

A NOVEL DEEP LEARNING ALGORITHM FOR COMPUTER-AIDED AUSCULTATION OF BOWEL SOUNDS USING PHONOENTEROGRAM: A FEASIBILITY STUDY

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ABSTRACT

Traditionally, auscultation of bowel sounds has been used to gain insight into bowel motility, obstruction, initiation of feeds after anesthesia, and overall digestive health. Parameters like the presence or absence of bowel sounds, the number of bowel sounds per minute, and their quality are used as metrics to gauge the patient's gastrointestinal status. A limited understanding exists of the exact definition of bowel sounds, their various subtypes, and methods to interpret bowel sound abnormalities. Our study aims to leverage the recent advances in machine learning and artificial intelligence to define and identify bowel sounds from eight healthy volunteers using the Eko Duo stethoscope. Phonoenterograms (PEG) obtained from the subjects were annotated and classified into prominent and baseline bowel sounds by a skilled observer. A total of 11,210 data points (5,605 balanced sounds) were used to train and test a novel deep-learning model. An accuracy of 0.895, precision of 0.890, recall of 0.854, F1 score of 0.871, and an area under the curve (AUC) of 0.89 were obtained reflecting the successful segregation of these sounds into the respective groups. The results motivate the design and development of patient-friendly PEG devices for digital gastroenterology practice. Larger studies with healthy and diseased volunteers are required to generalize the results and enhance our knowledge of the application of bowel sounds into clinical practice.

Keywords — phonoenterogram (peg), computer-aided auscultation (caa), deep learning, bowel sounds

INTRODUCTION

Bowel Sounds are auscultatory findings appreciated during an abdominal exam. Numerous theories have been postulated for the generation of bowel sounds ranging from peristalsis, striking of luminal contents against the gastrointestinal sphincters, and the movement of gas, secretions, and partially digested food in the gut [1-5]. Regardless of the origin, several studies have revealed altered bowel sounds in both structural and functional gastrointestinal diseases.

Intestinal obstruction, a surgical emergency, requires prompt diagnosis for timely lifesaving surgery [6-8]. It is characterized by an initial phase of high-pitched "tinkling" bowel sounds signifying acute mechanical obstruction progressing to muffled, hypoactive, or absent bowel sounds as the disease advances [9]. These sounds can be used for a quick preliminary diagnosis in an emergency setting even before imaging is available. Paralytic ileus or adynamic obstruction refers to the disruption of the