Published in final edited form as:

Hernia. 2012 August ; 16(4): 397–403. doi:10.1007/s10029-012-0926-1.

Trends in emergent inguinal hernia surgery in Olmsted County, MN: a population-based study

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Abstract

Background—Evidence suggests that watchful waiting of inguinal hernias (IH) is safe because the risk of acute strangulation requiring an emergent repair is low. However, population-based incidence rates are lacking, and it is unknown whether the incidence of emergent inguinal hernia repairs (IHR) has changed over time.

Study design—A retrospective review of all IHR performed on adult residents of Olmsted County, Minnesota from 1989 to 2008 was performed using the Rochester epidemiology project, a record-linkage system that covers more than 97 % of the population (2010 US Census = 146,466). Incidence rates/100,000 person-years were calculated, and trends over time were evaluated using Poisson regression.

Results—A total of 4,026 IHR were performed on 3,599 patients; 136 repairs (3.8 %) were emergent. Of these, 19 patients (14 %) had bowel resection and three (2 %) died within 30 days of the repair. Rates/100,000 person-years yielded an overall incidence of 7.6 for emergent IHR and

200.0 for elective IHR. Emergent IHR rates increased with age. Overall emergent IHR rates declined from 18.2 to 12.4 in men and from 6.4 to 2.4 in women from 1989 to 2008 ($p > 0.05$). Older age, obesity, a high ASA risk score, a femoral and/or a recurrent hernia were more likely to be associated with an emergent IHR (all $p < 0.05$).

Conclusion—The incidence of emergent IHR is low. This risk has decreased over the past 20 years. However, patients who are either 70 years old, obese, with a high ASA score, or with a femoral or recurrent hernias are more likely to require an emergent IHR and could benefit from elective operative intervention if deemed adequate surgical candidates.

Keywords

Inguinal hernia; Population; Community; Incidence; Repair; Emergent; Epidemiology

Introduction

With more than 800,000 repairs each year in the United States, inguinal hernia repair (IHR) is one of the most common procedures performed by general surgeons [1]. Historically, the presence of an inguinal hernia (IH) dictated prompt operative intervention to avoid the risk of bowel strangulation and the high morbidity and mortality associated with an emergent operation [2–5]. However, strong evidence suggests that watchful waiting of IH is an acceptable alternative to surgical intervention; the risk of acute strangulation is relatively low (3/1,000 patients) [6]. The practice of watchful waiting as espoused by Fitzgibbons et al. [6] is now considered an acceptable and cost-effective alternative [7].

It is known that the efficacy of an intervention, once proven in a controlled setting (i.e., a randomized trial), does not necessarily extrapolate to effectiveness in the community when implemented at large. In the case of IHR, population-based data on the effect of the widespread implementation of a watchful waiting approach to IH have not been carefully studied. If watchful waiting is effective in the community setting, one would expect the rate of emergent IHR to remain the same or even lessen since the publication of the landmark study in 2006 [6]. On the contrary, it would be worrisome if more hernias are now being observed and we were to find that the rate of emergent repairs is increasing.

To characterize emergent IH surgery from an epidemiological standpoint, we sought to determine the incidence of emergent IHR in the population of Olmsted County, MN, and examine trends over the last 20 years.

Methods

We retrospectively reviewed all IHR performed on adult residents of Olmsted County, Minnesota from January 1, 1989 to December 31, 2008. Olmsted County is located in southeastern Minnesota and the racial makeup of the county is predominantly white. According to the US Census, the population of Olmsted County in 2010 was 146,446, with 51 % women, 18 % over age 65, and 90 % white. We used the Rochester epidemiology project (REP) [8, 9] to identify our study cohort. The REP is a record-linkage system that provides the infrastructure for indexing and linking essentially all medical information of the county population. The REP covers more than 97 % of the population in Olmsted County. Each provider in the community employs a dossier system (or unit record) whereby all medical information for each individual is accumulated in a single record. Medical diagnoses, surgical interventions, and other key information from the medical records are routinely abstracted in a summary record (“master sheet”) and entered into computerized indices using the international classification of diseases, adapted code for hospitals (H-ICDA). We searched the REP electronic database for potential cases of IHR (both primary

and recurrent) using the following coding systems and respective codes: H-ICDA [10] (55,001, 55,003, 55,004, 55,011, 55,021, 55,101, 55,201, 55,301, 55,211) and ICD-9 [11] (550.01, 550.03, 550.11, 550.13, 550.91, 550.93) diagnostic codes, as well as Current Procedural Terminology (CPT) [12] codes (17.11–17.24, 53.00–53.17). The records of all patients with an IHR during the study period were reviewed by the study team using a specifically designed abstraction form and following a manual of instructions. Study data were collected and managed using REDCap electronic data capture tools hosted at Mayo Clinic [13].

Diagnostic classification

Emergent IHR were defined as any repair that was performed in a non-elective fashion, within 24 h of the presentation of the patient to medical attention (usually the emergency department), with symptoms of acute groin pain and inability to manually reduce the hernia. We grouped IHR according to the order of occurrence in life (initial vs. second or more), laterality (unilateral vs. bilateral), and recurrence (recurrent vs. non-recurrent). We also subclassified IH according to their location (left or right) and the type of hernia (direct, indirect, femoral, and pantaloon).

Statistical analysis

All subjects with a documented IHR during the study period, while residents of Olmsted County, Minnesota were considered incident cases. Incidence rates were calculated by treating the incident cases of IHR as the numerator and the age- and sex-specific estimates of the population of Olmsted County, Minnesota as the denominator. Incidence rates were expressed/100,000 person-years. The denominator was obtained from the US Census counts for 1980, 1990, and 2000 with linear interpolation for the years in between. The denominators for 2001–2009 were obtained from US Intercensal Estimates [14]. Prevalent IHR cases were not removed from the denominators. Incidence rates were age- and sex-adjusted to the distribution of whites in the United States in the year 2000. Trends in incidence rates over time were evaluated using generalized linear models using a Poisson probability distribution. Incident cases were grouped into calendar year intervals as follows: 1989–1993, 1994–1998, 1999–2003, and 2004–2008. Univariate and multivariate associations between emergent IHR and patient characteristics were evaluated with Cox-proportional logistic regression models. Statistical analyses were performed using the SAS software (SAS Institute; Cary, NC, USA). All tests were two-sided and p values <0.05 were considered statistically significant.

Results

During the study period, a total of 4,026 IHR were performed on 3,599 patients. Emergent repairs were performed in 136 (3.8 %), yielding an overall incidence of 7.6/100,000 person-years for emergent IHR. The incidence of elective IHR was 200.0/100,000 person-years. Of the 136 patients who underwent an emergent repair, 87 were men (64 %) and 49 were women (36 %). Fifty-six patients (44 %) had an indirect hernia, 39 (31 %) had a femoral hernia, 19 (15 %) had a direct hernia, and four (3 %) had a pantaloon type hernia. Twenty-two (16 %) hernias were recurrent, and bilateral hernias were present in nine patients (7 %). Nineteen patients (14 %) had bowel resection and three (2 %) died within 30 days of the repair (Table 1).

Incidence rates/100,000 person-years varied by age and sex (Table 2; Fig. 1). The overall incidence was 10.0 for men and 5.0 for women. For both men and women, rates remained relatively low and without clear gender predominance until after age 70; rates exponentially increased to 80.9 for men and 38.9 for women aged 80–89 years old. Rates also varied by

clinical type of IHR. For first time hernia developers, the overall emergent rate was 7.2 for men and 5.2 for women. For second, third, or fourth IH developers the rate was 2.9 for men and 0.1 for women.

Over time, the incidence of emergent IHR decreased (Table 3; Fig. 2). For men, rates/100,000 person-years, decreased from 18.2 in 1989–1993–12.4 in 2004–2008. For women, rates decreased from 6.4 to 2.4 in the same period. Such rate decrements were not statistically significant ($p > 0.05$).

By multivariate analysis, older age, a high American Society of Anesthesiology (ASA) operative risk score (≥ 3), obesity (body mass index [BMI] > 30), femoral, and recurrent hernias were more likely to be associated with an emergent IHR than an elective IHR ($p < 0.05$) (Tables 4, 5). Non-mesh-based repairs were more likely to be performed in an emergent IHR than in an elective IHR (OR 1.8, $p = 0.008$).

Discussion

This study found that the incidence of emergent IHR is low. The incidence varies greatly by age and sex, increasing with age and being more common in men only after the age of 60. In Olmsted County, over the last 20 years, rates have decreased for both men and women. The low rates of emergent IHR seen in this study provide evidence to support the feasibility of the watchful waiting approach in the treatment of IHs. Nonetheless, patients who are either older than 70 years have an ASA score ≥ 3 , obese, or present with femoral or a recurrent hernia would likely benefit from surgical repair rather than trial of observation (if appropriate surgical candidates), as their risk of requiring an emergent repair appears to be greater.

In a randomized clinical trial with 720 patients, Fitzgibbons et al. [6] showed that IH complications (acute incarceration and bowel obstruction) in asymptomatic or minimally symptomatic patients were extremely uncommon, although longer follow-up would be ideal to ascertain the risks of hernia complications in their study (median follow-up = 3.2 years). Our study, with a longer time frame of appraisal, found similar results, as the overall incident rate of emergent IHR was low at 7.6/100,000 patient-years. Hence, watchful waiting appears to be a feasible and safe alternative in the treatment of asymptomatic or minimally symptomatic patients.

A study by Abi-Haidar et al. [15] showed that in the Boston VA Healthcare System population, over an 8-year period, the frequency of emergent IHR among all IHR was 6.1 % ($n = 1,034$), with older aged patients, as well as those with femoral, scrotal, recurrent, or indirect hernias having a higher likelihood of requiring an emergent repair. Similarly, in our study, we observed that older age patients as well as those with femoral and recurrent hernias are at a higher risk of requiring an emergent IHR. Additionally, our observed frequency of emergent IHR was lower at 3.8 %. However, incident rates and not frequencies provide a better way to communicate and report estimates at a population level because they provide a common language for direct comparisons across studies and other disease types and take into account all patients at risk. Our study using IHR incidence rates over a 20-year period in a defined population should provide the most accurate assessment of risk.

Of interest is the *U*-shaped relationship between BMI and the risk of emergent repairs. Our data suggest that patients who are either underweight or obese are more likely to require an emergent IHR. Though underweight did not achieve statistical significance in the multivariate model, the trend is apparent. The relationship between BMI and IH is a controversial and complicated one. Intuitively, obesity is thought of as a predisposing factor for the development an IH (i.e., increases intraabdominal pressure); however, evidence

suggests that obese people have a lower incidence of IHR [6, 16]. The effect is reversed with recurrent hernias, as the risk of developing a recurrent IH increases with obesity [17]. On the contrary, for obturator hernias, patients are more likely to be underweight [18]. Clearly, further research in the field is needed to clarify the relationship between body weight and IH.

This study has several strengths: a population-based sample, such as the one in this study, avoids referral bias seen in hospital-based convenient samples. The REP database covers the two locations where a hernia repair can be performed in the county (Olmsted Medical Center and Mayo Clinic) minimizing the possibility for coverage error; it includes both academic and community practice patterns and inpatient and outpatient surgery. We acknowledge the limitations of this study: some Olmsted County residents may have elected to undergo a hernia repair elsewhere, thus eluding the coverage of the REP. We believe this is uncommon and of likely minimal impact, given the facilities and physicians available in the county and the nature of the disease. Additionally, because the watchful waiting trial was published in 2006 and our study time period ended in 2008, we did not have the length of follow-up or statistical power to draw strong conclusions on the effect that the watchful waiting trial might have had in our community; however, it is encouraging to see that the rates have remained low. Though epidemiological data generated in Olmsted County may not be generalizable to the US population at large [9], to our knowledge, this is the first study to examine trends in emergent hernia repair over a 20-year period in a US population.

In summary, emergent IHR are rare, thus making watchful waiting a reasonable alternative to prompt surgical repair. However, a subset of patients, who are either elderly, obese, have a high ASA risk score, or present with a femoral or recurrent IH, is more likely to benefit from prompt surgical repair; their risk of strangulation is greater, and hence, management of IH should remain tailored to each individual patient.

Acknowledgments

This publication was made possible by the Rochester Epidemiology Project (Grant Number R01 AG034676 from the National Institute on Aging) and by Grant Number 1 UL1 RR024150 from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH), and the NIH Roadmap for Medical Research. Its contents are solely the responsibility of the authors and do not necessarily represent the official view of NCRR or NIH. The authors would like to thank Admire Kuchena and Trahern Jones for their help with data collection.

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Fig. 1.
Age- and sex-specific incidence of emergent inguinal hernia repairs/100,000 person-years

Fig. 2.
Age-adjusted and sex-specific incidence of emergent inguinal hernia repairs/100,000 person-years from 1989 to 2008

Table 1

Characteristics of 136 patients with an emergent inguinal hernia repair in Olmsted County, MN, 1989–2008

Characteristics	Mean (median; range) or <i>N</i> (%)
Age	67.1 (73; 18–101)
Body mass index ^a (<i>N</i> = 123)	25.8 (25.8; 13.0–50.6)
<20	16 (13)
20–24.9	42 (34)
25–29.9	40 (33)
30	25 (20)
Sex	
Male	87 (64)
Female	49 (36)
ASA ^b (<i>N</i> = 130)	
1	13 (10)
2	46 (35)
3	59 (45)
4	12 (9)
Lateralization	
Unilateral	127 (93)
Bilateral	9 (7)
Side	
Right	69 (51)
Left	58 (43)
Bilateral	9 (7)
Type of hernia ^c (<i>N</i> = 127)	
Indirect	56 (44)
Femoral	39 (31)
Direct	19 (15)
Pantaloon	4 (3)
Recurrent ^c	
No	107 (79)
Yes	20 (15)
Bowel resection	
No	117 (86)
Yes	19 (14)
30-day mortality	
No	136 (98)
Yes	3 (2)
Repair	
Open non-mesh	82 (60)
Open mesh	52 (38)
Laparoscopic (TEP)	2 (2)

^a kg/m²

^b American Society of Anesthesia operative risk classification

^c For unilateral emergent IHR patients only

Age- and sex-specific incidence rates (per 100,000 person-years) of emergent inguinal hernia repairs in Olmsted County, MN, 1989–2008

Table 2

Clinical type ^a	Sex	Age (years)							
		18–29	30–49	50–59	60–69	70–79	80–89	90+	Total
All	Women ^b	0.0 (0)	1.6 (6)	3.0 (4)	8.1 (7)	20.3 (13)	38.9 (16)	22.9 (3)	5.3 (49)
	Men ^c	2.4 (5)	3.7 (14)	12.5 (16)	10.1 (8)	43.3 (21)	80.9 (17)	163.6 (6)	10.0 (87)
	Total	1.2 (5)	2.6 (20)	7.7 (20)	9.1 (15)	30.3 (34)	53.1 (33)	53.7 (9)	7.6 (136)
1st	Women ^b	0.0 (0)	1.6 (6)	3.0 (4)	8.1 (7)	20.3 (13)	36.4 (15)	22.9 (3)	5.2 (48)
	Men ^c	1.9 (4)	3.2 (12)	8.6 (11)	5.1 (4)	28.9 (14)	57.1 (12)	136.3 (5)	7.2 (62)
	Total	1.0 (4)	2.4 (18)	5.8 (15)	6.7 (11)	24.0 (27)	43.4 (27)	47.7 (8)	6.1 (110)
2nd	Women ^b	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	2.4 (1)	0.0 (0)	0.1 (1)
	Men ^c	0.5 (1)	0.5 (2)	3.9 (5)	5.1 (4)	14.4 (7)	23.8 (5)	27.3 (1)	2.9 (25)
	Total	0.2 (1)	0.3 (2)	1.9 (5)	2.4 (4)	6.2 (7)	9.6 (6)	6.0 (1)	1.4 (26)

Data are presented as incidence rates/100,000 person-years followed by the number of incident cases in parentheses

^aClinical types of IHR are as follows: 1st first in life: unilateral or bilateral IHR, 2nd second or more in life: contralateral IHR, or unilateral recurrent IHR, or unilateral recurrent and contralateral metachronous or bilateral recurrent IHR

^bDenominators (in person-years) for women are as follows: 18–29 = 211,405, 30–49 = 383,800, 50–59 = 132,316, 60–69 = 86,151, 70–79 = 63,902, 80–89 = 41,178, 90 and above = 13,100

^cDenominators (in person-years) for men are as follows: 18–29 = 206,015, 30–49 = 380,768, 50–59 = 127,803, 60–69 = 79,081, 70–79 = 48,449, 80–89 = 21,019, 90 and above = 3,668

Age- and sex-adjusted incidence rates (per 100,000 person-years) of emergent inguinal hernia repairs in Olmsted County, MN, 1989–2008

Table 3

Clinical type	Sex	Year of repair			
		1989–1993	1994–1998	1999–2003	2004–2008
All	Women ^a	6.4 (12)	5.4 (11)	8.4 (19)	2.4 (7)
	Men ^b	18.2 (20)	14.7 (22)	10.8 (20)	12.4 (25)
	Total	11.0 (32)	9.3 (33)	9.5 (39)	6.6 (32)

Data are presented as age-adjusted (women, men) or age- and sex-adjusted (total) incidence rates/100,000 person-years followed by the number of incident cases in parentheses

^aDenominators (in person-years) for women are as follows: 1989–1993 = 205,217, 1994–1998 = 221,365, 1999–2003 = 240,848, 2004–2008 = 264,422

^bDenominators (in person-years) for men are as follows: 1989–1993 = 186,589, 1994–1998 = 204,774, 1999–2003 = 225,760, 2004–2008 = 249,680

Table 4

Comparisons between non-emergent and emergent unilateral inguinal hernia repairs

Characteristics	Non-emergent <i>N</i> = 2,912	Emergent <i>N</i> = 127	<i>p</i> value*
Mean (median; range) or <i>N</i> (%)			
Age	53.4 (54; 18–97)	67.1 (73; 18–101)	<0.001
BMI ^a (<i>N</i> = 2,976)	26.1 (25.8; 16.0–58.1)	25.7 (25.8; 13.0–37.1)	0.34
<20	79 (3)	15 (13)	<0.001
20–24.9	1,077 (38)	40 (34)	
25–29.9	1,309 (46)	38 (33)	
30	395 (14)	23 (20)	
Sex			
Male	2,573 (88)	78 (61)	<0.001
Female	339 (12)	49 (39)	
ASA ^b (<i>N</i> = 2,941)			
1	825 (29)	12 (10)	<0.001
2	1,438 (51)	44 (36)	
3	529 (19)	54 (45)	
4	28 (1)	11 (9)	
Side			
Left	1,303 (45)	58 (46)	0.84
Right	1,609 (55)	69 (54)	
Diagnosis (<i>N</i> = 2,987)			
Indirect	1,837 (64)	56 (47)	<0.001
Direct	713 (25)	19 (16)	
Pantaloon	254 (9)	4 (3)	
Femoral	65 (2)	39 (33)	
Recurrent			
No	2,692 (92)	107 (84)	<0.001
Yes	220 (8)	20 (16)	
Repair			
Open mesh	1,530 (53)	47 (37)	<0.001
Open non-mesh	1,117 (38)	79 (62)	
Lap TEP	202 (7)	1 (1)	
Lap TAPP	63 (2)	0	

* Univariate comparisons evaluated using Wilcoxon rank sum and χ^2 tests. Bolded *p* values are considered statistically significant

^a kg/m²

^b American Society of Anesthesia operative risk classification

Table 5

Multivariable associations with emergent unilateral hernia repairs

Characteristics	Odds ratio (95 % CI)	<i>p</i> value*
Age (5-year increase)	1.13 (1.05–1.23)	0.001
ASA ^a		
1, 2	1.0 (reference)	
3	1.81 (1.06–3.11)	0.031
4	9.05 (3.73–21.95)	<0.001
BMI ^b		
<20	2.12 (0.99–4.55)	0.055
20–24.9, 25–29.9	1.0 (reference)	
30	2.48 (1.43–4.30)	0.001
Diagnosis		
Indirect, direct, pantaloon	1.0 (reference)	<0.001
Femoral	16.08 (9.06–28.55)	
Recurrent		
No	1.0 (reference)	
Yes	2.43 (1.29–4.56)	0.006
Type of repair		
Open mesh, or laparoscopic	1.0 (reference)	
Open non-mesh	1.82 (1.17–2.84)	0.008

* Multivariate associations were evaluated using logistic regression models. Bolded *p* values are considered statistically significant

^a American Society of Anesthesia operative risk classification

^b kg/m²