

**NOVEL STUDY TO DELINEATE, MEASURE AND TO COMPARE THE ORIENTATION
OF DUODENUM USING MRI IN NORMAL POPULATION AND PATIENT WITH
FUNCTIONAL DYSPEPSIA.**

A PILOT STUDY IN HOSPITAL UNIVERSITI SAINS MALAYSIA.

DR TIONG WEN JI

**DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR
MASTER OF MEDICINE (RADIOLOGY)**



UNIVERSITI SAINS MALAYSIA

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ACKNOWLEDGEMENT

The completion of this undertaking could not be possible without the assistance, participation, cooperation, and contribution of various parties. Their contribution is sincerely appreciated and gratefully acknowledged. I would like to express my deepest and utmost appreciation, particularly to the following:

1. Dr. Ahmad Hadif Zaidin Samsudin, as my supervisor who had assisted and persistently guided in carrying out this study until its completion.
2. Dr. Chandran Nadarajan, DR. Bilgin Kerseci, Prof Dr. Lee Yong Yeh, as my co-supervisor who had given me additional support and idea during the progress of this study.
3. Prof Madya Dr. Mohd Shafie Abdullah, Prof Madya Mohd Ezane Aziz, Dr. Khairil Amir Sayuti, Dr. Wan Aireene Wan Ahmed, and Dr. Nur Asma Sapiai (Lecturers cum radiologists), all of whom directly or indirectly contributed their ideas and comments to the success of this study.
4. En. Norzulfikri Bin Yahya, En Mohd Zhazreel Rizal Bin Shukri, Puan Syarida Ayu Binti Mohamed Sukeri, Radiographer in Hospital Universiti Sains Malaysia who willing to sacrifice their time to contribute as part of the study.
5. Dr. Kueh Yee Cheng, Lecturer and statistician from the Department of Biostatics and research methodology, Universiti Sains Malaysia, who had provided great assistance and guidance in the statical analysis and sample size calculation of this study.

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LIST OF SYMBOLS, ABBREVIATIONS, AND ACRONYMS

CT	Computed tomography
DGBI	Disorder of Gut-Brain Interaction
DJ junction	Duodenojejunal junction
D1	First segment of duodenum; Superior segment of duodenum
D2	Second segment of duodenum; Descending segment of duodenum
D3	Third segment of duodenum; Inferior segment of duodenum
D4	Fourth segment of duodenum; Ascending segment of duodenum
EGG	Electrogastrography
EPS	Epigastric pain syndrome.
FD	Functional dyspepsia
FGIB	Functional gastrointestinal disorder
GIT	Gastrointestinal tract
H.pylori	Helicobacter pylori
IBS	Irritable bowel syndrome
<i>JEPeM</i>	Human Research Ethics Committee of <i>USM</i>
KPP	Klinik Pakar Perubatan
LCOM	Low osmolar contrast media
MPR	Multiplanar reformatted technique
MRI	Magnetic Resonance Imaging
PDS	Post-prandial distress syndrome
PPM	Predictive/ Preventive Maintenance
RF	Radiofrequency

SMA	Superior mesenteric artery
SNR	Signal to noise ratio
SSFP	Steady-state free precession
TNF- α	Tumour necrotic factor- α
TSE	Turbo spine echo
T1WI	T1 weighted images
T2WI	T2 weighted images
UGIT	Upper gastrointestinal tract
USM	Universiti Sains Malaysia
2D	2- Dimension
3D	3- Dimension
1.5T	1.5 Tesla
3.0T	3.0 Tesla

ABSTRAK

Latar belakang:

Dispepsia adalah satu simptom yang mengganggu populasi seluruh dunia dan dispepsia fungsian atau *functional dyspepsia* (FD) merujuk kepada dispepsia tanpa sebab organik. Patofisiologi dispepsia fungsian yang sebenar, dan kaitan antara dispepsia fungsian dan duodenum masih dalam penyelidikan aktif. Pengimejan resonans magnet (MRI) boleh menunjukkan anatomi duodenum tanpa mendedahkan pesakit kepada risiko radiasi, dengan itu membantu dalam mengkaji perkaitan antara dispepsia fungsian dan duodenum.

Method:

Kajian prospektif ini dijalankan di Hospital Universiti Sains Malaysia (Hospital USM), Kubang Kerian, Kelantan dari 21 Jun 2021 sehingga 1 Mac 2022. Sejumlah 18 subjek yang memenuhi kriteria kelayakan dan pengecualian terlibat dalam penyelidikan ini. Dalam kalangan peserta yang terlibat, 14 peserta adalah sukarelawan yang normal dan sihat (kumpulan kontrol) yang terdiri daripada 7 orang lelaki dan 7 orang perempuan (julat umur = 22-36 tahun, min umur = 27.1) tanpa simptom dispepsia atau sejarah perubatan dan pembedahan. Sejumlah 4 pesakit perempuan FD dengan min umur 49.25 tahun (julat umur 36-65 tahun) yang menerima rawatan susulan di KPP, Hospital USM terlibat dalam penyelidikan ini. Semua peserta yang berkecualan menjalani pemeriksaan pengimejan resonans magnet bahagian abdominal, 20 minit selepas minum susu sebanyak 250 ml sebagai kontras oral. Imej MRI dikaji dalam PACS dan segmentasi duodenum dilakukan. Ukuran kepanjangan duodenum dan angulasi, penentuan angulasi duodenum telah dilakukan berdasarkan imej segmentasi duodenum 3D. Semua data dianalisis dengan menggunakan Statistical Product and Service Solutions (SPSS). Ujian Mann Whitney digunakan untuk mengkaji kepanjangan segmentasi duodenum dan angulasi duodenum. Manakala ujian Fisher Exact digunakan untuk mengesan hubungan kait antara kumpulan kontrol dan pesakit FD.

Keputusan:

Hanya angulasi duodenum inferior menunjukkan perbezaan yang ketara ($p=0.025$) antara populasi kontrol dan pesakit FD. Tiada perbezaan ketara pada kepanjangan segmen duodenum, kepanjangan duodenum, dan angulasi duodenum superior antara populasi kontrol dan pesakit FD. Ujian Fisher's exact menunjukkan tiada perhubungan ketara antara orientasi duodenum dengan populasi kontrol atau pesakit FD ($p=0.323$)

Kesimpulan:

Perkembangan dalam urutan MRI dan teknik pasca pemprosesan telah dibuktikan MRI sebagai satu alat pengimejan yang selamat dan mempunyai harapan dalam pengimejan duodenum. Ia mungkin memainkan peranan dalam rawatan pesakit FD pada masa hadapan.

Kata kunci: Dispepsia, dispepsia berfungsi, duodenum Pengimejan resonans magnet

ABSTRACT

Background:

Dyspepsia is a bothersome symptom affecting worldwide population while functional dyspepsia (FD) is defined as dyspepsia without organic causes. The exact pathophysiology and relation between the duodenum and dyspepsia remain under active investigation. MRI is capable to reproduce the duodenum anatomy without exposing the patient to the risk of radiation, hence facilitate the investigation to find the relationship between dyspepsia and duodenum.

Methods:

This is a prospective study that was conducted in Hospital Universiti Sains Malaysia (HUSM), Kubang Kerian Kelantan from 21 June 2021 to 1st March 2022. A total of 18 subjects who met the inclusion and exclusion was included in this study. Among the recruited participants, 14 of them were normal healthy volunteers (control group) which comprised of 7 male and 7 female participants (age range:22 -36 years old), mean age 27.1) without dyspeptic symptoms or previous medical and surgical history. While a total of 4 FD female patients with a mean age of 49.25, age range from 36-65; who is under KPP HUSM follow up. All eligible subjects underwent non-contrasted upper abdominal MRI 20 minutes after drinking 250mls of milk as oral contrast. MRI images were reviewed in PACS, and segmentation of the duodenum was performed. Measurement of duodenal length and angulation, determination of duodenal angulation were made based on the 3D duodenal segmentation images. All data were analyzed using Statistical Product and Service Solutions (SPSS). Mann Whitney test was used to correlate the segmental duodenal length and duodenum angulation. Fisher Exact test was used to detect the association between the control group and FD patients.

Results:

Only inferior duodenal angulation showed a statistically significant difference (p-value = 0.025) between the control population and FD patients. There were no statistically significant differences in the segmental duodenal length, duodenal length, and superior duodenal angulation between the control population and FD patients. Fisher's exact test showed there was no statistically significant correlation in duodenal orientation with the control population or FD patients (p-value: 0.323).

Conclusion:

Current advancement in the MRI sequence and post-processing technique have shown it as a promising and safe tool in duodenum imaging. It may play a role in the management of FD patient in the future.

Keywords: Functional dyspepsia; dyspepsia, duodenum, abdominal Magnetic resonance imaging abdomen

CHAPTER 1: BACKGROUND

1.1 Introduction

Functional dyspepsia (FD) is a heterogeneous spectrum of symptoms that originate at the gastroduodenal region that characterised by chronic and recurrence upper abdominal pain or discomfort in the absence of an organic, systemic, or metabolic disease that could explain the symptom (H. Lee et al., 2014; Tack et al., 2006). Gastric perturbation, such as delayed gastric emptying, impaired gastric fundus relaxation, impaired gastric accommodation, gastroduodenal dysmotility, inflammatory and immune responses of the gastroduodenal region, and infection, such as *Helicobacter pylori* (H.Pylori) infection, are some of the most widely discussed and associated mechanisms (Mimidis & Tack, 2008; Talley, 2016; Vanheel et al., 2017).

Previously, there were very few research that investigated the relationship between duodenal structure and FD. The study was small-scale, and it needs to be replicated to strengthen the relationship with dyspepsia (Thommesen, P., Funch-jensen, P., Oster, M.J., Løvgren, N.A., & Amdrup, 1980) . Furthermore, the upper gastrointestinal tract (UGIT) is imaged as utilizing a 2-dimensional (2D) fluoroscopic approach in the previous study. The disadvantages of the fluoroscopic examination remained technically challenging and operator dependent; time-consuming; and the sensitivity of detecting the pathology being hindered by overlapping bowel with limited information regarding the bowel wall and its surrounding structure. The advancement of modern medical imaging technology in the last 20–30 years, particularly with the introduction of cross-sectional imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI), has improved the ability to image the UGIT and allows for 3-dimensional analysis of the UGIT (3D). Modern medicine has been able to overcome the technological limitations of the prior technique thanks to advancements in cross-sectional imaging hardware and post-processing software allowing fast images acquisition without compromising images resolution. As a result, greater research into the link between the morphology of the upper

gastrointestinal tract, particularly the duodenum, and dyspepsia will indeed be feasible.

1.2 Problem Statement and Study Rationale

Dyspepsia is affecting a significant portion of the world's population. FD is defined by ROME criteria as the presence of symptoms that are thought to originate in the gastroduodenal region but that are not easily explained by an organic, systemic, or metabolic pathology. The pathophysiology of FD is a source of continuous investigation. Gastroduodenal dysmotility, visceral hypersensitivity, brain-gut contact, persistent low-grade inflammatory reaction, and bowel infection have all been related to the pathophysiology of FD in the past (Jung & Talley, 2018; Sha et al., 2009).

The duodenum plays an important part in the development of the dyspepsia symptom. The anatomical relationship between the duodenum and dyspepsia has yet to be identified. A positive connection between dyspepsia and an abnormal duodenal loop has already been reported in the literature. Patients with dyspeptic symptoms with an abnormal duodenal loop have poorer response to treatment response than those with a normal duodenal loop orientation, according to a study (Christensen et al., 1986; Thommesen & Funch-Jensen, 1986a). As a result, we hypothesized that changes in the temporospatial orientation of the duodenum would play a role in the pathogenesis of dyspepsia.

The imaging of the duodenum has become a crucial component in the search for a relationship between duodenal anatomy and FD. Prior to this, 2D fluoroscopic investigation could only analyze duodenal anatomy to a certain extent. However, because of breakthrough in cross-sectional imaging and post-processing techniques, accurate delineation of the duodenum's segmental structure is now possible. The purpose of this study is to examine the segmental morphology of the duodenum including the measurement of segmental length, superior and inferior angulation; and determine the duodenum angulation in normal and functional dyspepsia patients, using a cross-sectional imaging method. Aside from that, the

current study provides essential research material for future investigations on gastroduodenal-related illnesses by serving as control data.

1.3 Objective

General Objective

- To determine and compare the difference in the segmental duodenal length, angulation, and orientation between the normal population and patients with FD.

Specific Objective

1. To determine the duodenal length in the normal population and FD patients.
2. To determine the duodenal angulation in the normal population and FD patients.
3. To determine the duodenal orientation in the normal population and FD patients.
4. To compare differences in duodenal length, angulation, and orientation between normal population and FD patients.

1.4 Hypothesis

Null Hypothesis

- There is no difference in segmental duodenal length, duodenal curvature angulation, and orientation between the normal population and patients with FD

Alternative hypothesis

- There is a difference in segmental duodenal length, duodenal curvature angulation, and orientation between the normal population and patients with functional dyspepsia.

1.5 Research Question

- 1** What is the difference in segmental duodenal length between the normal population and FD?
- 2** What is the difference in duodenum angulation between the normal population and FD?
- 3** Is there any association in the duodenal orientation between the normal population and FD?

CHAPTER 2: LITERATURE REVIEW

2.1 The Anatomy of the duodenum.

Duodenum is derived from the distal foregut and proximal midgut embryologically. It is mostly located in the retroperitoneum (except for the proximal of the first segment of the duodenum). It has a close relationship with the pancreas and was once described as a C-shaped muscular tube looping around the pancreas' head and connecting the stomach's pylorus to the jejunum (Figure 2.1). Based on its orientation to the pancreatic head, the duodenum is divided into four segments. The superior section of the duodenum (D1) runs from the gastric pylorus to the gallbladder's neck. The second segment of the duodenum (D2), is also known as the descending portion of the duodenum, extends from the gallbladder's neck to the lumbar vertebrae at the level of L1 to L3 around the head of the pancreas. The third segment of the duodenum (D3) is the inferior section of the duodenum that runs from the right side of the L3 vertebral column to the left side of the aorta. The fourth segment of the duodenum (D4) is the ascending segment of the duodenum, which ascends upward and obliquely from the left of the aorta to the L2 vertebral level, where it stops at the duodenojejunal junction (DJ junction)(Butler P, Mitchell A, 2012; Mahmoud & Bennett, 2015; Moore et al., 2010; Netter, 2019; Ryan et al., 2011; Yeo, 2019).

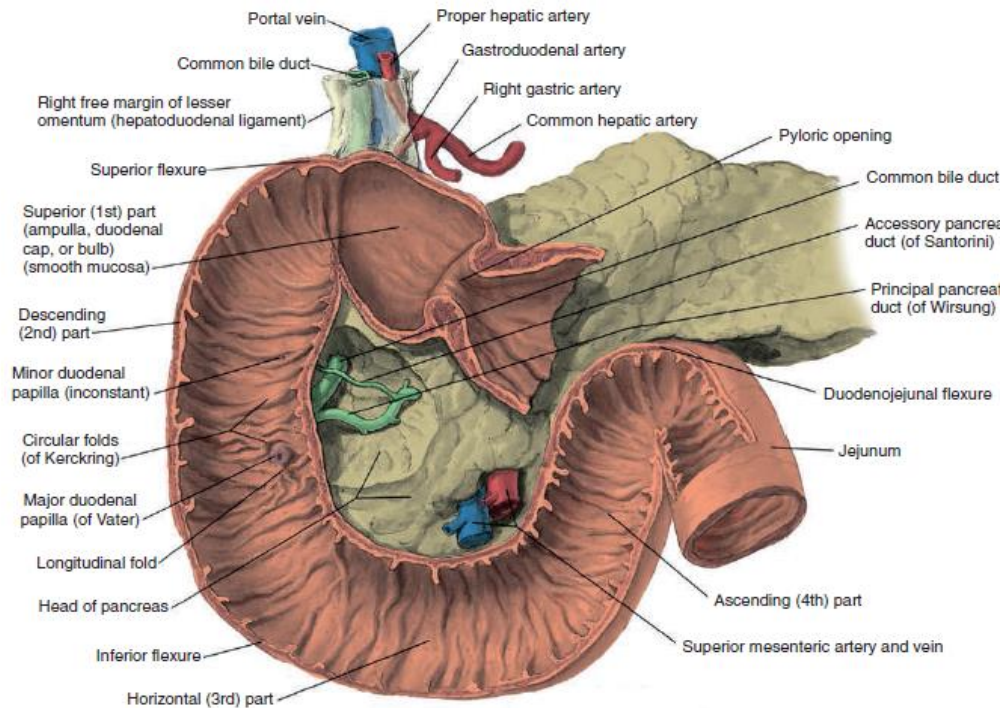


Figure 2.1: The duodenum, the four portions, and their relationship to the bile duct and pancreas. Adapted from (Netter, 2019)Atlas of Human Anatomy (7th ed., plate 278.),

The duodenum length is described as 25-30cm in the anatomy textbook and available published literature on intestinal length measurement based on cadaveric, surgically or endoscopic measurement. However, the length of the segmental duodenum and the length of GIT are still debated in the literature. Age, gender, body weight, and height have all been related to intestinal length, but their relation with duodenum length has yet to be established (Hounnou et al., 2002; Raines et al., 2015; Shailendra S. Jadhav, 2015). And yet, there is no available literature to discuss the measurement and clinical significance of the duodenal superior and inferior angulation (Figure 2.2 and figure 2.3).

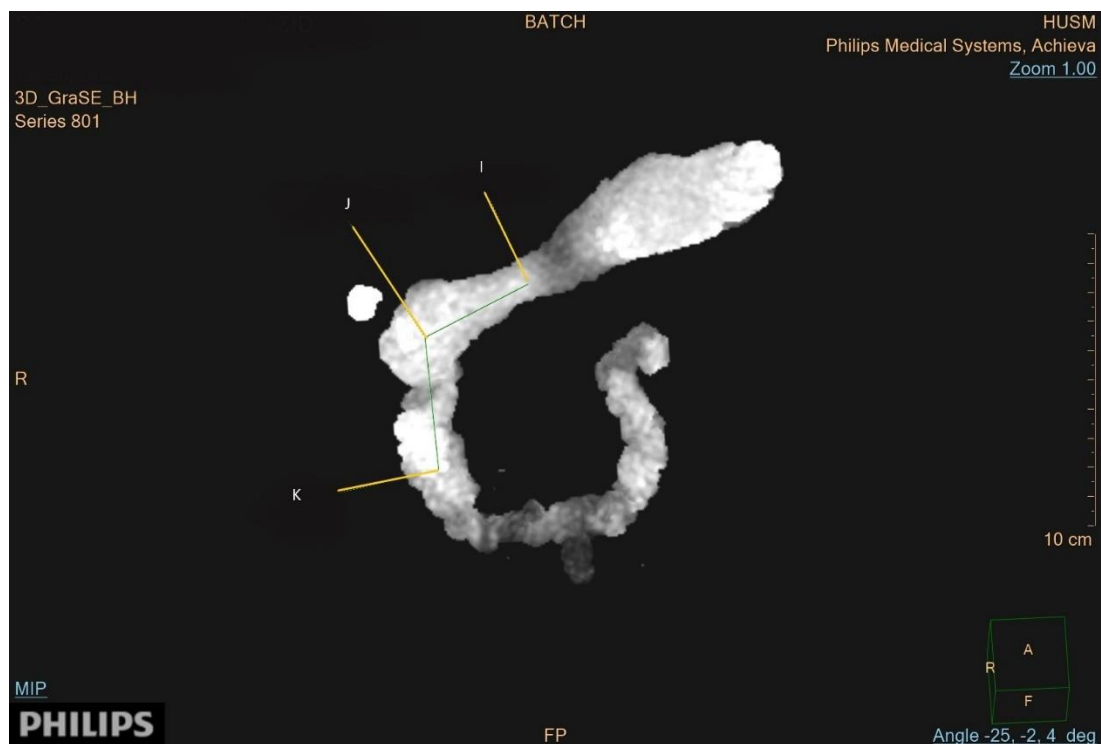


Figure 2.2: Selected 3D reconstructed image of the duodenum showing the measurement of the superior duodenal angulation.

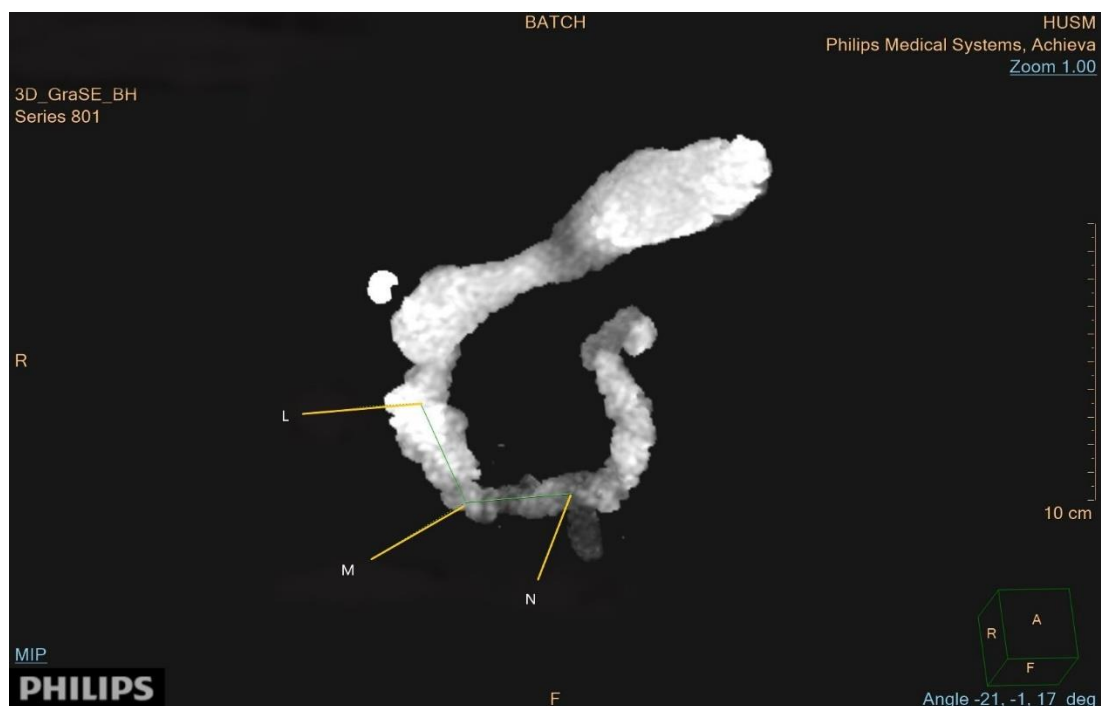


Figure 2.3: Selected 3D reconstructed image of the duodenum showing the measurement of inferior duodenal angulation.