International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 07, NCIRTAI - 2026

Ai-Based Gastric Cancer Screening using Upper Gastrointestinal Endoscopic Images

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ABSTRACT— Gastric cancer (GC) is a prominent disease with tumors in many of pathological research. Treatment must be suggested for early detection by using pathological confirmation through endoscopic examination. Mostly, 50 years old adults are suffering from the GC and 50 percent of humans die even with the treatment. This GC has affected adults who are with poor prognosis. Most of the GC insists the outcomes as not stable in genetic, microsatellite, and or chromosomal of gastric carcinogenesis. Deep Learning (DL) plays an important role in exploring gastric cancer with higher accuracy with various numerous tests by Convolutional Neural Networks (CNN)

II. INTRODUCTION

Gastric cancer, also known as stomach cancer, is a type of cancer that originates in the lining of the stomach. It often develops slowly over many years, and its early symptoms can be subtle or even absent, making it difficult to diagnose in its initial stages. Gastric cancer can occur in any part of the stomach and can spread to nearby lymph nodes or other parts of the body as it advances. Risk factors for gastric cancer include chronic infection with Helicobacter pylori bacteria, a history of stomach ulcers, smoking, certain dietary factors (such as a high intake of salted or smoked foods), and a family history of the disease. Though it is more common in certain parts of the world, such as East Asia, gastric cancer is a leading cause of cancer-related deaths globally. The prognosis and treatment options for gastric cancer depend on the stage at which the cancer is diagnosed. Early detection significantly improves the chances of successful treatment, often through surgery, chemotherapy, and radiation therapy. Despite advances in medical technology, the overall survival rate for gastric cancer remains low, underscoring the importance of prevention, early detection, and effective treatment strategies.

II. ENDOSCOPIC ADVANCES IN THE DIAGNOSIS OF EARLY GASTRIC CANCER AND PREMALIGNANT GASTRIC LESIONS

Gastric cancer (GC) remains one of the leading causes of cancer-related deaths worldwide, and early detection is critical for improving patient outcomes. Early gastric cancer (EGC) is defined as cancer confined to the mucosa or submucosa, regardless of lymph node metastasis. Premalignant lesions, such as atrophic gastritis, intestinal metaplasia, and dysplasia, are considered risk factors for the development of gastric cancer. Advances in endoscopic techniques have significantly improved the ability to detect these early lesions, allowing for earlier diagnosis and intervention. Below is an overview of the latest endoscopic technologies and their role in diagnosing early gastric cancer and premalignant gastric lesions.

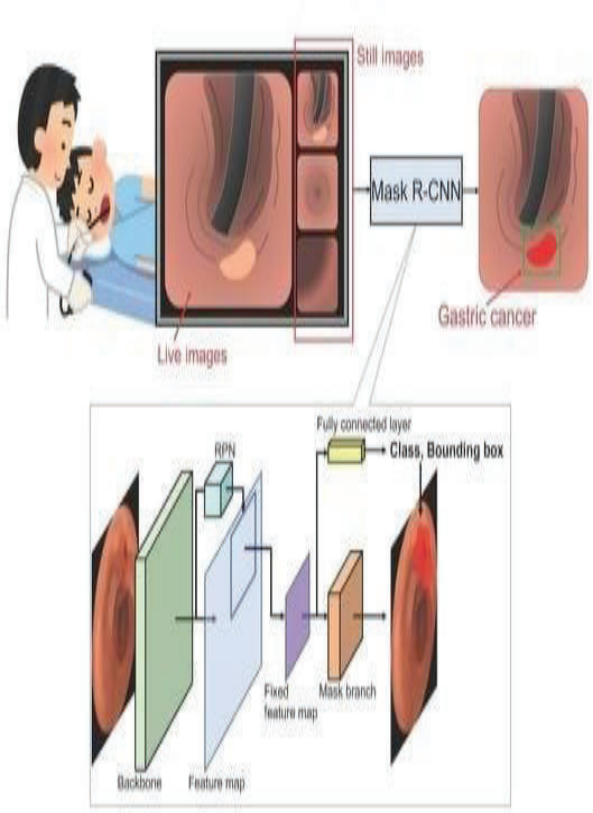

Fig 2.1 Gastric cancer

1. Conventional Endoscopy

Traditional white-light endoscopy (WLE) remains a primary diagnostic tool for gastric cancer. However, it often fails to detect early lesions, especially when they are flat or subtle. Despite its wide availability, WLE lacks the sensitivity required to detect small, early-stage cancers, making it less effective in identifying premalignant gastric lesions in their early stages.

2. Narrow-band imaging

In narrow-band imaging (NBI), wavelengths of light used for visualization are limited to a specific band. This allows for improved visualization of the architecture of the mucosa[14,17]. NBI is now used as part of a diagnostic

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algorithm known as magnifying endoscopy simple diagnostic algorithm for early gastric cancer for classifying early gastric cancer. With the use of NBI, the lesion is evaluated for a demarcation line (DL). If a DL is present, the lesion is then evaluated for an irregular microvascular pattern (IMVP) and an irregular micro surface pattern (IMSP). If the lesion has either an IMVP or IMSP, the diagnosis of early gastric cancer is made [18].

3. Endoscopic Ultrasound (EUS)

Endoscopic ultrasound (EUS) is another important tool in the diagnosis of early gastric cancer, particularly for assessing the depth of tumor invasion and regional lymph node involvement. EUS combines high-resolution imaging with an endoscope and provides a detailed view of the gastric wall layers, allowing for precise staging of gastric tumors. EUS is particularly useful when it comes to distinguishing between early gastric cancer that is confined to the mucosa/submucosa and more advanced stages. Endoscopic ultrasound (EUS) allows for assessment of the depth of gastric cancer as it is able to distinctly identify the layers of the stomach[29]. Ultrasound can be achieved using the linear or radial transducers on the endoscope or with a through-the-scope ultrasound catheter probe. The five layers of the gastric wall are identified by their alternating hyperechoic and hypoechoic appearance[29]. EUS therefore is utilized to determine the T category of staging according to the TNM classification. A query of the Surveillance, Epidemiology, and End Results-Medicare claims database performed in 2016 suggested that patients who underwent EUS were more likely to receive National Comprehensive Cancer Network recommended care such as perioperative chemotherapy[30]. Specifically, EUS has been reported to distinguish T1 from more advanced stages with a sensitivity of 83% and specificity of 96%[31]. However, there was significant heterogeneity among the studies included, with some studies using older TNM classification systems. Factors that appear to decrease EUS accuracy include larger cancer diameter, ulceration, undifferentiated histology, and proximal location[31,32]. Further studies are needed to evaluate the staging accuracy of EUS based on the updated TNM classification system.

4. Chromoendoscopy

chromoendoscopy, indigo carmine or a similar stain is applied topically to the mucosa to help improve identification of gastric cancer or premalignant gastric lesions. Early prospective studies suggest that the use of chromoendoscopy aids in the diagnosis of gastric neoplasia compared to conventional endoscopy[15]. Prior meta-analysis of the diagnostic efficacy of chromoendoscopy suggests that there is an increased diagnostic efficacy and detection of early gastric cancer and premalignant gastric conditions, with a sensitivity of 90% and specificity of 82%[16]. However, it is important to note that no randomized controlled trials have yet been performed to evaluate chromoendoscopy.

5. Artificial Intelligence (AI) in Endoscopy

Artificial intelligence (AI) is revolutionizing endoscopic practice by enhancing the ability to detect and diagnose early gastric cancer and premalignant lesions. AI algorithms, particularly those based on deep learning, are being developed to assist endoscopists in identifying suspicious lesions during real-time endoscopy. AI can analyze endoscopic images to detect subtle changes in the gastric mucosa that might be indicative of early cancer or premalignant conditions, offering a powerful tool for increasing the sensitivity and accuracy of endoscopic diagnosis.

6. Third-Generation Optical Coherence Tomography (OCT)

Optical coherence tomography (OCT) is an advanced imaging technique that uses light waves to create high-resolution cross-sectional images of the mucosa and submucosa. The third generation of OCT has significantly improved its ability to detect early-stage gastric cancer by providing more detailed images of the tissue layers. OCT is especially useful for detecting minute changes in the mucosal surface and identifying early-stage malignancies or precancerous lesions

2.1. Literature survey

1. **"**Artificial intelligence for gastric cancer in endoscopy: From diagnostic reasoning to market, Digestive and Liver Disease" by Carolina Ogawa Matsubayashi, Shuyan Cheng, Ismael Hulchafo, Yifan Zhang, Tomohiro Tada, James L. Buxbaum, Kentaro Ochiai (2024): Deep learning models utilizing AI have been created to assist in identifying and categorizing gastric lesions during endoscopic procedures, enhancing diagnostic precision. However, ongoing research faces obstacles such as significant variability among observers, insufficient rigorous validation studies, and regulatory challenges that impede broad implementation in clinical settings. This review examines the present status of AI in the endoscopic assessment of gastric cancer and precancerous conditions.

2. "Early gastric cancer detection and lesion segmentation based on deep learning and gastroscopic images" by Zhang, K., Wang, H., Cheng, Y. et al. (2024): With detection rates of less than 10%, stomach cancer— especially early gastric cancer (EGC)—is difficult to identify because of its mild symptoms. To enhance EGC detection, recent research has investigated deep learning models such as Mask R-CNN (MR-CNN). In detection and segmentation, the suggested Improved Mask R-CNN (IMR-CNN) model, which incorporates feature extraction and purification modules, performs noticeably better than MR-CNN, obtaining high Precision, Recall, Accuracy, and F1-Score values.

3. "Deep Learning and Gastric Cancer: Systematic Review of AI-Assisted Endoscopy" by Klang E, Sourosh A, Nadkarni GN, Sharif K, Lahat A. (2023): This systematic study assesses the use of deep learning (DL) in endoscopic image-based early-stage gastric cancer (GC) detection. It demonstrates how DL can classify GC, measure the depth of tumour invasion, and identify precancerous lesions, frequently matching or surpassing human endoscopists in these areas. But the study points to issues such algorithmic heterogeneity, single-center studies' low generalisability, and the need for more thorough, multi-center research with improved technical reporting.

4. "Automated Detection of Gastric Cancer by Retrospective Endoscopic Image Dataset Using U-Net R-CNN" by eramoto, A.; Shibata, T.; Yamada, H.; Hirooka, Y.; Saito, K.; Fujita, H. (2021): This study combines box

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 07, NCIRTAI - 2026

classification based on convolutional neural networks with semantic segmentation to develop a novel U-Net R-CNN object detection model for early stomach cancer detection from endoscopic pictures. Using DenseNet169, the model showed a low false positive rate of 0.01 per image and a high detection sensitivity of 98%. These results indicate significant improvement over earlier approaches, suggesting possibility for automated early stomach cancer detection.

III. TREATMENT

3.1. There are different types of treatment for patients with gastric cancer :

- Endoscopic mucosal resection
- Surgery
- Chemotherapy
- Radiation therapy
- Chemoradiation
- Trageted therapy
- immunotherapy

Fig 3.1 Treatment

3.2.Endoscopic advances in treatment of gastric cancer and premalignant gastric lesions

Prior studies have shown that patients diagnosed with early gastric cancer who did not undergo resection, whether endoscopic or surgical, had a greater 5-year risk for progression to the advanced stage[33,34]. Current guidelines established for the therapy of early gastric cancer recommend resection once the diagnosis has been established[33,34]. Traditional criteria for endoscopic resection of early gastric cancer included adenocarcinoma that was 2 cm or less in diameter without ulceration or lymph node or vascular involvement[35,36]. More recently, this criteria has been expanded as additional studies have shown favorable long term outcomes of endoscopic resection in early gastric cancer, especially with the advances made in endoscopic submucosal dissection (ESD)[35,36]. In fact, multiple studies have now found 5-year survival rates to be nearly 100%[34].

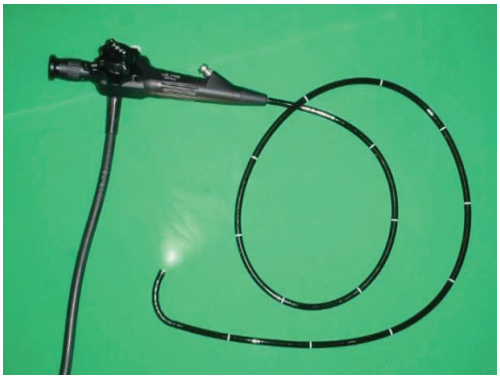

Fig 3.2 Endoscopic tube

3.3.Endoscopic mucosal resection

Endoscopic mucosal resection (EMR) is a procedure where a submucosal injection is used to lift the lesion, followed by resection of the lesion using snare. This technique allows for safe removal of intramucosal cancers that are 2 cm or less in diameter[37]. EMR has proven to be an effective treatment for early gastric cancer in terms of long-term outcomes. In one prior study in Japan with 479 cases of gastric cancer treated with EMR, there were no gastric cancer-related deaths during a median follow up period of 38 mo[38]. Notably, the rates of complete resection with EMR decrease with larger lesions with prior studies demonstrating complete resection rates as low as 20%-30% in lesions greater than 2 cm[39].

3.4.ESD

ESD is a technique in which the submucosal layer is injected to lift the lesion. Following injection, careful dissection of the submucosal layer from the muscular layer is performed using through-the-scope endoscopic knives, until the entire lesion is completely removed[40] (Figure 1). More recently, tools including various endoscopic knives and hemostatic forceps have been developed in order to perform quicker, more secure, and more precise incisions[38,39,41]. ESD has been shown to be more effective at complete resection of larger gastric cancer lesions[34]. In a meta-analysis of 18 observational studies, ESD proved to have a greater incidence of complete and curative resection compared to patients who underwent EMR[42]. ESD also has been associated with a lower risk of recurrence compared to EMR.

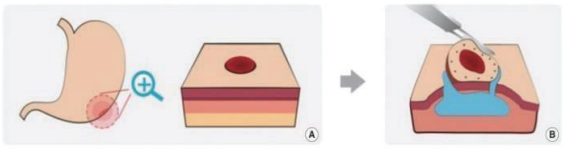

Fig 3.4 ESD

IV. ENDOSCOPIC SURVEILLANCE

4.1. Surveillance of gastric cancer

At present, there are no established evidence-based gastric

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 07, NCIRTAI - 2026

cancer surveillance guidelines in the United States. Patients with gastric cancer that was treated with resection continue to have a risk for metachronous gastric cancer. Prior studies report an incidence of metachronous gastric cancer of 3 to 4 percent per year[49]. Japanese guidelines suggest annual or biannual endoscopic surveillance. Other studies have recommended earlier follow-up of 3 mo after resection, followed by gradual spacing to 6 mo and then a year if no lesion identified[49].

4.2. Surveillance of premalignant gastric conditions

Premalignant gastric conditions include atrophic gastritis and intestinal metaplasia. There are various guidelines for the surveillance of these premalignant conditions. The European Society of Gastrointestinal Endoscopy suggests surveillance intervals depending on the degree and extent of the premalignant lesion [50]. However, the American Gastroenterological Association suggests against endoscopic surveillance in patients with gastric intestinal metaplasia in the general population, and elective surveillance for those with a higher risk of gastric cancer, including family history, certain ethnic minorities, or extensive premalignant conditions[51]. In Japan, patients with atrophic gastritis are recommended to have surveillance endoscopy at 1-2 year intervals[52].

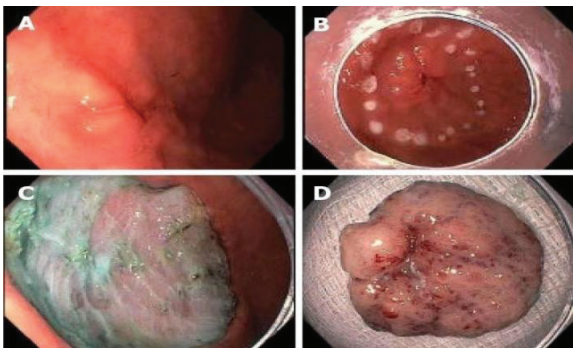

Fig 4.2 Gastric condition

Prior studies report varying rates of progression of dysplastic lesions to gastric cancer, ranging anywhere from 0% to 73% per year[53]. This is in part due to the difference between specific populations such as Asian populations, who appear to have a greater risk of progression. A prior cohort of patients with dysplastic lesions showed progression from high grade dysplasia to

gastric cancer in 25% of patients, and progression from low grade dysplasia to gastric cancer in 7% of patients[54]. Based on the current evidence, the International Consensus Project from 2012 has proposed that patients with intestinal metaplasia should be offered endoscopic surveillance every 3 years, while patients with low grade dysplasia should have surveillance imaging every 12 mo. Those with high grade dysplasia are recommended to have surveillance every 6 mo[54].

V. PROGNOSIS

The difference between the younger and older patients and its thought that younger patients have worse prognosis than older patients due to the delayed Diagnosis and more aggressive tumor behavior. These characteristics,remain controversial.

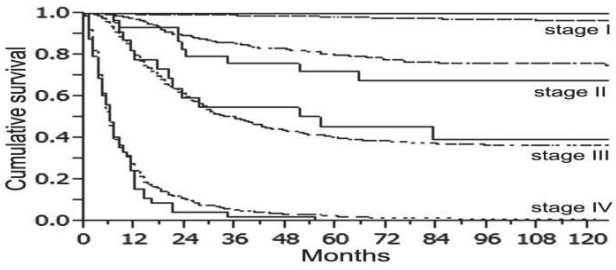

Fig 5 .1 Flow chart

CONCLUSION

Over recent years, many endoscopic advances have been made for the diagnosis and treatment of gastric cancer lesions. Further studies to enhance visualization and diagnosis of early-stage gastric cancer tumors as well as different techniques for removal should be encouraged.

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