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RESEARCH ARTICLE

Archives of Obstetrics and Gynecology

Impact of Body Mass Index on Pelvic Inflammatory Disease

Sogol Ashrafian BS, Melodee L Nugent MA, Pippa M Simpson and Denise Uyar

Medical College of Wisconsin, Milwaukee WI, USA

Abstract

Objective: *To compare pelvic inflammatory disease (PID) between women with body mass index (BMI)≥30 and <30 and evaluate how obesity affects infection management.*

Methods: *Retrospective study of patients ages 18-40 admitted for PID treatment between January 2010 and July 2017. Patients were stratified as obese versus non-obese, defined by BMI≥30 vs. BMI <30. Data reviewed included diagnosis, age, past medical history, length of stay, readmissions, antibiotic use, and procedural interventions. Increased morbidity was defined as greater tubo-ovarian abscess (TOA) incidence, longer length of stay, increased readmission rate, greater number of antibiotics used, longer antibiotic days, and increased procedural interventions. Percentage (N %) of total patients was used to describe categorical variables and median (range) was used to describe continuous variables.*

Results: *Seventy-two patients met inclusion criteria. Thirty-eight patients had BMI>30 and 34 patients had BMI<30. Women with BMI>30 had a higher incidence of TOA (66% v. 38%, p=0.033), were older with median age of 31(18-40) versus 24(18-39) p=0.009, more likely to be diabetic (24% v. 3%, p=0.015), had longer hospital stays 5(2-24) v. 3(2-10) days (p=0.002), and more procedures performed (50% v. 15%, p=0.002). BMI>30 patients also had more antibiotics used during admission 6.5 (3-13) v. 5(2-10) (p=0.001) and greater antibiotic duration 35(8-83) v. 32(7-54) days (p=0.047). However, BMI>30 patients had less readmissions (24% v. 41%), p=0.134), though this was not statistically significant.*

Conclusions: *Among women admitted for PID treatment, obesity was associated with greater morbidity demonstrated by greater incidence of TOAs, longer hospital stays, more antibiotic usage, and more invasive interventions. Elevated BMI is a risk factor to consider when treating women with PID, as obese patients are more likely to have more severe PID and more rapid TOA progression. Early recognition may allow for expedited interventions, morbidity reduction, and possibly cost reduction.*

Keywords: *Pelvic Inflammatory Disease, Tubo-ovarian Abscess, Obesity, BMI*

Introduction

Pelvic inflammatory disease (PID) is prevalent in sexually active women ages 20-40. According to the 2013-2014 United States National Health and Nutrition Examination Survey, 2.5 million women have had a PID diagnosis in their lifetime [1]. PID is a spectrum of upper genital tract inflammatory disorders, with tubo-ovarian abscess (TOA) being the most severe late-stage form. TOA is an inflammatory mass involving the fallopian tubes, ovaries or adjacent organs, and is reported in 35% of patients diagnosed with PID [2].

PID and TOA are associated with serious morbidity including infertility, ectopic pregnancy, chronic pelvic pain, and pelvic thrombophlebitis [1,3]. One study found that 9.1% of PID patients vs 1.4% of control patients had subsequent ectopic pregnancies [4]. Pregnancy rates following TOA are 15% or less, which can have life-changing implications for these reproductive-aged women [5]. Mortality from PID sequelae is often due to ectopic pregnancy or TOA rupture [-8]. Classically, PID and TOA are treated with IV antibiotics. One-third of TOA patients require surgical intervention for failed antibiotic treatment or suspected rupture [6,9,10].

Studies have identified multiple risk factors associated with increased PID and TOA severity including age, gynecologic and obstetric history, smoking, education level, diabetes, and vaginal cultures [8,9]. However, the impact of obesity on PID and TOA is relatively unknown. In the United States, 39.8% of adults are obese, and obesity has been shown to increase morbidity from chronic diseases [1]. Our study compares outcomes of inpatient management of pelvic inflammatory disease in women with body mass index (BMI) ≥30 and <30 to determine how obesity affects infection management. We hypothesized that patients with PID and BMI >30 have greater morbidity when compared to non-obese patients.

Materials and methods

A retrospective study was performed on patients ages 18-40 admitted for inpatient treatment of PID between January 2010 and July 2017. IRB approval was granted by the Medical College of Wisconsin (MCW) and Froedtert Hospital prior to initiating data collection. Clinical records on 539 patients were obtained using the Cohort Discovery tool of the MCW Clinical Data Warehouse. A total of 467 patient were excluded from the study due to age below 18 or above 40, incomplete records, incorrect diagnosis of PID, or outpatient only treatment of their PID. Data was collected by the first author and reviewed for accuracy by the senior author.

Patients were stratified into two groups, obese v. non-obese as defined by BMI≥30 v. BMI <30. Data collected from patient charts and compared between the groups included: diagnosis of PID, diagnosis of TOA per imaging, age, past medical history, length of stay, readmissions, antibiotic use and procedural interventions. Past

medical history included smoking status, history of gynecologic infection of Chlamydia trachomatis or Neisseria gonorrhoeae, or diabetes. Chlamydia and gonorrhea were the only infections considered in the patient's gynecologic history because they are the most common pathogens implicated in PID [7]. In developed countries, approximately 50% of PID cases are due to chlamydia, while 20% are due to gonorrhea [12].

Morbidity was compared between the BMI≥30 and <30 PID patients. Increased morbidity was defined as more severe PID infection progressing to TOA, longer length of stay, increased number of readmissions, increased number of antibiotics used, longer duration of antibiotic days, and increased number of procedural interventions necessary. Readmissions were counted as any hospital admission after the initial inpatient treatment that was related to their PID diagnosis. This included readmissions for abdominal, flank or pelvic pain, nausea, vomiting, fevers, drain complications, recurrent fluid collection, recurrent TOA, persistent PID, vaginal bleeding or discharge. Procedural interventions considered were any procedure done during admission for diagnosis or treatment of the patient's PID or TOA, including diagnostic laparoscopy or laparotomy, biopsy, lysis of adhesion, IR guided drainage and drain placement, hysterectomy, salpingo-oophorectomy, or salpingectomy.

N (%) was used to describe categorical variables and median (range) was used to describe continuous variables. Fisher's exact test was used to compare categorical variables. Mann-Whitney test was used to compare continuous variables. Statistical significance was considered as p<0. 05.

Classification and regression tree analysis (CART) is a non-parametric multivariable modelling approach used identify possible thresholds and interrelationships, especially with outcomes. An advantage of this approach is that any number of variables can be considered irrespective of the sample size due to the way the tree is obtained, and the distribution of the variables do not matter. The classification tree was optimized by Gini with PID/TOA as a binary outcome. The regression tree was optimized using mean absolute deviation with Length of stay as the outcome. In both trees 10-fold cross validation, and a split criterion were 10 for parent node and 5 minimum for the terminal nodes was used. trees were obtained for the whole dataset and for a subset excluding those with diabetes. The following were variables considered: age, PID/TOA group, BMI group, chlamydia, trichomonas, smoker, diabetes, chronic steroids and cardiac problems. Analysis was performed using SPSS version 24 (IBM Software, Chicago, IL, USA) and CART 8.2 software (Salford Systems, San Diego, CA, USA).

Results

Of the clinical records obtained, 72 patients met inclusion criteria. Thirty-eight patients had BMI≥30 and 34 patients had a BMI<30. The two groups were stratified according to their BMI and inpatient diagnosis of either PID or TOA, as summarized in Appendix 1. Twenty-five patients with BMI≥30 patients were diagnosed with TOA (66%). Only 13 patients (34%) with BMI≥30 had an inpatient diagnosis of PID. Conversely, PID was the more prevalent diagnosis in the BMI<30 group, as 21 (62%) were diagnosed with PID and only 13 (38%) TOA, p= 0.033. Thus, there was a significantly greater prevalence of TOA (66%) in patients with in BMI≥30 v. BMI<30 (38%), p=0.017.

A comparison of the past medical history of each group is given in Table 1. There was no statistically significant difference in smoking status or history of gynecologic infections of chlamydia or gonorrhea. Patients with BMI≥30 were more likely to be diabetic with 9 (24%) patients versus 1 (3%) BMI<30 patient, p=0.015. In addition, patients with BMI≥30 were found to be older with a median age of 31 (18-40), versus those with BMI<30 with median age of 24 (18-39), p=0.009. Classification tree analysis, taking into account other conditions, found in Appendix 2, also identified that patients with diabetes had a higher risk of TOA versus those without diabetes (p=0.015) and those without diabetes and ≥26 years of age had a higher risk of TOA (p=0.041). the same result was true for those without diabetes.

Characteristic	*BMI ≥30 N (%) or Median(range)	BMI <30 N (%) or Median(range)	p-value
Current Smokers	11 (29)	16 (47)	0.146
History of Gynecologic Infections	13 (34)	13 (38)	0.81
Diabetes	9 (24)	1 (3)	0.015
Age	31(18-40)	24 (18-39)	0.009

*Body Mass Index

Table 1. Past Medical History of Inpatient PID Patients

Outcome	*BMI ≥30 N (%) or Median(range)	BMI <30 N (%) or Median(range)	p-value
Diagnosis of TOA†	25 (66)	13 (38)	0.033
Average LOS‡ (days)	5 (2-24)	3 (2-10)	0.002
# of Patients w/ a Readmission	9 (24)	14 (41)	0.134
# of Antibiotics Used	6.5 (3-13)	5 (2-10)	0.001
# of Antibiotic Days	35 (8-83)	32 (7-54)	0.047
# of Patients w/ a Procedure	19 (50)	5 (15)	0.002

*Body Mass Index; †Tubo-ovarian abscess; ‡Length of Stay

Table 2. Morbidity Outcomes in BMI≥30 and BMI<30 PID Patients

Clinical outcomes to assess morbidity between the BMI≥30 and BMI<30 patients are shown in Table 2. Women with BMI≥30 had a longer hospital stay by 5 (2-24) versus 3 (2-10) days, p=0.002. However, less readmissions were seen in the BMI≥30 group, 9 (24%) patients versus 14 BMI <30 patients (41%, p=0.134), though this was not statistically significant. Those with BMI<30 had a fewer number of antibiotics used during admission with a median of 5 (2-10) compared to those with BMI≥30 with a median of 6.5 (3-13), p=0.001. Patients in the BMI<30 group also required shorter courses of antibiotics with 32 (7-54) days versus 35 (8-83) days, p=0.047. Finally, a greater number of BMI≥30 patients had procedural interventions during admission, 19 (50%) patients versus 5 (15%) BMI<30 patients, p=0.002. Regression tree analysis for LOS, taking into account other conditions such as diabetes, found in Appendix 3 identified that patients with TOA had a longer length of stay than PID patients (p=0.002), and those with TOA and a BMI≥30 had a longer length of stay (p=0.002).

Discussion

We conclude that elevated BMI may be an additional risk factor to consider when treating women with severe PID. In our study population, 38% of inpatient non-obese PID patients had a TOA diagnosis. This is consistent with the current literature that cites nearly one-third of hospitalized cases of PID are due to TOA [2,13]. However, this percentage was doubled in the obese group, as 66% of patients were found to have a TOA, indicating that obesity is associated with more severe PID.

Obese patients required more aggressive treatment than non-obese patients. Standard PID treatment includes broad-spectrum antibiotics covering the most common bacteria implicated in PID–Chlamydia trachomatis and Neisseria gonorrhoeae. Over 90% of uncomplicated PID cases are successfully treated with the CDC oral antibiotic treatment regimen exclusively. However, studies show only 70% of TOA cases respond to oral antibiotic therapy alone [6,13,14]. Our study population focused on inpatients with severe PID or TOA and thus may not be representative of typical uncomplicated PID infections.

The majority of the non-obese patients requiring inpatient management were diagnosed with PID without TOA but required admission due to severity of symptoms. These patients were primarily treated with antibiotics alone, with only 15% of non-obese patients requiring procedural intervention for symptom resolution. In contrast, the majority of obese patients met criteria for TOA, and 50% required a procedure in addition to intravenous antibiotics for symptom resolution. Obese patients also required a greater number of antibiotics used and longer courses of antibiotic treatment.

On average, obese patients stayed two additional days during their admission. However, there was no significant difference in readmission rate between the two groups.

Patients with BMI≥30 were older than those with BMI<30. PID is typically seen in sexually active women between 20-40 years old [3]. TOA however is more common in the third and fourth decade of life, which is consistent with our findings [6]. The majority of BMI<30 patients had a diagnosis of PID and were in their second decade of life, while BMI≥30 patients had a greater incidence of TOA and were in their third decade of life.

As might be expected, PID patients with greater BMI were also more likely to be diagnosed with type II diabetes. Excess adipose tissue plays a known role in the development of insulin resistance and type 2 diabetes mellitus [15]. Diabetes is a risk factor for infection in both obese and non-obese patients. The association between diabetes and obesity is well established and determination of which factor is influencing PID outcomes more is difficult. The underlying pathophysiology of infection in obese patients is still being studied. Current literature indicates that obese patients have increased production of pro-inflammatory molecules like TNF-alpha, fibrinogen, and other acute phase reactants [15,16], while lean individuals primarily release anti-inflammatory adipokines. Inflammation is implicated as the underlying mechanism in multiple obesity associated disorders such as insulin resistance and type II diabetes [17]. The pro-inflammatory state of obesity has also been found to contribute to pathologies including endometrial neoplasia, accelerated muscle catabolism, and the neuro-inflammation that exacerbates neuronal death in transient ischemia [18-20]. As PID is considered an inflammatory disorder, the proinflammatory state of obesity may be contributing to a more severe form of PID that results in greater risk or earlier development of TOAs. Thus the combination of diabetes and obesity are likely synergistic.

Our study's greatest limitation was the small patient population. Most patients with PID diagnosis code were excluded from our final evaluation due to age <18 years, incomplete records, misdiagnosis, or outpatient treatment only. Demonstrating our results with a larger population sample can strengthen these conclusions.

We conclude among women admitted for PID treatment obesity was associated with greater morbidity demonstrated by greater incidence of TOAs, longer hospital stays, more antibiotic usage, and more invasive interventions. Elevated BMI may be an additional risk factor to consider when treating women with severe PID. Identifying risk factors that cause more severe PID is of clinical value, as associated sequela of tubal factor infertility, ectopic pregnancy, and chronic pelvic pain are significant and potentially life-changing. The majority of morbidity and public health burden due to PID also stems from the future management of these long-term sequelae. Obese patients presenting with PID symptoms should be treated with greater urgency and caution, as they are more likely to have a severe form of PID and possibly a more rapid progression to TOA. Recognition of this may allow for expedited interventions, reduction of morbidity, and possibly cost reduction for the care of these difficult patients at the time of diagnosis and over the course of their future gynecologic care.

Acknowledgements

Poster session presented at: Medical and Surgical Innovations in Health Care. 2018 American College of Obstetricians and Gynecologists Annual Clinical and Scientific Meeting; 2018 April 27-30; Austin, Tx.

Disclosure of Financial Support: 2017 Dr. Michael J Dunn Summer Research Fellowship Award: $3600 awarded to Sogol Ashrafian as a second-year medical student at the Medical College of Wisconsin for working full time for eight weeks on this research project.

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Correspondence: Denise Uyar, MD, 9200 West Wisconsin Avenue, Milwaukee, WI 53226, USA, Tel: 414-805-6606; E-mail: duyar@mcw.edu

Rec: Feb 04, 2020; Acc: Feb 21, 2020; Pub: Feb 24, 2020

Archives Obs Gynec. 2020;1(1):03
DOI: gsl.aog.2020.0003