. For microcytic anemia, 24 (77.4%); for macrocytic anemia, 19 (73.1%); for dimorphic anemia, 8 (47.1%).

Lymphocytosis: 13.5% of the total population. For microcytic anemia, none (0%); for macrocytic anemia, 5 (19.2%); for dimorphic anemia, 5 (29.4%).

The difference in lymphocyte count in various types of anemia was statistically significant (p =- 0.019).

Platelet Count
Thrombocytopenia was seen in 44 (59.5%) of the total population, with 6 (19.4%) of microcytic anemia, 23 (88.5%) of macrocytic anemia, and 15 (88.2%) of dimorphic anemia.

Normal Platelet was seen in 29 (39.2%) of the total population, with 24 (77.4%) of microcytic anemia, 3 (11.5%) of macrocytic anemia, and 2 (11.8%) of dimorphic anemia.

Thrombocytosis was seen in 1 (1.4%) of the total population, with 1 (3.2%) of microcytic anemia, none in macrocytic anemia and dimorphic anemia.

This difference in platelet count between various anemia groups was statistically significant (p < 0.0001).

Peripheral Blood Smear Findings:
RBC Size:
Microcytes were seen in 16 (21.6%) of the total population, with 16 (51.6%) of microcytic anemia and none in macrocytic anemia, and dimorphic anemia.

Macrocytes were seen in 16 (21.6%) of the total population, with none in microcytic anemia, 16 (61.5%) of macrocytic anemia, and none in dimorphic anemia.

Normocytes with Microcytes were seen in 15 (20.3%) of the total population, with 15 (48.4%) of microcytic anemia, none in macrocytic anemia and none in dimorphic anemia.

Normocytes with Macrocytes were seen in 10 (13.5%) of the total population, with none in microcytic anemia, 10 (38.5%) of macrocytic anemia and none in dimorphic anemia.

Microcytes with Macrocytes were seen in 14 (18.9%) of the total population, with none in microcytic anemia, none in macrocytic anemia, and 14 (82.4%) of dimorphic anemia.

Microcytes with Normocytes with Macrocytes were seen in 3 (4.1%) of the total population, with none in microcytic anemia, none in macrocytic anemia, and 3 (17.6%) of dimorphic anemia.

The difference in RBCs size and various anemia groups was statistically significant (p = 0.0001).

RBC Colour
Hypochromia was seen in 57 (77.0%) of the total population, with 28 (90.3%) of microcytic anemia, 15 (57.7%) of macrocytic anemia, and 14 (82.4%) of dimorphic anemia.

Normochromia was seen in 7 (9.5%) of the total population, with none in microcytic anemia, 4 (15.4%) of macrocytic anemia, and 3 (17.6%) of dimorphic anemia.

Hypochromia with Normochromia was seen in 10 (13.5%) of the total population, with 3 (9.7%) of microcytic anemia, 7 (26.9%) of macrocytic anemia and none in dimorphic anemia.

The difference in colour of RBCs and various anemia groups was statistically significant (p = 0.01).

RBC Morphology:
Anisopoikilocytosis was seen in 48 (64.9%) of the total population, with 13 (41.9%) of microcytic anemia, 19 (73.1%) of macrocytic anemia, and 16 (94.1%) of dimorphic anemia (p = 0.001).

Tear Drop Cells were seen in 28 (37.8%) of the total population, with 11 (35.5%) of microcytic anemia, 6 (23.1%) of macrocytic anemia, and 11 (64.7%) of dimorphic anemia (p = 0.021).

Pencil Cells were seen in 24 (32.4%) of the total population, with 13 (41.9%) of microcytic anemia, 5 (19.2%) of macrocytic anemia, and 6 (35.3%) of dimorphic anemia (p = 0.182).

Ovalocytes were seen in 16 (21.6%) of the total population, with 1 (3.2%) of microcytic anemia, 11 (42.3%) of macrocytic anemia, and 4 (23.5%) of dimorphic anemia (p = 0.002).

Macro Ovalocytes were seen in 12 (16.2%) of the total population, with none in microcytic anemia, 8 (30.8%) of macrocytic anemia, and 4 (23.5%) of dimorphic anemia (p = 0.005).

Basophilic Stippling was seen in 2 (2.7%) of the total population, with none in microcytic anemia, 1 (3.8%) of macrocytic anemia, and 1 (5.9%) of dimorphic anemia (p = 0.44).

Cabot Rings were seen in 1 (1.4%) of the total population, with none in microcytic anemia, 1 (3.8%) of macrocytic anemia, and none in dimorphic anemia (p = 0.392).

WBC Morphology
Hypersegmented Neutrophils were seen in 10 (13.5%) of the total population, with none in microcytic anemia, 6 (23.1%) of macrocytic anemia, and 4 (23.5%) of dimorphic anemia (p = 0.015).

Platelet Morphology
Giant Platelet was seen in 2 (2.7%) of the total population, with 1 (3.2%) of microcytic anemia, none in macrocytic anemia, and 1 (5.9%) of dimorphic anemia (p = 0.495).

Absolute Reticulocyte Count
Low Absolute Reticulocyte count was seen in 49 (66.2%) of the total population, with 22 (71.0%) of microcytic anemia, 17 (65.4%) of macrocytic anemia, and 10 (58.8%) of dimorphic anemia.

Normal Absolute Retic Number was seen in 25 (33.8%) of the total population, with 9 (29.0%) of microcytic anemia, 9 (34.6%) of macrocytic anemia, and 7 (41.2%) of dimorphic anemia.

The difference in absolute reticulocyte counts and various anemia groups was not statistically significant (p = 0.692).

Renal Function Test
The mean and median for Sr. Creatinine (mg/dL) for the total population was 0.9 ± 0.3 mg/dL and 0.9 mg/dL, respectively. For microcytic anemia, the mean was 1.0 ± 0.3 mg/dL and the median was 0.9 mg/dL. For macrocytic anemia, the mean was 0.9 ± 0.3 mg/dL and the median was 0.9 mg/dL. For dimorphic anemia, the mean was 0.9 ± 0.3 mg/dL and the median was 0.8 mg/dL (p = 0.831).

The mean and median for Sr. Urea (mg/dL) for the total population was 25.2 ± 15.1 mg/dL and 22.0 mg/dL, respectively. For microcytic anemia, the mean was 29.3 ± 19.8 mg/dL and the median was 22.0 mg/dL. For macrocytic anemia, the mean was 25.2 ± 15.1 mg/dL and the median was 22.2 mg/dL. For dimorphic anemia, the mean was 20.9 ± 8.3 mg/dL and the median was 18.0 mg/dL. (p = 0.2)

Prothrombin Time and International Normalized Ratio:
The mean and median for Prothrombin Time (PT) for the total population was 14.7 ± 2.4 seconds and 14.7 seconds, respectively. For microcytic anemia, the mean was 15.4 ± 2.4 seconds and the median was 15.0 seconds. For macrocytic anemia, the mean was 13.6 ± 1.3 seconds and the median was 13.2 seconds. For dimorphic anemia, the mean was 14.5 ± 2.4 seconds and the median was 13.5 seconds (p = 0.0080).

The mean and median for International Normalized Ratio (INR) for the total population was 1.1 ± 0.2 and 1.1, respectively. For microcytic anemia, the mean was 1.2 ± 0.1 and the median was 1.2. For macrocytic anemia, the mean was 1.1 ± 0.1 and the median was 1.1. For dimorphic anemia, the mean was 1.1 ± 0.2 and the median was 1.1 (p = 0.0060).

Serum Electrolytes
The mean and median for serum sodium for the total population were 133.3 ± 5.2 mEq/L and 134.0 mEq/L, respectively. For microcytic anemia, the mean was 134.2 ± 5.3 mEq/L and the median 135.0 mEq/L. For macrocytic anemia, the mean was 133.5 ± 4.6 mEq/L and the median 134.0 mEq/L. For dimorphic anemia, the mean was 132.3 ± 5.9 mEq/L and the median 133.0 mEq/L (p = 0.5120).

The mean and median for serum potassium for the total population were 4.0 ± 0.5 mEq/L and 4.0 mEq/L, respectively. For microcytic anemia, the mean was 4.2 ± 0.6 mEq/L and the median 4.1 mEq/L. For macrocytic anemia, the mean was 3.9 ± 0.5 mEq/L and the median 3.8 mEq/L. For dimorphic anemia, the mean was 3.8 ± 0.4 mEq/L and the median 3.8 mEq/L (p = 0.0230).

Liver Function Tests
Serum Glutamic Oxaloacetic Transaminase (SGOT) (U/L): The mean and SD for the total population was 33.3 ± 25.4 U/L. For microcytic anemia, the mean was 28.0 ± 13.4 U/L. For macrocytic anemia, the mean was 44.1 ± 36.4 U/L. For dimorphic anemia, the mean was 27.5 ± 15.3 U/L (p = 0.028).

Serum Glutamic Pyruvic Transaminase (SGPT) (U/L): The mean and SD for the total population were 26.5 ± 18.4 U/L. For microcytic anemia, the mean was 21.6 ± 13.3 U/L. For macrocytic anemia, the mean was 32.2 ± 20.8 U/L. For dimorphic anemia, the mean was 20.7 ± 10.5 U/L (p = 0.021).

Alkaline Phosphatase (ALP) (U/L): The mean and SD for the total population were 69.1 ± 34.3 U/L. For microcytic anemia, the mean was 77.9 ± 34.5 U/L. For macrocytic anemia, the mean was 64.3 ± 30.2 U/L. For dimorphic anemia, the mean was 65.3 ± 27.5 U/L (p = 0.211).

Total Bilirubin (BT) (mg/dL): The mean and SD for the total population were 1.3 ± 1.2 mg/dL. For microcytic anemia, the mean was 1.0 ± 1.2 mg/dL. For macrocytic anemia, the mean was 1.7 ± 1.3 mg/dL. For dimorphic anemia, the mean was 1.2 ± 0.8 mg/dL (p = 0.05).

Direct Bilirubin (BD) (mg/dL): The mean and SD for the total population were 0.5 ± 0.4 mg/dL. For microcytic anemia, the mean was 0.4 ± 0.8 mg/dL. For macrocytic anemia, the mean was 0.5 ± 0.3 mg/dL. For dimorphic anemia, the mean was 0.5 ± 0.3 mg/dL (p = 0.865).

Total Protein (TP) (g/dL): The mean and SD for the total population were 6.3 ± 1.0 g/dL. For microcytic anemia, the mean was 6.1 ± 1.1 g/dL. For macrocytic anemia, the mean was 6.5 ± 0.7 g/dL. For dimorphic anemia, the mean was 5.9 ± 0.6 g/dL (p = 0.08).

Albumin (Alb) (g/dL): The mean and SD for the total population were 3.3 ± 0.6 g/dL. For microcytic anemia, the mean was 3.1 ± 0.7 g/dL. For macrocytic anemia, the mean was 3.5 ± 0.6 g/dL. For dimorphic anemia, the mean was 3.3 ± 0.4 g/dL (p = 0.054).

ECG Changes:
Short PR Interval: 75.7% of the total population. For microcytic anemia, 22 (71%), macrocytic anemia, 18 (69.2%) and dimorphic anemia, 16 (94.1%) (p = 0.129).

Narrow QRS Complex: 100% in all groups (p = NA).

Prolonged QTc Interval: 33.8% of the total population. For microcytic anemia, 10 (32.3%), macrocytic anemia, 10 (38.5%) and dimorphic anemia, 5 (29.4%) (p = 0.806).

ST Segment Depression: 6.8% of the total population. For microcytic anemia, 2 (6.5%), macrocytic anemia, 2 (7.7%), and dimorphic anemia, 1 (5.9%) (p = 0.387).

T Wave Inversion: 10.8% of the total population. For microcytic anemia, 4 (12.9%), macrocytic anemia, 3 (11.5%), and dimorphic anemia, 1 (5.8%) (p = 0.561).

Chest X Ray Findings

The mean and percentage for normal chest x-ray for the total population was 81.1%. For microcytic anemia was 23 (74.2%), for macrocytic anemia 24 (92.3%) and for dimorphic anemia 13 (76.5%) (p = 0.189).

The mean and percentage for abnormal chest x-ray for the total population was 18.9%. For microcytic anemia was 8 (25.8%), for macrocytic anemia was 2 (7.7%) and for dimorphic anemia was 4 (23.5%).

The difference in chest x-ray findings in various anemia groups was not statistically significant (p = 0.1889).

Ultrasound (Abdomen + Pelvis) Findings:

No significant abnormality: 59.5% of the total population. For microcytic anemia, 17 (54.8%), for macrocytic anemia, 17 (65.4%), and for dimorphic anemia, 10 (58.8%) (p = 0.76).

Splenomegaly: 10.8% of the total population. For microcytic anemia, 2 (6.5%), for macrocytic anemia, 3 (11.5%), and for dimorphic anemia, 3 (17.6%) (p = 0.23).

Hepatomegaly: 8.1% of the total population. For microcytic anemia, 2 (6.5%), for macrocytic anemia, 4 (15.4%), and for dimorphic anemia, none (0%) (p = 0.11).

Fatty Liver: 5.4% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, 1 (3.8%), and for dimorphic anemia, 2 (11.8%) (p = 0.19).

Liver Parenchymal Disease: 4.1% of the total population. For microcytic anemia, 2 (6.5%), for macrocytic anemia, 1 (3.8%), and for dimorphic anemia, none (0%) (p = 0.21).

PCOS: 4.1% of the total population. For microcytic anemia, 2 (6.5%), for macrocytic anemia, none (0%), and for dimorphic anemia, 1 (5.9%) (p = 0.13).

Hepatosplenomegaly: 2.7% of the total population. For microcytic anemia, 2 (6.5%), for macrocytic anemia, none (0%), and for dimorphic anemia, 1 (5.9%) (p = 0.14).

Bilateral Small Kidney: 1.4% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, none (0%), and for dimorphic anemia, none (0%) (p = 0.27).

Right Pyelonephritis with PCOS: 1.4% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, none (0%), and for dimorphic anemia, none (0%) (p = 0.27).

Thickened Caecum and Ascending Colon with Pre- and Para-aortic Lymphadenopathy: 1.4% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, none (0%), and for dimorphic anemia, none (0%) (p = 0.27)

Upper Gastrointestinal Endoscopy Findings:

Oesophagus:

Candida: 4.1% of the total population. For microcytic anemia, none (0%), for macrocytic anemia, 3 (11.5%), and for dimorphic anemia, none (0%) (p = 0.147).

Grade A Esophagitis: 6.8% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, 3 (11.5%), and for dimorphic anemia, 1 (5.9%) (p = 0.31).

Grade B Esophagitis: 1.4% of the total population. For microcytic anemia, none (0%), for macrocytic anemia, 1 (3.8%), and for dimorphic anemia, none (0%) (p = 0.27).

Schatzki's Ring: 1.4% of the total population. For microcytic anemia, none (0%), for macrocytic anemia, 1 (3.8%), and for dimorphic anemia, none (0%) (p = 0.27).

Stomach:

Fundus of Stomach:

Mild PHG: 9.5% of the total population. For microcytic anemia, 2 (6.5%), for macrocytic anemia, 3 (11.5%), and for dimorphic anemia, 2 (11.8%) (p = 0.79).

Pale: 6.8% of the total population. For microcytic anemia, 3 (9.7%), for macrocytic anemia, 1 (3.8%), and for dimorphic anemia, 1 (5.9%) (p = 0.69).

Mild Erythema: 4.1% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, 2 (7.7%), and for dimorphic anemia, none (0%) (p = 0.28).

Gastric Ulcer: 1.4% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, none (0%), and for dimorphic anemia, none (0%) (p = 0.27).

Erosive Gastritis: 1.4% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, none (0%), and for dimorphic anemia, none (0%) (p = 0.27).

Body of Stomach:

Pale: 6.8% of the total population. For microcytic anemia, none (0%), for macrocytic anemia, 4 (15.4%), and for dimorphic anemia, 1 (5.9%) (p = 0.45).

Erythema: 5.4% of the total population. For microcytic anemia, 3 (9.7%), for macrocytic anemia, 1 (3.8%), and for dimorphic anemia, none (0%) (p = 0.32).

Mild PHG: 5.4% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, 3 (11.5%), and for dimorphic anemia, none (0%) (p = 0.32).

Gastritis with Gastric Ulcer: 1.4% of the total population. For microcytic anemia, 1 (3.2%), for macrocytic anemia, none (0%), and for dimorphic anemia, none (0%) (p = 0.27).

Moderate PHG: 1.4% of the total population. For microcytic anemia, none (0%), for macrocytic anemia, none (0%), and for dimorphic anemia, 1 (5.9%) (p = 0.27).

Antrum of Stomach:

Pale: 6.8% of the total population. Microcytic anemia (0%), macrocytic anemia (15.4%), dimorphic anemia (5.9%) (p = 0.45).

Erythema: 5.4% of the total population. Microcytic anemia (9.7%), macrocytic anemia (3.8%), dimorphic anemia (0%) (p = 0.32).

Mild PHG: 5.4% of the total population. Microcytic anemia (3.2%), macrocytic anemia (11.5%), dimorphic anemia (0%) (p = 0.32).

Gastritis with Gastric Ulcer: 1.4% of the total population. Microcytic anemia (3.2%), macrocytic anemia (0%), dimorphic anemia (0%) (p = 0.27).

Moderate PHG: 1.4% of the total population. Microcytic anemia (0%), macrocytic anemia (0%), dimorphic anemia (5.9%) (p = 0.27).

First part of Duodenum:

Erythema: 8.1% of the total population. Microcytic anemia (3.2%), macrocytic anemia (19.2%), dimorphic anemia (0%) (p = 0.09).

Deep Ulcer: 2.7% of the total population. Microcytic anemia (6.5%), macrocytic anemia (0%), dimorphic anemia (0%) (p = 0.12).

Superficial Ulcer: 1.4% of the total population. Microcytic anemia (0%), macrocytic anemia (3.8%), dimorphic anemia (0%) (p = 0.27)

Second Part of Duodenum:

Fissuring: 48.6% of the total population. For microcytic anemia, 11 (35.5%); for macrocytic anemia, 11 (42.3%); for dimorphic anemia, 14 (82.4%) (p = 0.01).

Deep Ulcer: 4.1% of the total population. For microcytic anemia, 3

(9.7%); for macrocytic anemia, none (0%); for dimorphic anemia, none (0%) (p = 0.10).

Duodenitis: 4.1% of the total population. For microcytic anemia, 2 (6.5%); for macrocytic anemia, 1 (3.8%); for dimorphic anemia, none (0%) (p = 0.29).

Erythema: 2.7% of the total population. For microcytic anemia, 1 (3.2%); for macrocytic anemia, 1 (3.8%); for dimorphic anemia, none (0%) (p = 0.56).

Sessile Polyp: 1.4% of the total population. For microcytic anemia, 1 (3.2%); for macrocytic anemia, none (0%); for dimorphic anemia, none (0%) (p = 0.27).

Superficial Ulcer: 1.4% of the total population. For microcytic anemia, none (0%); for macrocytic anemia, 1 (3.8%); for dimorphic anemia, none (0%) (p = 0.27).

Histopathology Findings of Duodenal Biopsy:
Mucosa:
Normal: 97.2% of the total population. For microcytic anemia, 29 (93.5%); for macrocytic anemia, 26 (100%); for dimorphic anemia, 17 (100%) (p = 0.583).

Lymphoplasmacytic Infiltration: 1.4% of the total population. For microcytic anemia, 1 (3.2%); for macrocytic anemia, none (0%); for dimorphic anemia, none (0%).

Moderate Infiltration with Lymphocytes and Plasma Cells: 1.4% of the total population. For microcytic anemia, 1 (3.2%); for macrocytic anemia, none (0%); for dimorphic anemia, none (0%).

Submucosa:
Normal: 97.3% of the total population. For microcytic anemia, 30 (96.8%); for macrocytic anemia, 25 (96.2%); for dimorphic anemia, 17 (100%) (p = 0.728).

Moderate Lymphocytic Infiltrates: 2.7% of the total population. For microcytic anemia, 1 (3.2%); for macrocytic anemia, 1 (3.8%); for dimorphic anemia, none (0%).

Lamina Propria:
Mild Lymphocytic Infiltrate: 43.2% of the total population. For microcytic anemia, 14 (45.2%); for macrocytic anemia, 12 (46.2%); for dimorphic anemia, 6 (35.3%) (p = 0.254).

Mild to Moderate Lymphocytic Infiltrate: 10.8% of the total population. For microcytic anemia, 1 (3.2%); for macrocytic anemia, 5 (19.2%); for dimorphic anemia, 2 (11.8%) (p = 0.14).

Moderate Infiltration with Lymphocytes and Plasma Cells: 8.1% of the total population. For microcytic anemia, 3 (9.7%); for macrocytic anemia, 2 (7.7%); for dimorphic anemia, 1 (5.9%) (p = 0.67).

Moderate Lymphocytic Infiltrate: 8.1% of the total population. For microcytic anemia, 1 (3.2%); for macrocytic anemia, 1 (3.8%); for dimorphic anemia, 4 (23.5%) (p = 0.34).

Mild Lymphocytic Infiltrate with Foamy Cells: 2.7% of the total population. For microcytic anemia, 2 (6.5%); for macrocytic anemia, none (0%); for dimorphic anemia, none (0%) (p = 0.23).

Mild Lymphoplasmacytic Infiltrate: 1.4% of the total population. For microcytic anemia, 1 (3.2%); for macrocytic anemia, none (0%); for dimorphic anemia, none (0%) (p = 0.27).

Upper and Lower Gastrointestinal Bleed:
UGI Bleed: 35.1% of the total population. For microcytic anemia, 14 (45.2%); for macrocytic anemia, 6 (23.1%); for dimorphic anemia, 6 (35.3%) (p = 0.22).

LGI Bleed: 8.1% of the total population. For microcytic anemia, 3 (9.7%); for macrocytic anemia, 1 (3.8%); for dimorphic anemia, 2 (11.8%) (p = 0.594)

Diagnostic Outcome:
Gastritis: 47.3% of the total population. For microcytic anemia, 15 (48.4%); for macrocytic anemia, 11 (42.3%); for dimorphic anemia, 9 (52.9%) (p = 0.50).

Peptic Ulcer: 13.5% of the total population. For microcytic anemia, 8 (25.8%); for macrocytic anemia, 1 (3.8%); for dimorphic anemia, 1 (5.9%) (p = 0.02).

DUB: 10.8% of the total population. For microcytic anemia, 5 (16.1%); for macrocytic anemia, none (0%); for dimorphic anemia, 3 (17.6%) (p = 0.02).

Duodenitis: 6.8% of the total population. For microcytic anemia, 3 (9.7%); for macrocytic anemia, 2 (7.7%); for dimorphic anemia, none (0%) (p = 0.31).

PCOS: 5.4% of the total population. For microcytic anemia, 3 (9.7%); for macrocytic anemia, none (0%); for dimorphic anemia, 1 (5.9%) (p = 0.18).

Haemorrhoids: 8.1% of the total population. For microcytic anemia, 4 (12.9%); for macrocytic anemia, 1 (3.8%); for dimorphic anemia, 1 (5.9%) (p = 0.32).

Duodenal Polyp: 2.7% of the total population. For microcytic anemia, 1 (3.2%); for macrocytic anemia, none (0%); for dimorphic anemia, 1 (5.9%) (p = 0.23).

Ulcerative Colitis: 1.4% of the total population. For microcytic anemia, none (0%); for macrocytic anemia, none (0%); for dimorphic anemia, 1 (5.9%) (p = 0.27).

Intestinal Mass: 1.4% of the total population. For microcytic anemia, none (0%); for macrocytic anemia, 1 (3.8%); for dimorphic anemia, none (0%) (p = 0.27).

DISCUSSION

In the landscape of Indian healthcare, where anemia is a prevalent challenge, the study of the clinicopathological profiles of different types of anemia is critical. Our study at a tertiary care center on the clinicopathological complexities of microcytic, macrocytic, and dimorphic anemia, highlights the need for a systematic diagnostic approach. Upper GI endoscopy and duodenal biopsies are central to this endeavor, serving as crucial investigative tools to exclude gastrointestinal causes of anemia. Upper GI endoscopy allows for the detection of bleeding lesions and other structural abnormalities in the gastrointestinal tract that could lead to chronic blood loss or malabsorption—common aetiologias in iron deficiency and macrocytic anemia. [17, 18] Duodenal biopsies provide valuable insights into malabsorptive disorders, which are pivotal in the diagnosis of conditions that disrupt the absorption of critical nutrients like iron, folate, and vitamin B12. [9] By incorporating these investigations, our study highlights their indispensable roles in establishing the etiology of anemia and thus guiding precise and effective management strategies in the Indian clinical setting.

Prevalence of Anemia

In our study, microcytic anemia was identified in 41.90% of cases, aligning closely with Deepthi A et al.'s [26] report of 43.55%. Similarly, Suarez et al., [27] reported 35.9% IDA. Premkumar et al., [28] in their pancytopenia study observed a much lower rate of 7.14%.

As for macrocytic anemia, it was seen in 35.10% patients. This is somewhat higher than the 19% reported by Suarez et al. [27] It also exceeds the 19.35% noted by Deepthi A et al. [26] A much higher rate of 81% noted by Premkumar et al. [28] in their pancytopenia study.

Lastly, dimorphic anemia was present in 23% of our cases, closely resembling Deepthi A et al.'s [26] observation of 27.42%. This was significantly higher than the 3.51% reported by Premkumar et al. [28] Notably, Suarez et al. [27] did not report any cases of dimorphic anemia.

The variations in the prevalence of anemia types across different studies can largely be attributed to differences in selection criteria. Selection criteria in these studies varied based on age, symptoms and often MCV criteria.

Gender Distribution:

The gender distribution in our study reflects both continuities and shifts in the patterns of anemia compared to historical data:
Microcytic Anemia: Females comprised 54.80% of cases in our study, reflecting a decrease from the 67.70% reported by Emami MH et al. (2012) [25], but it was comparable to the 46.98% observed by Odhaib SA. et al. (2020) [50]. A recent Indian Epidemiology study by Sharif N et al [30] reported that IDA was more prevalent in India that too in a less privileged socioeconomic groups, the demographic which forms the majority in this tertiary care center.

Macrocytic Anemia: Males represented 69.20% of cases in our study, marking a continuation of the trend observed in earlier studies such as those by Unnikrishnan V et al. in 2008 (65%) [31] and Kotli N et al. in 2019 (58.6%) [51] This consistent increase in male prevalence over time indicates a strengthening male dominance in macrocytic anemia diagnoses. Our finding was supported by recent Indian study who reported that Male patients were more likely than female individuals to have megaloblastic anemia. In their study male patients made up 77.21% of the prevalence, while female patients made up 22.79%.

Dimorphic Anemia: The gender distribution in dimorphic anemia has seen a notable shift towards male dominance, with males constituting 64.70% of cases in the current study. This was nearly comparable to distribution reported by Deepthi. A et al. in 2018 (53.2% male). [26]

Overall, males constitute 58.1% and females 41.9% of the cohort in the present study.

Age Distribution
In the current study, age distributions for various anemia subtypes were characterized as follows:
Microcytic Anemia was documented with a mean age of 44.3 ± 19.1 years, Macrocytic Anemia at 42.4 ± 15.8 years, and Dimorphic Anemia at 41.4 ± 13.8 years. These metrics establish a benchmark for juxtaposing contemporary findings with historical datasets.

Ozdil K in (2011) [32] reported a mean age for Microcytic Anemia at 43.39 ± 14.00 years, aligning closely with the current study's findings. In contrast, Emami MH. et al. (2012) [25] observed a considerably lower mean age of 35.5 ± 13.7 years for the same condition, indicative of a demographic shift toward older populations in more recent cohorts. Additionally, Odhaib SA. et al. (2020) [50] noted a significantly elevated mean age of 52 ± 9 years, further supporting the trend of an aging demographic among patients diagnosed with microcytic anemia.

Macrocytic Anemia, the current study's mean age of 42.4 ± 15.8 years shows a progressive increase compared to earlier findings by Kotli N. et al. (2019) [51] who documented a mean age of 37.18 ± 14.8 years, and a notably younger female demographic at 33.84 ± 19.7 years within the same study. Unnikrishnan V et al. (2008) [31] recorded a mean age of 38.96 ± 16.4 years, matching to current study's findings.

Dimorphic Anemia, Deepthi. A et al. (2018) [26] presented a mean age of 40.95 ± 17.61 years, which is commensurate with the mean age derived from the current study, implying a stable age distribution for this anemia subtype over the last decade.

Clinical Profile of Cases with Different Anemia Types
In the present study, general weakness (GW) was a predominant symptom across all types of anemia, observed in 71.0% of patients with microcytic anemia, 76.9% with macrocytic anemia, and 76.5% with dimorphic anemia. This was similar to Aryal D et al (2023) [33] findings where easy fatigability was reported in 76.2% of the patients, indicating a high prevalence of generalized weakness in anemia patients regardless of the type. Both studies underscored the commonality of general weakness or easy fatigability as a prominent symptom in anemia.

Dyspnea on exertion was noted in 58.1% of patients with microcytic anemia, 76.9% with macrocytic anemia, and 70.6% with dimorphic anemia in the present study. Comparatively, Aryal D et al (2023) [33] reported breathlessness on exertion in 30.1% of patients, while Drissa S et al. (2023) [34] observed DOE in 51.26% of patients. The present study indicated a higher prevalence of DOE, particularly in macrocytic anemia, suggesting that this symptom manifested more commonly in macrocytic anemia compared to other forms of anemia.

Giddiness was reported in 29.0% of microcytic anemia, 19.2% of macrocytic anemia, and 41.2% of dimorphic anemia patients in the current study. Aryal D et al (2023) [33] found light-headedness in 21.8% of cases, while Drissa S et al., (2023) [34] reported vertigo in 56.85%. Although the terminology differs slightly between studies, the occurrence of dizziness or vertigo-related symptoms was consistent, with varying prevalence across different types of anemia.

Abdominal pain in anemia patients is crucial for diagnosis as it often signals underlying gastrointestinal issues, such as ulcers, gastritis, or malabsorptive disorders, which can cause or exacerbate anemia. It prompts comprehensive evaluations, including imaging and endoscopic procedures, to identify and treat the root causes, such as nutrient malabsorption or chronic blood loss. Abdominal pain in the present study was observed in 16.1% of microcytic, 11.5% of macrocytic, and 17.6% of dimorphic anemia patients. This was lower than reported by Drissa S et al., (2023) [34] where 44.67% of patients experienced abdominal pain. The difference in prevalence could be attributed to variations in study populations or the criteria for reporting abdominal symptoms.

Pedal oedema in anemic patients often signals underlying conditions such as heart failure, kidney disease, or liver dysfunction, which may contribute to both anemia and fluid accumulation. This symptom necessitates a thorough evaluation of cardiac, renal, and hepatic functions to identify and treat the root causes effectively. Pedal oedema was observed in 16.1% of microcytic, 15.4% of macrocytic, and none of the dimorphic anemia patients in the present study. This closely matched Aryal D et al (2023) [33] findings, where limb swelling was noted in 10.4% and pedal oedema in 13.5% of patients.

In the present study, splenomegaly was noted in 6.5% of microcytic, 11.5% of macrocytic, and 17.6% of dimorphic anemia patients. Aryal D et al (2023) [33] reported a lower incidence of splenomegaly at 2.1%. The present study showed that splenomegaly was more common, especially in dimorphic anemia, indicating possible variations in the etiology or severity of anemia types between study populations.

Symptoms such as headache, anorexia, hematemesis, and black stools were less commonly reported in the present study, with variable prevalence across the anemia types. For instance, anorexia was more frequent in macrocytic anemia (30.8%) compared to microcytic (12.9%) and dimorphic (23.5%). Drissa S et al. (2023) [34] reported headache in 50.25% and constipation in 53.3%, suggesting regional or population differences in the symptom profile.

Mean Haemoglobin Concentration
In the present study, the haemoglobin concentrations for different types of anemia were quantified as follows: Microcytic Anemia recorded a mean of 4.84 ± 1.54 g/dl, Macrocytic Anemia at 4.73 ± 1.56 g/dl, and Dimorphic Anemia at 4.28 ± 1.03 g/dl. These results provide a context for comparing recent data against historical findings from past studies.

From previous research, Deepthi. A et al. (2018) [26] reported a wider range of haemoglobin concentration for Dimorphic Anemia, spanning from 1.49 gm/dl to 10.5 gm/dl, with a mean of 5.74 ± 2.43 gm/dl. This mean is higher than the one observed in the current study for Dimorphic Anemia, suggesting a possible shift towards lower average haemoglobin levels in recent years or variations in the study populations or measurement techniques.

Unnikrishnan V et al. [31] documented a mean haemoglobin level of 5.6 ± 2.12 g/dl for Macrocytic Anemia, which is slightly higher than the mean of 4.73 ± 1.56 g/dl noted in the present study. This discrepancy might indicate a trend of decreasing haemoglobin concentrations in Macrocytic Anemia, or it may reflect differences in the severity or staging of the disease among the study cohorts.

For Microcytic Anemia, Gulen h et al. [35] found a considerably higher mean haemoglobin concentration of 7.9 ± 1.8 g/dL, significantly greater than the mean of 4.84 ± 1.54 g/dl recorded in the current study. This substantial difference highlights the severity of cases in the present study and need of advanced diagnostic techniques such as UGI endoscopy and duodenal biopsy for root cause evaluation and early management.

ECG Findings in Anemia

In the present study, a significant 75.7% of anemic patients exhibited a short PR interval, potentially linked to tachycardia, a common compensatory response in anemia. The increased heart rate observed in anemic patients may accelerate electrical conduction through the heart, manifesting as a shortened PR interval.

In the current study, prolonged QTc intervals were observed in 32.3% of patients with microcytic anemia, 38.5% with macrocytic anemia, and 29.4% with dimorphic anemia. Khatri M et al. (2018) [36] also identified prolonged QT intervals in 5.66% of patients, though they did not specify the anemia type. The present study found a higher prevalence of QTc prolongation, especially in macrocytic anemia, which may reflect varying degrees of cardiac repolarization abnormalities linked to the type and severity of anemia.

ST segment depression was documented in the present study in 6.5% of microcytic anemia patients, 7.7% with macrocytic anemia, and 5.9% with dimorphic anemia. Khatri M et al. [36] reported a much higher occurrence of ST segment changes, with 66.03% of patients with severe anemia showing these changes. Similarly, Biradar SM et al. [37] observed ST segment changes in 18% of patients. The lower incidence of ST segment depression in the present study could indicate differences in anemia severity or the presence of underlying ischemic heart conditions in the populations studied by Khatri and Biradar.

In the present study, T wave inversion was observed in 12.9% of patients with microcytic anemia, 11.5% with macrocytic anemia, and 5.8% with dimorphic anemia. This indicated a relatively lower prevalence of T wave changes compared to findings reported in previous studies. Similarly, Biradar SM et al. [37] found T wave changes in 12% of their patients, which aligns more closely with the rates observed in the present study, particularly in microcytic anemia. Khatri M et al. [36] reported T wave changes in 33.96% of patients, a significantly higher proportion than that observed in the current study.

Gastrointestinal Tract Involvement in Anemia:

In the present study, majority of gastrointestinal lesions in patients with microcytic anemia were in the upper gastrointestinal tract.

Specifically, stomach lesions were observed in 41.9% of microcytic anemia patients, 19.2% of those with macrocytic anemia, and 23.5% of dimorphic anemia patients. The esophagus showed a relatively low prevalence of lesions in microcytic anemia (3.2%) and dimorphic anemia (5.9%), but a higher incidence in macrocytic anemia at 30.8%. Notably, the gastroesophageal (GE) junction was frequently involved across all anemia types, with lesions found in 48.4% of microcytic, 53.8% of macrocytic, and 76.5% of dimorphic anemia patients. The antrum also had a high prevalence of lesions, observed in 48.4% of microcytic anemia patients, 61.5% of macrocytic, and 64.7% of dimorphic anemia cases.

Reddy S et al. [38] found that the highest number of lesions responsible for microcytic anemia (IDA) were in the stomach, accounting for 49.3% of cases, which is in line with the findings of the present study. However, they reported a higher prevalence of esophageal lesions at 44%, compared to the present study's findings in microcytic anemia. This is possibly because of their inclusion criteria of only IDA cases compared to present study's more generic selection criteria.

In contrast, other studies like Ozdil et al. (2011) [32] and Elloumi et al. (2017) [40] reported a higher incidence of mucosal abnormalities, such as atrophic gastritis and H. pylori infection. Elloumi et al. [40] noted chronic gastritis in 84% of patients, indicating a greater prevalence of mucosal changes than observed in the current study. Gonen C et al. (2007) [41] also reported a higher incidence of duodenal and gastric ulcers than was found in the present cohort.

In the present study, most patients showed normal findings in the D1 segment. Specifically, 90.3% of microcytic anemia patients, 76.9% of macrocytic anemia patients, and 100% of those with dimorphic anemia had no significant abnormalities. Erythema was more commonly seen in macrocytic anemia (19.2%), while deep ulcers were present only in microcytic anemia (6.5%). These results aligned with Carmack SW et al. (2009), [42] where over 82% of duodenal biopsies were normal, regardless of the indication for EGD. Similarly, Chellat H. et al. (2013) [43] found normal endoscopic findings in 66% of cases, although they also reported a mosaic pattern and scalloping in some patients.

In the D2 segment, fissuring was the most common abnormality, especially in dimorphic anemia (82.4%), macrocytic anemia (42.3%), and microcytic anemia (35.5%). Deep ulcers and duodenitis were primarily seen in microcytic anemia (9.7% and 6.5%, respectively). In the present study duodenal fissuring was significantly more commonly seen in dimorphic anemia. However, among other abnormalities, the differences across anemia types in the present study were not statistically significant, indicating no strong association between anemia type and specific duodenal abnormalities. This finding was consistent with findings of Blaban DV et. Al. where in duodenal fissuring was the commonest UGI endoscopy finding [44]. A study by Leffler et al. found a sensitivity of 81% and specificity of 88% for endoscopic markers, including duodenal fissuring, scalloping, and micro nodularity, in the diagnosis of celiac disease [45]. Similarly, a study by Oxentenko et al. reported a sensitivity of 75% and specificity of 96% for the presence of duodenal fissuring in celiac disease. [46]

In the present study duodenal intraepithelial lymphocytosis was seen with varying degree of severity. Duodenal lymphocytosis is a nonspecific finding that is being detected with heightened frequency. Although increased intraepithelial lymphocytosis with normal villous architecture classically corresponds to grade 1 of the Marsh classification, many other conditions have been reported to be associated with this histologic pattern. Duodenal lymphocytosis once observed in between 1.3% and 2.2% of patients undergoing upper GI tract endoscopy and small intestinal biopsy, has been increasingly noted in up to 7% over the last 11 years in a single-center study of 15839 duodenal biopsies. However, it remains a vexing diagnostic problem, as a specific etiology is never discovered for many cases of duodenal lymphocytosis. [47]

However, this study did not identify specific histopathological abnormalities such as celiac disease. This differed from Pivetta G et al., [48] who found histopathological changes in 8.7% of patients, including conditions like celiac disease and duodenal intraepithelial lymphocytosis. Carmack SW et al. [39] observed variable villous atrophy and intraepithelial lymphocytosis, particularly in suspected sprue cases, while this aspect was not a significant focus in the present study. This suggests a potentially lower incidence or different focus in histopathological examination compared to the other study.

Mucosal abnormalities were minimal in the current study, only 1.4% of the total cohort exhibited lymphoplasmacytic infiltration or moderate infiltration with lymphocytes and plasma cells. Submucosal findings were similarly unremarkable, moderate lymphocytic infiltrates were observed in just 2.7% of cases, mostly affecting microcytic and macrocytic anemia patients.

Upper and Lower Gastrointestinal Bleeding in Anemia

In the present study, upper gastrointestinal (UGI) bleeding was identified as a more common finding among anemia patients, with 45.2% of microcytic anemia patients, 23.1% of macrocytic anemia patients, and 35.3% of those with dimorphic anemia being affected. This contrasted with the findings of Reddy et al. (2021), [38] where isolated upper GI lesions were responsible for iron deficiency anemia (IDA) in a significantly higher proportion of cases, accounting for 80%. The difference in the prevalence of UGI bleeding between the present study and Reddy et al. [38] could suggest variations in patient populations, underlying etiologies of anemia, or differences in diagnostic methods employed in detecting UGI lesions.

Lower gastrointestinal (LGI) bleeding was less common in the present study, occurring in 9.7% of microcytic anemia cases, 3.8% of macrocytic cases, and 11.8% of dimorphic cases. This was somewhat lower compared to the findings of Niv E et al. (2005), [49] who reported anemia-causing lesions in both the upper and lower GI tracts in 29% and 33% of patients, respectively. The lower incidence of LGI bleeding in the current study might indicate a predominance of UGI sources of bleeding in this patient cohort or reflect a difference in the diagnostic criteria or detection rates for LGI bleeding.

Final Diagnosis

In the present study, the most common diagnosis across all types of anemia was gastritis, which was diagnosed in 47.3% of patients. It was particularly prevalent in dimorphic anemia (52.9%) and microcytic anemia (48.4%). This finding aligns with those from past studies, such as Elloumi et al. (2017), [40] who reported chronic gastritis in 84% of patients with iron deficiency anemia (IDA), with a strong association with Helicobacter pylori infection.

Similarly, Ozdil et al. (2011) [32] identified mucosal changes such as atrophic gastritis and H. pylori gastritis in a significant portion of their patient population, reinforcing the present study's emphasis on the high prevalence of gastritis in anemic patients.

Peptic ulcers were observed more frequently in microcytic anemia (25.8%) compared to macrocytic (3.8%) and dimorphic anemia (5.9%) in the present study. This is consistent with Gulen et al., [35] who noted the occurrence of antral gastritis, duodenal ulcers, and polyps in 56.8% of their patients, highlighting the link between gastrointestinal pathology and anemia. Majid S. et al. similarly found that gastrointestinal lesions were responsible for 52.6% of cases of iron deficiency anemia, with majority of lesions located in the stomach (22.5%).

Dysfunctional uterine bleeding (DUB) was also a notable diagnosis in the present study, affecting 16.1% of microcytic anemia cases and 17.6% of dimorphic anemia cases, but absent in patients with macrocytic anemia. This observation adds a dimension which was not heavily highlighted in previous studies, where gastrointestinal pathology was the main area of investigation.

Hemorrhoids were present in 12.9% of patients with microcytic anemia, with lower rates in macrocytic (3.8%) and dimorphic anemia (5.9%). While this finding was not a major focus in past studies, it contributes to the understanding of the varied causes of bleeding contributing to anemia in different patient groups.

The differences in the prevalence of specific gastrointestinal findings across the present and past studies may reflect variations in the populations studied, diagnostic criteria, and the types of anemia under investigation. However, the consistent finding of gastritis as a leading diagnosis highlights the importance of gastrointestinal evaluation in patients with anemia.

Study Limitations

The study's observational nature inherently limits the ability to draw causal inferences between different types of anemia and their associated clinical and pathological conditions. The absence of longitudinal follow-up constrains our understanding of the long-term outcomes and effectiveness of the interventions implemented. Furthermore, due to financial constraints, comprehensive biomarker data, including iron profiles and serum Vitamin B12 levels, were not collected for all patients, which may have limited a more detailed understanding of the underlying etiologies of anemia.

Prospects

Future research should prioritize longitudinal studies that can monitor the progression of anemia and the long-term outcomes of various treatment strategies. Additionally, the adoption of advanced diagnostic techniques, such as molecular assays and detailed imaging studies, could significantly enhance the diagnostic accuracy and allow for more tailored treatment approaches. These advancements will aid in addressing the gaps identified in this study and enhance our understanding and management of anemia in diverse populations.

CONCLUSION

The study demonstrated, out of the total cohort 54.8 % were females and 45.2% were males. Tobacco chewing was significantly more common in dimorphic anemia ($p = 0.034$).

Generalized weakness was the most common symptom occurring in 74.3 % of the cohort. Pallor was the most common sign seen in 100 % of cohort. Knuckle pigmentation was seen most in macrocytic anemia group and its distribution was statistically highly significant ($p=0.0001$). Platynychia was significantly seen more commonly in microcytic anemia group ($p=0.012$). Bald tongue was seen significantly more commonly in macrocytic anemia ($p=0.002$). Low MCV was seen in microcytic anemia and a normal and high MCV was seen in macrocytic anemia ($p=0.0001$). Low MCH was seen in microcytic anemia, while a normal and high MCH was seen in macrocytic anemia ($p=0.001$). Leukopenia was significantly more commonly seen in macrocytic and dimorphic anemia than in microcytic anemia ($p=0.001$). Thrombocytopenia was also seen significantly more commonly in Macrocytic and dimorphic anemia than in microcytic anemia ($p<0.0001$). Neutropenia was more commonly seen in dimorphic anemia and the difference approached near statistical significance ($p=0.056$). Lymphocytopenia was also significantly more commonly seen in dimorphic anemia ($p=0.019$). Hypochromia was significantly more common in microcytic anemia ($p=0.01$).

While studying blood cell morphology it was found that Anisopoikilocytosis was most seen in dimorphic anemia and macrocytic anemia. Tear drop cells were seen significantly more commonly in dimorphic anemia ($p = 0.02$). Ovalocytes were seen significantly more commonly in macrocytic anemia than in dimorphic and microcytic anemia ($p = 0.02$). Macro ovalocytes were predominantly seen in Macrocytic and dimorphic anemia ($p = 0.005$). Hypersegmented neutrophils were significantly more commonly seen in macrocytic ($p = 0.015$). Studying the coagulation profile, it was found that prothrombin time and International Normalized Ratio was prolonged significantly in microcytic anemia group ($p=0.008$, $p=0.006$). On studying the liver function tests it was found that SGOT and SGPT were significantly raised in macrocytic anemia than in microcytic and dimorphic anemia ($p=0.028$, $p=0.021$), it was also found that total bilirubin was significantly more in macrocytic anemia group ($p=0.05$). Serum albumin levels were less in microcytic anemia group and this difference approached a near statistical significance ($p=0.054$).

On upper gastrointestinal endoscopy it was found that esophageal abnormalities were significantly more common in macrocytic anemia group ($p=0.006$) and the most common abnormality was grade A esophagitis. In the stomach gastritis especially in gastric antrum was the most common abnormality and was most seen in dimorphic anemia ($p =0.02$). Erythematous mucosa the next most common abnormality seen in stomach and was mostly seen in macrocytic anemia. ($p>0.05$) Abnormalities in first part of duodenum were more common in macrocytic anemia with a near statistical significance ($p=0.06$). On studying the second part of duodenum it was found that duodenal fissuring was the most common abnormality seen in all types of anemia with it being notably more common in dimorphic anemia group ($p=0.01$).

A biopsy from second part of duodenum and its histopathological examination showed lymphocytic infiltration to varying degree of severity, however, the distribution was not statistically significant ($p > 0.05$).

It was concluded that gastritis was seen in majority of participants from all types of anemia, however, the distribution was not significantly statistically ($p > 0.05$). Peptic ulcer disease was found significantly more common in microcytic anemia group ($p = 0.02$) while Dysfunctional Uterine Bleeding was significantly more commonly seen in dimorphic anemia group ($p = 0.02$).

REFERENCES

[1] Haemoglobin concentrations for the diagnosis of Anemia and assessment of severity [Internet]. [cited 2024 May 30]. Available from: https://www.who.int/publications-detail-redirect/WHO-NMH-NHD-MNM-11.1

[2] Kassebaum NJ, Jasrasaria R, Naghavi M, Wulf SK, Johns N, Lozano R, et al. A systematic analysis of global anemia burden from 1990 to 2010. Blood. 2014 Jan 30;123(5):615–24.

[3] Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJL, Comparative Risk Assessment Collaborating Group. Selected major risk factors and global and regional burden of disease. Lancet Lond Engl. 2002 Nov 2;360(9343):1347–60.

[4] Chaudhry HS, Kasarla MR. Microcytic Hypochromic Anemia. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 [cited 2024 Jun 4]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK470252/

[5] Moore CA, Adil A. Macrocytic Anemia. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 [cited 2024 Jun 4]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK459295/

[6] Umbreit J. Iron deficiency: a concise review. Am J Hematol. 2005 Mar;78(3):225–31.

[7] Nasrin NN, Shanmugasundaram S, Kartikayan RK. The Value of Duodenal Biopsies in the Evaluation of Megaloblastic Anemia. J Lab Physicians. 2021 Jul 12;13(4):291–5.

[8] Singh A. Back to Basics: Dimorphic Anemia and Peripheral Blood Smear Examination. J Appl Hematol. 2017 Dec;8(4):159.

[9] Elli L, Norsa L, Zullo A, Carroccio A, Girelli C, Oliva S, et al. Diagnosis of chronic Anemia in gastrointestinal disorders: A guideline by the Italian Association of Hospital Gastroenterologists and Endoscopists (AIGO) and the Italian Society of Paediatric Gastroenterology Hepatology and Nutrition (SIGENP). Dig Liver Dis Off J Ital Soc Gastroenterol Ital Assoc Study Liver. 2019 Apr;51(4):471–83.

[10] Zuckerman G, Benitez J. A prospective study of bidirectional endoscopy (colonoscopy and upper endoscopy) in the evaluation of patients with occult gastrointestinal bleeding. Am J Gastroenterol. 1992 Jan;87(1):62–6.

[11] Gordon SR, Smith RE, Power GC. The role of endoscopy in the evaluation of iron deficiency anemia in patients over the age of 50. Am J Gastroenterol. 1994 Nov;89(11):1963–7.

[12] Capurso G, Baccini F, Osborn J, Panzuto F, Di Giulio E, Delle Fave G, et al. Can patient characteristics predict the outcome of endoscopic evaluation of iron deficiency anemia: a multiple logistic regression analysis. Gastrointest Endosc. 2004 Jun;59(7):766–71.

[13] Annibale B, Capurso G, Chistolini A, D'Ambra G, DiGiulio E, Monarca B, et al. Gastrointestinal causes of refractory iron deficiency anemia in patients without gastrointestinal symptoms. Am J Med. 2001 Oct 15;111(6):439–45.

[14] Niv E, Elis A, Zissin R, Naftali T, Novis B, Lishner M. Iron deficiency anemia in patients

without gastrointestinal symptoms--a prospective study. Fam Pract. 2005 Feb;22(1):58–61.
[15] Jolobe O. Does this elderly patient have iron deficiency Anemia, and what is the underlying cause? Postgrad Med J. 2000 Apr;76(894):195–8.
[16] Zuckerman GR, Prakash C, Askin MP, Lewis BS. AGA technical review on the evaluation and management of occult and obscure gastrointestinal bleeding. Gastroenterology. 2000 Jan;118(1):201–21.
[17] Park DI, Ryu SH, Oh SJ, Yoo TW, Kim HJ, Cho YK, et al. Significance of endoscopy in asymptomatic premenopausal women with iron deficiency anemia. Dig Dis Sci. 2006 Dec;51(12):2372–6.
[18] Stephens MR, Hopper AN, White SR, Jugool S, Stratford R, Lewis WG, et al. Colonoscopy first for iron-deficiency Anemia: a Numbers Needed to Investigate approach. QJM Mon J Assoc Physicians. 2006 Jun;99(6):389–95.
[19] Broide E, Matalon S, Kriger-Sharabi O, Richter V, Shirin H, Leshno M. Cost effectiveness of routine duodenal biopsies in iron deficiency anemia. World J Gastroenterol. 2016 Sep 14;22(34):7813–23.
[20] Ludvigsson JF, Bai JC, Biagi F, Card TR, Ciacci C, Ciclitira PJ, et al. Diagnosis and management of adult coeliac disease: guidelines from the British Society of Gastroenterology. Gut. 2014 Aug;63(8):1210–28.
[21] Rashtak S, Murray JA. Celiac disease in the elderly. Gastroenterol Clin North Am. 2009 Sep;38(3):433–46.
[22] Hoffbrand V, Moss P, Pettit J. Essential Haematology. Wiley; 2006. 391 p.
[23] Desai HG, Antia FP. Vitamin B12 Malabsorption Due to Intrinsic Factor Deficiency in Indian Subjects. Blood. 1972 Nov 1;40(5):747–53.
[24] Allen LH. Causes of vitamin B12 and folate deficiency. Food Nutr Bull. 2008 Jun;29(2 Suppl): S20-34; discussion S35-37.
[25] Emami MH, Karimi S, Kouhestani S. Is routine duodenal biopsy necessary for the detection of celiac disease in patients presenting with iron deficiency anemia? Int J Prev Med. 2012 Apr;3(4):273–7.
[26] Deepthi A, Prasad CSBR, Raghavendra Prasad BN. Study of dimorphic anemia in adults with reference to basic etiology. Indian J Pathol Oncol. 2018;5(1):61-66. doi: 10.18231/2394-6792.2018.0012.
[27] Suarez T, Torrealba M, Villegas N, Osorio C, Garcia-Casal MN. Iron, folic acid and vitamin B12 deficiencies related to anemia in adolescents from a region with a high incidence of congenital malformations in Venezula. Arch Latinoam Nutr 2005;55(2):118-23.
[28] Premkumar M, Gupta N, Singh T, Velpandian T. Cobalamin and folic acid status in relation to the etiopathogenesis of pancytopenia in adults at a tertiary care centre in North India. Anemia 2012;2012, Article ID 707402, 12 pages. doi:10.1155/2012/707402.
[29] Odhaib SA, Mohammed MJ, Hammadi S. Efficacy of Gastrointestinal Endoscopy in 398 Patients With Iron Deficiency Anemia Who Lack Gastrointestinal Symptoms: Basrah Experience. Cureus. 2020 Jul 15;12(7):e9206.
[30] Sharif N, Das B, Alam A. Prevalence of anemia among reproductive women in different social group in India: Cross-sectional study using nationally representative data. PLoS One. 2023 Feb 2;18(2):e0281015\.
[31] Unnikrishnan V, Dutta TK, Badhe BA, Bobby Z, Panigrahi AK. Clinico-aetiologic profile of macrocytic anemias with special reference to megaloblastic anemia. Indian J Hematol Blood Transfus. 2008;24(4):155-165.
[32] Ozdil K, Sahin A, Akyuz U, Calhan T, Nigdelioglu A, Yuzbasıoglu B, et al. THE IMPORTANCE OF DUODENAL BIOPSY IN THE ADULTS WITH IRON DEFICIENCY ANEMIA. Yeditepe Med J. 2011 Jan 1;
[33] Aryal D, Ghimire MR, Pandey S, Paudel D, Gaire A. Clinical profile of patients with anemia in a tertiary care hospital. J Univ Coll Med Sci. 2023;11(02):20-24. doi:10.3126/jucms.v11i02.57984.
[34] Drissa S, CS M, Youssouf G, D A, Niagalé D, BB B, et al. Etiological and Evolutionary Profile of Anemia in Outpatients at the Internal Medicine Unit of the Fousseyni Daou Hospital in Kayes. SAS J Med. 2023;9(02).
[35] Gulen H, Kasirga E, Yildirim SA, Kader S, Sahin G, Ayhan S. Diagnostic yield of upper gastrointestinal endoscopy in the evaluation of iron deficiency anemia in older children and adolescents. Pediatr Hematol Oncol. 2011 Nov;28(8):694–701.
[36] Khatri M, Deokar V, Patel J, et al. Study of electrocardiographic changes in mild, moderate and severe Anemia in a tertiary care hospital. Journal of Contemporary Medical Research 2018;5(12):L9-13.
[37] Biradar SM, Teja VR, Shannawaz M, Holyachi R. Electrocardiographic abnormalities in severe Anemia and its reversibility after correction of Anemia in North Karnataka, India. Int J Adv Med 2020;7:1566-9.
[38] Reddy S, Vaishnav B, Sharma P, Tonde T, Bamnikar A, Barla DR, Basha F. Upper and Lower Gastrointestinal Endoscopic Lesions in Patients with Unexplained Iron Deficiency Anemia- A Cross-sectional Study. J Clin Diagn Res. 2021 Aug;15(8),49-53.
[39] Carmack SW, Genta RM. The Clinical Value of the Duodenal Biopsy: A Nation-Wide Clinicopathologic Analysis of 20,000 Patients. Gastrointest Endosc. 2009 Apr 1;69(5):AB104.
[40] Elloumi H, Sabbah M, Debbiche A, Ouakaa A, Bibani N, Trad D, et al. Systematic gastric biopsy in iron deficiency Anemia. Arab J Gastroenterol Off Publ Pan-Arab Assoc Gastroenterol. 2017 Dec;18(4):224–7.
[41] Gonen C, Yilmaz N, Yalcin M, Simsek I, Gonen O. Diagnostic yield of routine duodenal biopsies in iron deficiency Anemia: a study from Western Anatolia. Eur J Gastroenterol Hepatol. 2007 Jan;19(1):37.
[42] Carmack SW, Genta RM. The Clinical Value of the Duodenal Biopsy: A Nation-Wide Clinicopathologic Analysis of 20,000 Patients. Gastrointest Endosc. 2009 Apr 1;69(5):AB104.
[43] Chellat H, Salihoun M, Kabbaj N, Amrani L, Serraj I, Chaoui Z, et al. Diagnostic Yield of Routine Duodenal Biopsies in Iron Deficiency Anemia for Celiac Disease Diagnosis. Int Sch Res Not. 2013 Feb 20;2013:e769519.
[44] Balaban DV, Popp A, Vasilescu F, Haidautu D, Purcarea RM, Jinga M. Diagnostic yield of endoscopic markers for celiac disease. J Med Life. 2015 Oct-Dec;8(4):452-7. PMID: 26664469; PMCID: PMC465695.
[45] Ludvigsson JF, Leffler DA, Bai JC, et al. The Oslo definitions for coeliac disease and related terms. Gut. 2013;62(1):43-52.
[46] Green PH, Cellier C. Celiac disease. N Engl J Med. 2007;357(17):1731-1743.
[47] Lauwers, G., Fasano, A. & Brown, I. Duodenal lymphocytosis with no or minimal enteropathy: much ado about nothing?. Mod Pathol 28 (Suppl 1), S22–S29 (2015). https://doi.org/10.1038/modpathol.2014.135.
[48] Pivetta G, Coluccio C, Dilaghi E, Lahner E, Pilozzi E, Carabotti M, et al. In Elderly Anemic Patients without Endoscopic Signs of Bleeding Are Duodenal Biopsies Always Necessary to Rule Out Celiac Disease? Diagn Basel Switz. 2022 Mar 10;12(3):678.
[49] Niv E, Elis A, Zissin R, Naftali T, Novis B, Lishner M. Iron deficiency anemia in patients without gastrointestinal symptoms—a prospective study. Fam Pract. 2005;22:58-61.
[50] Odhaib SA, Mohammed MJ, Hammadi S. Efficacy of Gastrointestinal Endoscopy in 398 Patients With Iron Deficiency Anemia Who Lack Gastrointestinal Symptoms: Basrah Experience. Cureus. 2020 Jul 15;12(7):e9206.
[51] Kotli N, Sagar S. Upper Gastrointestinal Endoscopic Findings in Patients with Vitamin B12 Deficiency. 2019 [cited 2024 May 16]; Available from: http://imsear.searo.who.int/handle/123456789/187148