



## The Significance of Routine Abdominal Ultrasound Before Bariatric Surgery: A Comprehensive Review

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### Abstract:

**Background:** Bariatric surgery is emerging as an absolute treatment for morbid obesity with long-lasting weight loss and comorbidity improvement due to the pandemic of obesity all over the world. Preoperative abdominal ultrasound is generally taken for identification of pathologic features to assist in surgical decision, although there is controversy over its role and clinical utility due to varying guideline practices and the absence of cost-effectiveness studies.

**Aim:** This review estimates the efficacy of routine preoperative abdominal ultrasound for bariatric surgery on its basis of diagnostic yield, influence on surgical planning, cost-utility, and its ability to decrease perioperative complications as criteria.

**Methods:** A Systematic literature review was conducted on PubMed, Embase, and Cochrane Library from January 2000 to April 2024 according to PRISMA guidelines. Studies in patients with BMI  $\geq 30$  kg/m<sup>2</sup> with primary bariatric surgery were taken into account. Extracts regarding data of ultrasound results, modification of surgical plan, and cost-effectiveness were matched, and the quality of studies was evaluated by STROBE and Jadad score.

**Results:** Routine pre-operative ultrasound scanning will typically detect anomalies, for example, gallstones and fatty liver, but in no more than 7–15% of instances does this change surgical decision. Incidental diagnoses of malignancy are uncommon but important.

**Results:** Technical challenges in grossly obese individuals and cost make routine use impossible, case selection for imaging is a more cost-effective alternative.

**Conclusion:** Routine ultrasound has limited, focused utility in preoperative bariatric assessment. Focusing on usage, within clinical risk factors, would optimize benefit and resource utilization, pending further assessment on cost-effectiveness.

**Keywords:** Preoperative ultrasound, abdominal ultrasound, bariatric surgery, obesity, cost-effectiveness.

## Introduction

Obesity represents one of the most pressing global public health issues of the 21st century with an estimated 650 million adults globally defined as obese according to a body mass index of  $\geq 30$  kg/m<sup>2</sup>, with unprecedented rates of prevalence across all population strata (World Health Organization, 2020). Obesity is associated with a wide variety of comorbidity including type 2 diabetes mellitus, hypertension, cardiovascular disease, obstructive sleep apnea, and several malignancies, all of which are predictors of decreased life expectancy as well as escalating healthcare expenditures (Guh et al., 2009). Surgical weight loss approach, known as bariatric surgery, has proven to be effective therapy for morbidly obese patients (BMI  $\geq 40$  kg/m<sup>2</sup> or 35 kg/m<sup>2</sup> with associated comorbidities) providing considerable and durable weight loss, remission or improvement of obesity-associated illness, and improvement in patient quality of life (Sjöström et al., 2014; Arterburn & Courcoulas, 2018).

Classic procedures in bariatric surgery, including sleeve gastrectomy, Roux-en-Y gastric bypass, and adjustable gastric banding, lead to weight loss through limiting ingestive capacity, altering nutrient absorption, or using a combination of the two (Buchwald et al., 2004). These procedures have not only been shown to induce weight loss but also perform quite well to cause remission of type 2 diabetes mellitus, with rates as high as 80% or higher in certain populations (Mingrone et al., 2012). Bariatric surgery also shows incredible successes on the risk factors of heart disease and mortality of all causes, and therefore is one of the pillars of management of morbid obesity if lifestyle treatment and pharmacologic management are failing (Mentias et al., 2020).

While these advantages exist, bariatric surgery is also dangerous, and a comprehensive preoperative workup is required to reduce complications and achieve optimal surgical results. A preoperative nutrition counseling, a psychologist's evaluation, cardiopulmonary evaluation, and imaging studies to define possible anatomical or functional contraindications to surgery are commonly a multimodal preoperative workup (Mechanick et al., 2013). Among these, abdominal ultrasound as preoperative workup is standard before bariatric surgery was increasingly used in most bariatric surgery units, and its use and its clinical significance remain in controversy (Abou Hussein et al., 2018).

Abdominal ultrasound is a non-invasive, cost-effective, radiation-free imaging modality, which enables the visualization of abdominal organs such as the liver, gallbladder, pancreas, spleen, great vessels and kidneys. In bariatric surgery it may be the first imaging modality that detects some abnormalities affecting surgical planning that may require treatment or predict post-surgical complications (Hany et al 2024). Obese subjects are more prone to gallstones, non-alcoholic fatty liver disease (NAFLD), hepatomegaly, renal cysts, and less frequently malignancy (Schlottmann et al., 2018). For instance, gallstones, more frequent in obese subjects based on metabolic dysregulation of bile, can require simultaneous resection during bariatric surgery to avoid future complications (Everhart & Ruhl, 2009). Likewise, detection of advanced NAFLD or cirrhosis can warn surgeons about potential intra-operative complications such as increased risk of bleeding or requirement for special surgical intervention (Nagarajan et al., 2020).

Whilst diagnostically useful, universal preoperative abdominal ultrasound before bariatric surgery is contentious. Its advocates think that it offers

valuable information capable of altering surgery, decreasing perioperative risk, and forestalling future intervention (Tsirline et al., 2014). Others think that most results of ultrasound are of clinical insignificance, will have minimal impact on surgical care, and may provoke extra redundant procedures or studies and thus cost and patient inconvenience (Almazeedi et al., 2014). universal preoperative ultrasound in the morbidly obese patient may also be restricted by technical difficulties, including poor image quality by virtue of excess body mass, and whose efficacy in such patients is questionable (Brahee et al., 2013).

Absence of consensus guidelines, however, perpetuates this debate. Larger professional organizations, like the American Society for Metabolic and Bariatric Surgery (ASMBS) and the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO), have general statements on preoperative workup but do not require or prohibit routine abdominal ultrasound (Eisenberg et al., 2022). This lack of consensus has allowed a high amount of variability in practice, with some centers using ultrasound as part of routine practice and others when specific risk factors are noted, like a patient's personal history with gallstones or liver function tests (Quake et al., 2022). This lack of consensus demands a call for a systematic review of data to inform clinical decision-making.

This review attempts to critically contrast routine preoperative abdominal ultrasound use in candidates for bariatric surgery. We also summarize its diagnostic yield, its impact on surgical decision, cost-effectiveness, and its role in the prevention of perioperative complications. Some of the objectives include determining the prevalence and clinical relevance of sonographically detectable abnormalities, determining the percentage by which surgical plans

are modified by such findings, and approximating the economic impact of universal versus selective use of ultrasound. We also address technical limitations of ultrasound use in obese subjects and contrast utility of other preoperative modalities like esophagogastroduodenoscopy (EGD) with its own. Lastly, this review attempts to derive evidence-based data to inform clinical practice, standardize guideline development, and determine future research needs within the context of bariatric surgery.

## 1. Methodology

A literature search was completed on studies related to preoperative abdominal ultrasound in bariatric surgery in PubMed, Embase, and Cochrane Library. Searches were completed from 2000 to April 2024. The keywords used in searches included "bariatric surgery", "preoperative ultrasound", "abdominal ultrasound," and "obesity." Retrospective and prospective studies, randomized control studies (RCTs), and meta-analyses in patient populations with body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup> presenting for primary bariatric surgery were inclusion criteria. Less than 10 patients, or pediatric population, or revisional surgeries were excluded. Data included that were extracted were on ultrasound imaging, change in surgical plan, and cost-effectiveness. Quality of the studies was validated using the STROBE checklist (Berger et al, 2012) for case-control studies and the Jadad score (Jadad et al, 1996) for RCTs.

## 2. Clinical Implications of Pre-operative Abdominal Ultrasonography

### 2.1. Application of Ultrasonography in Diagnosis

Ultrasonography as a universal preoperative work-up before bariatric surgery can routinely identify bariatric surgery candidates' pathologies because bariatric surgery candidates bear a high prevalence of

bariatric surgery candidates' comorbidities. Irresistibly, studies have always identified a correlation between obesity and gastrointestinal diseases, liver disease, and gallbladder disease (Mulliri et al., 2022). In a retrospective analysis of 937 subjects, Abou Hussein et al. (2018) divided results of ultrasonography into four classes: Group 0 (normal results), Group 1 (abnormal results not altering surgical timing or surgical type), Group 2 (postoperative follow-up necessary results), and Group 3 (abnormal results directly altering procedures) (Abou Hussein et al., 2018). 44.7% of subjects gave normal results (Group 0), while 7.2% gave results altering the surgical plan (Group 3) (Abou Hussein et al., 2018).

Likewise, another bigger study of 4,418 patients carried out by Hany et al. (2024) identified that 45.7% of the patients exhibited normal findings, 35.7% exhibited insignificant findings, 17% needed further procedure or follow-up, and 1.5% exhibited findings cancelling or delaying surgery. Remarkably, 15.9% of patients benefited from the diagnosis of chronic calculous cholecystitis, for whom bariatric surgery was augmented by concomitant cholecystectomy (Hany et al., 2024). These results affirm the effectiveness of ultrasound in determining clinically relevant diseases, such as gallstones, which are prevalent in obese patients due to compromised bile metabolism (Everhart & Ruhl, 2009).

## 2.2. Impact on Surgical Planning

The main justification of routine preoperative abdominal ultrasound in bariatric surgical candidates is its educational benefit and its ability to inform surgical decision-making to optimize procedural efficiency and safety. Obesity is mirrored by and is followed by anatomical and functional changes that make bariatric laparoscopic surgery difficult, such as

sleeve gastrectomies or Roux-en-Y gastric bypass. For instance, non-alcoholic fatty liver disease (NAFLD) - induced hepatomegaly is a frequent finding and can compromise the surgical site, compromise access to the stomach, and expose to intraoperative morbidity (Nagarajan et al., 2020). Nagarajan et al. (2020) described in a prospectively studied 40 bariatric surgical candidates that preoperatively defining by ultrasound measurement of left liver lobe had good correlation with intrasurgery results and allowed proceeding and preparation by surgeons for technical challenge, and to adapt the technique, for instance, by using extra portal or switching retraction technique. This preoperative information can decrease operative time and decrease the risk of conversion to open procedures that are followed by increased morbidity (Schwartz et al., 2003).

Another irreplaceable role of ultrasound is its capability to diagnose gallstones, common in obese patients as a consequence of bile composition change and disease stasis (Everhart & Ruhl, 2009). Identification of asymptomatic gallstones may compel the surgeon to undergo a concomitant cholecystectomy at the time of bariatric surgery to prevent future dilemmas in the form of acute cholecystitis or biliary pancreatitis, necessitating a single operation (Tsirlin et al., 2014). Tsirlin et al. (2014) opined that in bariatric surgical patient populations, patients with pre-operative gallstones identified by ultrasound and having simultaneous cholecystectomy had fewer post-operative biliary complications compared with expectant management. This active method, apart from enhancing the patient's outcome, prevents extra surgery, which, among obese populations, is susceptible to increased risk (Flum et al., 2009).

While these advantages do exist, their collective advantage of routine preoperative planning

with ultrasound would seem to be limited in most cases. A retrospective review by Abou Hussein et al. (2018) of 937 bariatric procedures identified only 7.2% of ultrasound reports as having a direct impact on surgical planning, and the majority of abnormalities—mild liver disease or small renal cysts—were clinically insignificant or susceptible to surveillance postoperatively. A systematic review by Chang et al. (2014) of preoperative imaging in bariatric surgery noted that although preoperative ultrasound always detects abnormalities, the majority have no direct influence on surgical technique. For example, mild liver enlargement or asymptomatic gallstones may have no influence on bariatric surgical technique per se but may influence postsurgical care, such as the introduction of ursodeoxycholic acid to prevent gallstone formation (Almazeedi et al., 2014). These studies would thus reason that a routine preoperative use of ultrasound may have a high percentage of results not potentially actionable or useful and thus fueled controversy as to its use on a widespread scale compared with selective use on a case-by-case basis based on clinical need.

### 2.3. Identification of Incidental Findings

The routine abdominal ultrasound will, on rare occasions, show incidental imaging findings that, although uncommon, have significant relevance to patient care. These have ranged from benign lesions such as renal or small hepatic hemangiomas to life-threatening malignancies. One such case was a bariatric patient referred to by Quake et al. (2022) having a previously unrecognized hepatocellular carcinoma (HCC) on preoperative ultrasound, with resulting staged hepatic wedge resection on bariatric surgery. In addition to excising a malignancy, this procedure enabled a patient to achieve a bariatric surgical advantage in the form of a concomitant rise in metabolism. This sort of case would suggest that

sonography can identify significant issues within high-risk groups of obese patients at risk of liver cancer on the basis of chronic NAFLD and by its contribution to inducing a state of cardio-metabolic syndrome (Schlottmann et al., 2018).

Clinical significance of most incidental findings, however, remains undefined. It has been illustrated that most identified sonographically in surgical candidates presenting for bariatric surgery, for instance, mild fatty liver disease, small gallstones, or simple renal cysts, are not a surgical emergency and can remain conservatively managed after surgery (Almazeedi et al., 2014). Voluminous NAFLD, for instance, is almost universal among the morbidly obese group, does not usually impact surgical planning unless advanced steatohepatitis or cirrhosis has made it so (Hany et al., 2024). The challenge is differentiating between findings that require immediate treatment from those that do not, because excessive diagnosis can be followed by unwarranted additional investigation, patient anxiety, and increased cost. Hany et al. (2024) pointed out a requirement for refinement in clinical prediction tests, possibly machine learning-based, to risk-stratify preoperatively on a patient's basis their risk of having significant sonographically found incidentals. These would allow selective imaging protocols, refining resource use and incident finding burden.

### 2.4. Cost-Effectiveness of Routine Ultrasound

The cost-effectiveness of abdominal ultrasound screening was questioned in response to rising volumes of bariatric procedures worldwide, more than 250,000 procedures annually in the United States alone (English et al., 2018). Systematic use of ultrasound is lamented as a wasteful expense because a vast majority of reports do not change surgical planning or patient outcome. Quantification by Abou

Hussein et al. (2018) found that a minority of results on ultrasound amenable to intervention (7.2%) do not make the universal cost of screening, including procedure, interpretation by a radiologist, and tests for incidentals, cost-effective. Initial results of Hany et al. (2024) imply selective use of ultrasound, focusing on patient risk factors on clinical grounds, such as previous history of gallstones, abnormal liver biochemical tests, or upper abdominal pain, may become cost-effective with comparable diagnostic yield.

On the other hand, advocates of routine ultrasound believe that it could possibly save money on expensive complications and thus pay for itself in the short run. For example, preoperative identification of gallstones could avoid emergency cholecystectomy with its increased morbidity, increased length of stay, and expense in obese women (Tsirlina et al., 2014). Likewise, the early diagnosis of cancerous and potentially life-threatening conditions like HCC can decrease long-term costs of care through early therapy (Quake et al., 2022). The lack of systematic cost-benefit analyses in the literature, however, restricts making firm conclusions. In the future, studies should try to conduct explicit economic analysis, such as direct costs (e.g., ultrasound and follow-up imaging) and indirect costs (e.g., complications and reoperations), to settle the debate and determine evidence-based practice.

### 3. Limitations of Abdominal Ultrasound in Obese Patients

The efficacy of abdominal ultrasound in candidates for bariatric surgery is limited by technical constraints inherent to imaging in obese subjects. Fat layer thickness within the abdominal wall or in visceral compartments has the capacity to absorb or scatter energy of ultrasound waves and thus diminish

image quality and diagnostic efficacy (Brahee et al., 2013). Brahee et al. (2013) found a consensus among sonographers that image quality was grossly impaired by a body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup>, and particular difficulties were introduced to deep structure imaging, like that of the pancreas or kidneys. Lowered sensitivity may cause false-negative results, and small abnormalities like tiny gallstones or early liver lesions may be overlooked, with consequences on surgical planning or post-operative course.

Other modalities of imaging, like computerized tomography (CT) or magnetic resonance imaging (MRI), have higher resolution and are less body-habit-dependent, but these have tremendous drawbacks. CT involves the use of ionizing radiation and, hence is something to be avoided in young bariatric patients, and MRI is expensive and less accessible and thus limited to general applications (Shah et al., 2011). New technologies applied using ultrasound, like high-frequency transducers or contrast-enhanced ultrasound, can potentially image obese patients more accurately, but these modalities have not yet become part of the bariatric preoperative protocol (Brahee et al., 2013). It would take innovation in technology as well as standard education of sonographers to overcome these obstacles in optimizing imaging in this difficult population.

### 4. Comparison with Other Preoperative Assessments

The preoperative evaluation of candidates for bariatric surgery is commonly a multimodal effort involving esophagogastroduodenoscopy (EGD), laboratory (e.g., lipid profile, liver enzymes), and cardiopulmonary (e.g., sleep studies, electrocardiogram) evaluation to risk-stratify adequately (Mechanick et al., 2013). In contrast to

abdominal ultrasound, for which no consensus exists to advocate its use, EGD is chosen as a recommendation in a North American (e.g., in a patient with a symptomatic gastroesophageal reflux disease) but used routinely by a European (Quake et al., 2022) guideline. Quake et al. (2022) identified on a meta-analysis of 10,685 patient populations that preoperative EGD resulted in a change in surgical plans in roughly 8% of cases, as with that of ultrasound, by revealing severe esophagitis, Barrett's oesophagus, or gastric ulcers that required medical therapy or surgical revision.

The complementarity between EGD and ultrasound would help these modalities to cover more ground and have a wider diagnostic yield for upper gastrointestinal and hepatobiliary diseases. It increases cost and patient burden, and therefore, more studies are required to establish its incremental benefit. Other preoperative tests like cardiopulmonary tests are system-based as well as disorder-based on anatomy, and therefore, there is a clear-cut role for ultrasound to identify organ-specific disorders (Mechanick et al., 2013). There is a need for more comparative studies that compare their comparative contribution in order to decrease preoperative protocols.

## 5. Guidelines and Recommendations

The inability to agree on the routine abdominal ultrasound is represented in the guidelines by the major organizations for bariatric surgery today. Both the American Society for Metabolic and Bariatric Surgery (ASMBS) and the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) have their own general guidelines on preoperative evaluation and do not necessarily include or exclude ultrasound, leaving it to institutional practice or physician preference (Eisenberg et al., 2022). European guidelines promote selective imaging by clinical indication>, e.g., suspected gallstones by

symptom or by liver function tests, while others' high-volume units include routine ultrasound as part of their standard workup (Quake et al., 2022).

This practice variation will necessitate evidence-based guidelines from high-level data on clinical outcomes and cost-utility. High-volume, multicenter research will need to establish the actual benefit of routine ultrasound and establish patient subsets that would benefit from imaging before surgery. Further, incorporation of risk stratification tools, like clinical prediction rules or machine learning algorithms, would allow selective use of ultrasound and derive maximal diagnostic benefit while optimizing use of resources (Hany et al., 2024).

## 6. Future Directions

Later research needs to emphasize predictive modeling to determine the best candidates for preoperative ultrasound and use machine learning techniques, as shown by Hany et al. (2024). Multicenter randomized trials comparing routine and selective ultrasound use need to be conducted to assess clinical and cost advantages. Ultrasound protocols need to be standardized, and imaging techniques optimized for obese individuals to ensure maximum diagnostic accuracy (Brahee et al., 2013).

## 7. Conclusion

Routine preoperative abdominal ultrasound before bariatric surgery is a contentious topic. Helpful in the identification of clinically important abnormalities, like biliary stones or liver disease, in surgical patients, its utility is proportionally diminished since most of these abnormalities never require immediate surgical intervention. The presence of cost-effectiveness studies and technical difficulties in morbidly obese patients further renders its routine application questionable. Focused or custom-made

ultrasound according to clinical risk factors and risk prediction scores is a possible compromise solution. In the short term, doctors would need to weigh the benefits as well as the costs on a case-by-case basis and promote custom-made preoperative assessment modalities.

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