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REVIEW

Obturator hernias: a systematic review of the literature

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Abstract

Purpose Obturator hernias (OH) are extremely rare hernias, accounting for 0.07–1% of all hernias. This is the first systematic review investigating their presentation, imaging, treatment outcomes, and recurrence rate.

Methods After a detailed search in electronic search engines, 74 studies matched our criteria. A review of these reports was conducted and the full texts were examined.

Results A total of 146 patients with a mean age of 78.8 years were included in our analysis, with 40.1%, 29.9%, and 25.2% of patients suffering from either a right, a left or bilateral OH, respectively. OH were associated with non-specific symptoms and signs; bowel obstruction being the most common. Howship–Romberg sign was present in 56.2% of patients. Computed tomography (CT) scan was the most frequently used diagnostic modality, inversely associated with perioperative mortality. Mesh repair demonstrated a significantly improved perioperative morbidity rate, compared with non-mesh repair. Approximately 30% of patients underwent a laparoscopic operation, which was associated with significantly decreased morbidity and mortality rate as well as length of hospital stay, compared with the open repair.

Conclusion OHs are not associated with specific symptoms and signs; thus, they constitute a diagnostic challenge, requiring a high level of clinical suspicion. Undoubtedly, CT scan of the abdomen is the gold standard diagnostic tool. Their operative repair is mandatory, with the laparoscopic approach demonstrating significant advantages over the open repair.

Keywords Obturator · Hernia · Obstruction · Howship–Romberg · Mesh · Laparoscopic

Introduction

Obturator hernia (OH) is a relatively rare but quite important form of abdominal wall hernia. It has been first described by Pierre Roland Arnaud de Ronsil in 1724 and accounts for 0.07–1% of all hernias. It is also responsible for 0.4% of all patients with mechanical bowel obstruction [1–5]. OH occurs through the obturator foramen, which is formed by the rami of the ischium and the pubis, subsequently passing into the obturator canal which is 2–3 cm long and 1 cm wide, bordered by the free edge of the obturator membrane and the pubic bone and contains the obturator nerve and vessels [6].

Obturator hernia tends to occur more frequently in elderly, slender, multiparous women, with the vast majority of OH patients presenting with mechanical bowel obstruction. The associated clinical symptoms are mostly vague and non-specific with the pathognomonic sign for its diagnosis being the Howship–Romberg sign, which consists of ipsilateral inner thigh pain on internal rotation of the hip [1].

OH's localization, its difficult palpation, and its non-specific clinical symptoms render its timely diagnosis extremely demanding, which, in most patients, is definitely achieved via an exploratory laparotomy or laparoscopy for acute bowel obstruction [7, 8]. These facts underline the paramount importance of timely diagnosis, especially in elderly people with multiple comorbidities, as any treatment delay may disproportionally increase the morbidity and mortality

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rates, with published mortality rates ranging between 11 and 50% [6, 9–12]. Fortunately, the wide spread and availability of computed tomography imaging allow for an early and precise diagnosis, favoring elective instead of emergent surgical treatment [7, 13].

This is the first systematic review investigating OH's clinical presentation, radiological imaging, surgical treatment outcomes, perioperative morbidity, mortality, and recurrence rates.

Materials and methods

A combined automated and manual systematic database search in electronic search engines PubMed, Web of Science, Cochrane Library, and Google Scholar, for citations that included obturator hernias, using the keywords "obturator hernia" as well as "little old lady hernia" revealed over 800 studies. After an initial review of them, papers reporting only row data for each individual patient with surgically treated obturator hernias were included in our analysis. Publications of interest included randomized and non-randomized studies, case series, case reports, letters to the editor, and conference abstracts. Papers reporting only on obturator hernias discovered in the setting of a radiological examination or autopsy without commenting on their surgical treatment, studies in languages other than English, papers reporting on obturator hernias in children and adolescents, as well as studies published before 1990, were excluded from the analysis. Sub-studies of larger series by the same group were also excluded from our analysis to avoid data duplication.

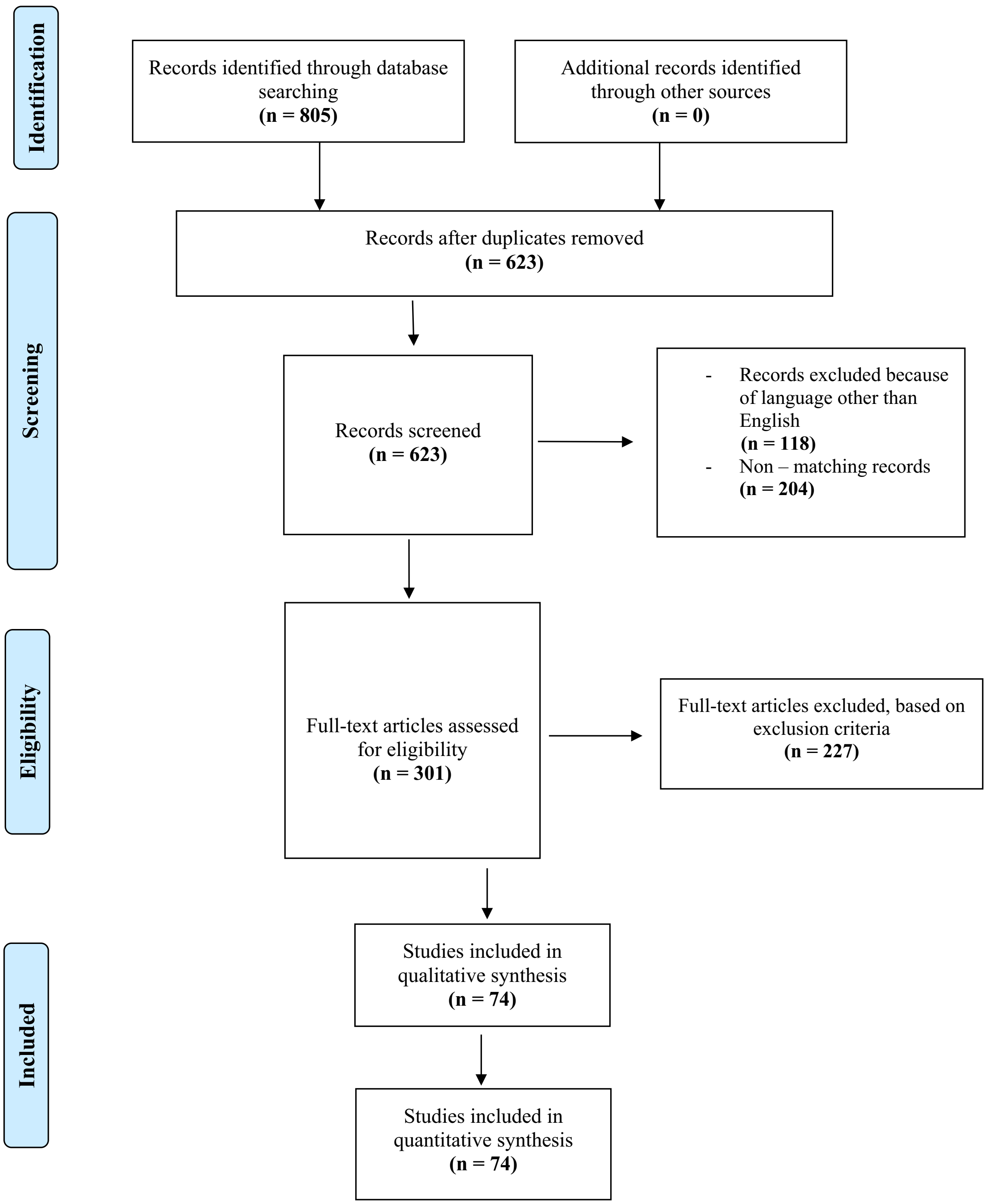
Studies were individually screened by two independent reviewers and data were independently extracted using the same template, decided in advance. Discrepancies between the two reviewers were then examined, until a final consensus was reached. Data extracted from eligible studies included patient characteristics such as age, sex, body mass index (BMI), previous surgical history, clinical symptoms and signs on presentation, radiological evaluation modalities, surgical treatment, length of hospital stay (LOS), perioperative morbidity and mortality (defined as morbidity and mortality within 30 days from the surgical operation), as well as a possible obturator hernia recurrence during the follow-up period.

Statistical analysis was performed using the R language and environment for statistical computing (R Foundation for Statistical Computing, Vienna, Austria https://www.R-project.org). For continuous variables, Shapiro–Wilk test for normality was used and univariate analysis was performed using *T* test or the non-parametric Mann–Whitney *U* test, as appropriate. Categorical variables were examined using Chi-square test. Morbidity and mortality were analyzed by univariate logistic regression analysis. LOS was analyzed by linear regression with logistic transformation of the outcome. Survival analysis was performed using Kaplan–Meier log-rank test and univariate Cox proportional hazard models. Multivariate models were not attempted due to missing data. The level of statistical significance was set at 5% ($\alpha = 0.05$).

Results

Study characteristics

A total of 74 studies [12, 14–86] were included in the present review (Flow Diagram). Sixty-one studies were reports of a single case and 13 studies [12, 32, 41, 43, 44, 48, 62, 64, 80, 81, 83–85] were case series, reporting on a total of 146 patients suffering from an obturator hernia. Forty studies originated from Asia, 17 from Europe, 7 from USA, 6 from Australia, 2 from Latin America, 1 from Canada and the remaining 1 from Africa. Nearly all included studies reported specific data regarding diagnosis, treatment strategy, and patients' outcomes.



Patient characteristics

One hundred and forty-six patients with a total of 167 OH were included in our analysis, with 40.1% ($n=67$ patients), 29.9% ($n=50$ patients), and 25.2% ($n=21$ patients) suffering from either a right, a left or bilateral OH, respectively. Apart from bilateral OH, a contralateral OH was intraoperatively identified in 5 patients (4.7%), further categorized as an occult contralateral OH. In 8 patients (4.8%), the OH localization was not reported. Mean patient age was 78.8 ± 13.4 years, and mean BMI was 17.9 ± 2.8 kg/m^2, with females representing the vast majority of patients (97.9%). Additionally, 25.4% of the patients had undergone some kind of abdominal surgery in the past (Table 1). However, no statistically significant differences were observed, as for the mean patient age, mean BMI, patient's gender as well as the past medical history of any abdominal surgical operation, between patients with either a right or a left OH (Table 2).

Table 1 Demographic data, obturator hernia localization as well as clinical, radiological, and operative and postoperative data for the entire cohort of the study

	Available data (N^a)	All
Demographic data	146	100%
Age (years) (mean ± SD[b])	146	78.8 ± 13.4
Male gender	146	3 (2.1%)
Female gender	146	143 (97.9%)
Previous abdominal surgery	114	29 (25.4%)
BMI[c] (kg/m^2)	48	17.9 ± 2.8
Hernia localization		
Right	146	67 (40.1%)
Left	146	50 (29.9%)
Bilateral	146	21 (25.2%)
Occult contralateral OH [d]	107	5 (4.8%)
Symptoms and signs		
Bowel obstruction	146	137 (93.8%)
Abdominal pain	79	67 (84.8%)
Vomiting	70	53 (75.7%)
Howship–Romberg sign	64	36 (56.2%)
Nausea/anorexia	69	30 (43.5%)
Fever	47	6 (12.8%)
Radiological evaluation		
CT[e]	146	123 (84.2%)
XR[f]	66	52 (78.8%)
Preoperative OH diagnosis	140	115 (82.1%)
Surgical treatment		
Emergent operation	146	139 (95.2%)
Intraperitoneal approach[g]	146	126 (86.3%)
Mesh repair	129	63 (48.8%)
Laparoscopic operation	146	42 (28.8%)
Conversion rate[h]	42	4 (9.5%)
Enterectomy	146	60 (41.1%)
Outcomes		
LOS[i] (days)	111	10.5 ± 9.7
Perioperative morbidity	120	32 (26.7%)
Perioperative mortality	121	14 (11.6%)
OH Recurrence	85	2 (2.4%)

[a] *N* number of patients

[b] *SD* standard deviation

[c] *BMI* body mass index

[d] *OH* obturator hernia

[e] *CT* computed tomography

[f] *XR* plain abdominal radiograph

[g] *Intraperitoneal approach* includes laparotomy and laparoscopic transabdominal preperitoneal (TAPP) approach

[h] *Conversion rate* laparoscopic to open conversion rate

[i] *LOS* length of hospital stay

Table 2 Comparison of left- and right-sided obturator hernias as for demographic, clinical, and operative and postoperative data

	Hernia localization		
	Left	Right	*p* value
Demographic data	50 (42.7%)	67 (57.3%)	–
Age (years) (Mean ± SD[a])	79.1 ± 13.4	78.6 ± 15.1	0.848
Male gender	2 (4%)	0 (0%)	0.352
Female gender	48 (96%)	67 (100%)	*reference*
Previous abdominal surgery	17 (29.8%)	15 (20.8%)	0.252
BMI[b] (kg/m^2)	16.9 ± 1.9	17.5 ± 2.9	0.447
Symptoms and signs			
Abdominal pain	16 (69.6%)	34 (87.2%)	0.173
Nausea/anorexia	12 (57.1%)	16 (42.1%)	0.404
Bowel obstruction	47 (94%)	63 (94%)	1.000
Vomiting	17 (77.3%)	30 (78.9%)	1.000
Fever	3 (21.4%)	3 (11.5%)	0.710
Howship–Romberg sign	15 (60%)	15 (48.4%)	0.551
Surgical treatment			
Emergent operation	49 (98%)	65 (97%)	1.000
Intraperitoneal approach[c]	42 (84%)	56 (83.6%)	1.000
Mesh repair	27 (56.2%)	27 (45%)	0.333
Laparoscopic operation	17 (34%)	15 (22.4%)	0.236
Conversion rate[d]	11.8%	13.3%	1.000
Enterectomy	23 (46%)	27 (40.3%)	0.669
Occult contralateral OH[e]	3 (8.6%)	2 (3.9%)	0.532
Outcomes			
LOS[f] (days)	10.9 ± 9.0	10.2 ± 10.2	0.725
Perioperative morbidity	14 (35%)	12 (20%)	0.149
Perioperative mortality	7 (17.1%)	6 (10.2%)	0.479
OH recurrence	0 (0%)	2 (4.9%)	0.632

[a] *SD* standard deviation

[b] *BMI* body mass index

[c] *Intraperitoneal approach* includes laparotomy and laparoscopic transabdominal preperitoneal (TAPP) approach

[d] *Conversion rate* laparoscopic to open conversion rate

[e] *OH* obturator hernia

[f] *LOS* length of hospital stay

The presence of an OH was associated with various non-specific symptoms and signs, which in a descending order of frequency included signs of bowel obstruction (93.8%), abdominal pain (84.8%), vomiting (75.7%), nausea (43.5%), and fever (12.8%). The Howship–Romberg sign was present in slightly more than half of the patients (56.2%) (Table 1). No statistically significant differences were demonstrated between these symptoms and signs and the localization of the OH (Table 2).

Table 3 Univariate logistic regression analysis for factors associated with perioperative morbidity and mortality

	Morbidity			Mortality		
Outcome:	(Events/non-events)	OR[a] (LCI[2]–HCI[3])	*p* value	(events/non-events)	OR (LCI–HCI)	*p* value
Left	18/34	2.12 (0.91 – 5.07)	0.084	2/94	1.54 (0.50–4.98)	0.456
Right	16/56	0.53 (0.22–1.25)	0.146	0/44	0.52 (0.17–1.64)	0.260
Age (patients with an event) (years) (mean ± SD[d])	84.1 ± 6.3	1.00 (1.00–1.01)	**0.007**	84.9 ± 7.4	1.00 (1.00–1.01)	0.086
Age (patients without an event) (years) (mean ± SD)	76.7 ± 14.6	NA[e]		78.4 ± 13.9	NA	
Male gender	1/1	2.81 (0.11–72.42)	0.470	1/1	8.15 (0.31–214.72)	0.146
Female gender	31/87	NA		13/106	NA	
BMI[f] (patients with an event) (kg/m^2) (mean ± SD)	18.1 ± 2.6	NA		16.0	0.99 (0.98–1.01)	
BMI (patients without an event) (kg/m^2) (mean ± SD)	18.0 ± 2.8	1.00 (0.96–1.04)		18.0 ± 2.8	NA	
Previous abdominal surgery	7/20	0.75 (0.26–2.01)	0.581	2/25	0.41 (0.06–1.66)	0.265
Symptoms and signs						
Abdominal pain	12/48	1.00 (0.21–7.19)	1.000	3/54	1.05 (0.92–1.21)	0.465
Nausea/anorexia	4/24	0.72 (0.17–2.84)	0.644	1/25	1.01 (0.91–1.11)	0.901
Bowel obstruction	30/81	1.30 (0.29–9.03)	0.754	14/98	1.13 (0.91–1.41)	0.263
Vomiting	9/36	1.75 (0.39–12.42)	0.507	3/39	1.07 (0.94–1.22)	0.280
Fever	2/3	2.42 (0.28–17.20)	0.376	1/4	1.15 (0.90–1.48)	0.268
Howship–Romberg sign	6/21	2.29 (0.53–11.91)	0.282	1/28	1.04 (0.96–1.11)	0.348
Radiological evaluation						
CT[g]	26/74	0.80 (0.30–2.52)	0.712	9/92	0.29 (0.09–1.06)	**0.049**
Preoperative OH[h] diagnosis	24/65	1.00 (0.40–2.70)	0.918	9/81	0.44 (0.14–1.58)	0.185
Surgical treatment						
Emergent operation	30/83	0.90 (0.18–6.54)	0.907	14/100	1.13 (0.88–1.44)	0.328
Intraperitoneal approach	30/75	2.60 (0.67–17.27)	0.226	14/92	1.14 (0.96–1.36)	0.137
Mesh repair	9/45	0.35 (0.14–0.84)	**0.022**	3/54	0.28 (0.06–0.97)	0.062
Enterectomy	18/28	2.76 (1.21–6.42)	**0.017**	10/38	4.54 (1.41–17.46)	**0.016**
Open/laparoscopic approach						
Laparoscopic repair	5/34	0.29 (0.09–0.78)	**0.022**	0/39	0.84 (0.75–0.95)	**0.006**
LOS[i] (patients with an event) (days) (mean ± SD)	16.3 ± 13.7	1.02 (1.01–1.03)	**< 0.001**	13.0 ± 10.5	1.00 (1.00–1.01)	0.360
LOS (patients without an event) (days) (mean ± SD)	7.5 ± 4.4	NA		10.3 ± 9.8	NA	

Bold indicates the statistically significant differences (*p* value < 0.05)

[a]*OR* odds ratio

[b]*LCI* lower confidence interval

[c]*HCI* higher confidence interval

[d]*SD* standard deviation

[e]*NA* not available (used as reference)

[f]*BMI* body mass index

[g]*CT* computed tomography

[h]*OH* obturator hernia

[i]*LOS* length of hospital stay

Following hospital admission and clinical examination, nearly all patients underwent a radiological evaluation, with the most common modality used being the computed tomography (CT) of the abdomen (84.2%), followed by

Table 4 Linear regression analysis for factors associated with length of hospital stay (LOS)

Outcome	OR[a]	LCI[b]	HCI[c]	p value
Demographic data				
Age	1.03	1.02	1.04	**< 0.001**
Previous abdominal surgery	0.73	0.5	1.05	0.097
BMI[d] (kg/m^2)	0.98	0.91	1.06	0.684
Hernia localization				
Left	1.03	0.75	1.41	0.860
Right	0.95	0.69	1.32	0.779
Occult contralateral OH[e]	0.8	0.46	1.39	0.439
Occult inguinal hernia	0.99	0.2	4.97	0.989
Occult femoral hernia	1.34	0.67	2.68	0.404
Occult multiple hernias	0.61	0.32	1.16	0.135
Symptoms and signs				
Abdominal pain	0.87	0.48	1.57	0.644
Nausea/anorexia	1.31	0.84	2.04	0.240
Bowel obstruction	3.08	1.81	5.22	**< 0.001**
Vomiting	1.61	0.99	2.61	0.059
Fever	1.94	0.97	3.88	0.072
Howship–Romberg sign	1.12	0.7	1.8	0.643
Radiological evaluation				
CT[f]	1.12	0.75	1.67	0.572
XR[g]	2.26	1.45	3.51	**0.001**
Surgical treatment				
Emergent operation	2.32	1.24	4.37	**0.010**
Intraperitoneal approach[h]	1.73	1.11	2.7	**0.018**
Mesh repair	0.66	0.49	0.87	**0.004**
Laparoscopic operation	0.5	0.38	0.68	**< 0.001**
Conversion rate[i]	2.02	0.82	4.99	0.135
Enterectomy	1.61	1.22	2.14	**0.001**
Outcomes				
Perioperative morbidity	1.92	1.42	2.6	**< 0.001**
Perioperative mortality	1.29	0.81	2.04	0.285

Bold indicates the statistically significant differences (*p* value < 0.05)

[a]*OR* odds ratio

[b]*lCI* lower confidence interval

[c]*HCI* higher confidence interval

[d]*BMI* body mass index

[e]*OH* obturator hernia

[f]*CT* computed tomography

[g]*XR* plain abdominal radiograph

[h]*Intraperitoneal approach* includes laparotomy and laparoscopic transabdominal preperitoneal (TAPP) approach

[i]*Conversion rate* laparoscopic to open conversion rate

plain abdominal radiographs (78.8%). An accurate preoperative diagnosis of OH was made in the majority of patients (82.1%) who underwent preoperative radiological evaluation (Table 1).

All patients ($n = 146$) were operated on, with 139 patients (95.2%) being operated emergently and the rest on an elective basis. An intraperitoneal surgical approach was performed in most cases (86.3%). Forty-two patients (28.8%) underwent a laparoscopic operation, out of which 9.5% required conversion to laparotomy. Nearly 40% of the patients required an enterectomy due to a non-viable bowel segment, caused by bowel strangulation (Table 1). Closure of the hernia defect was performed with the use of mesh in approximately half of the patients ($n = 63$ patients, 48.8%), whereas in the remaining patients, the hernia defect was closed with the use of stiches. Mesh repair was significantly more frequently implemented in patients without intestinal resection ($n = 43$ patients, 68.3%), compared with patients who underwent an intestinal resection due to bowel strangulation ($n = 20$ patients, 31.7%) ($p = 0.036$). An occult contralateral OH was intraoperatively identified in 5 patients (4.7%), without any significant difference between patients being operated on for a left or a right OH (Table 2). The mean LOS was 10.5 ± 9.7 days, whereas the perioperative morbidity and mortality rates were 26.7% and 11.6%, respectively. Recurrence of the surgically treated OH was observed in 2 cases (2.4%), both being right-sided hernias (Table 1). However, mean LOS, perioperative morbidity and mortality, as well as OH recurrence were irrespective of OH localization (Table 2).

Univariate logistic regression analysis

To investigate which parameters may influence the morbidity and mortality rates, we performed a univariate logistic regression analysis. Older patient age was demonstrated as a significant risk factor for postoperative morbidity ($p = 0.007$), without though showing any difference in the respective mortality rate. However, neither OH localization nor patient's gender, BMI, or past medical history of an abdominal operation, were significantly correlated with the postoperative morbidity and mortality rate (Table 3).

Regarding the presence of symptoms and signs as well as the preoperative imaging modality used, no statistically significant correlation was demonstrated between them and the postoperative morbidity and mortality rate, except for the preoperative use of abdominal CT scan, which was associated with a significantly decreased postoperative mortality rate (OR 0.29, $p = 0.049$), without affecting the morbidity rate though (Table 3).

Not surprisingly, the presence of a non-viable intestinal segment and the subsequent need for an enterectomy was significantly correlated with an increased morbidity (OR 2.76, $p = 0.017$) and mortality (OR 4.54, $p = 0.016$) rate. The laparoscopic treatment of an OH demonstrated a significantly decreased morbidity (OR 0.29, $p = 0.022$) and mortality rate (OR 0.84, $p = 0.006$), compared with the respective open repair. The same pattern was also observed as for the use of mesh for hernia defect closure, which was associated with a decreased morbidity rate (OR 0.35, $p=0.022$), without affecting the mortality rate. Moreover, as it was expected, an increased morbidity rate was strongly correlated with an increased LOS ($p<0.001$) and postoperative mortality rate (OR 1.55, $p<0.001$), as well (Table 3).

Length of hospital stay was also independently analyzed as for various parameters which may be associated with. Older age ($p<0.001$), presence of bowel obstruction (OR 3.08, $p<0.001$), the use of plain abdominal radiographs for preoperative imaging (OR 2.26, $p=0.001$), the need for bowel resection (OR 1.61, $p=0.001$), emergent operation (OR 2.32, $p=0.01$), as well as intraperitoneal surgical approach (OR 1.73, $p=0.018$) were significant risk factors for an increased LOS. On the other hand, laparoscopic approach (OR 0.50, $p<0.001$) and use of mesh for hernia defect closure (OR 0.66, $p=0.004$) were associated with a decreased LOS (Table 4).

Discussion

The distinct anatomical stages of OH formation have been well described in the literature, consisting of the first stage in which preperitoneal fat enters the obturator foramen forming a fat plug, followed by the second stage of hernia sac formation through peritoneal dimpling into the existing fat plug, with the hernia sac subsequently occupied by intraabdominal viscera herniating into it and causing symptoms and/or signs in the third stage [6, 87, 88].

Multiple predisposing factors have been associated with OH formation, including a wider pelvis causing a triangular-shaped obturator canal with an increased transverse diameter, multiparity, increased age usually in conjunction with emaciation, as well as chronic concomitant medical conditions which increase the intraabdominal pressure, such as chronic obstructive pulmonary disease, chronic constipation, ascites, and kyphoscoliosis [5]. The underlying mechanism predisposing elderly and emaciated people to OH formation is the extensive loss of preperitoneal adipose and lymphatic tissue, which normally overlies the obturator canal, thus creating a greater space around the obturator vessels and nerve, facilitating OH formation [44, 89]. Considering that most of the aforementioned predisposing factors affect elderly, emaciated, and multiparous women, it is easily conceivable why OH are frequently characterized as "little old lady's hernias".

As previously described, OH have been reported to be six-to-nine times more frequent in females than in males [7, 90, 91]. Further highlighting these data, our study demonstrated that an overwhelming predominance of females over males does exist in symptomatic OH development, as 97.9% of the patients included were females, absolutely justifying their characterization as "lady's hernia". Plausible explanations of this phenomenon may be the fact that most of the aforementioned predisposing factors occur in females than in males, as discussed earlier. One step further, the mean BMI of the present series of patients is far lower than the lower normal limit of 25 kg/m^2 and even lower than 18.5 kg/m^2 [92], classifying these patients as underweight. This is in accordance with multiple publications of Asian origin regarding patients with a lean body build [3, 10, 83, 93, 94], confirming the association between emaciation and OH emergence published in the literature.

Considering OH localization, it has been reported that OH are more frequently formed on the right side, as the presence of the sigmoid colon on the left side is postulated to be a protective factor against OH development [1, 3, 7, 10, 93, 94]. Furthermore, the incidence of an occult contralateral OH in the published literature varies widely, with published frequencies of 6% [95], 50% [62], and 63% [96], depending highly on the individual surgical approach chosen for peritoneal exploration and OH repair. Our study demonstrated that an occult contralateral OH was intraoperatively discovered in 4.7% of patients, a prevalence which is lower compared with all published series so far. A possible explanation of this phenomenon may be the fact that the accumulated experience in advanced laparoscopic surgery in recent years has led to a broader implementation of the totally extraperitoneal approach for OH repair, which, despite its several advantages in terms of postoperative morbidity rate, is associated with a limited ability of peritoneal exploration and, therefore, occult contralateral OH identification.

Obturator hernia is associated with non-specific symptoms and signs, which render its clinical diagnosis difficult and require a high level of suspicion, especially in the aforementioned group of patients with high-risk characteristics. The most common presenting symptom is acute mechanical bowel obstruction, which is usually consistent, but sometimes may be intermittent, if the hernia content is spontaneously reduced within the peritoneal cavity. Intermittent abdominal pain was observed in about one-third of OH patients in another study, highlighting that such an intermittent relief of bowel obstruction may be an important clue for its diagnosis [97]. One step further, a higher occurrence of Richter hernias (41–100%) protruding into the obturator canal and usually spontaneously reduced has been observed in such cases of intermittent intestinal obstruction [5, 6, 97]. Abdominal pain is the second most common presenting symptom of OH, whereas the Howship–Romberg sign, which is pathognomonic for OH, was found to be present in approximately half of our patients. This finding is also supported by the other studies [1, 2], leading to the conclusion that the absence of the Howship–Romberg sign cannot safely preclude OH presence. Moreover, the presence of that sign may be obscured by other patient's comorbidities, such as spinal, knee and/or hip arthropathy as well as by the overwhelming severity of the concurrent abdominal pain, thus misguiding the involved clinician. It should be also mentioned that fever is not a common sign in OH patients, with only 10% of patients being febrile at their presentation.

The masquerading clinical appearance of OH requires the implication of sensitive and specific imaging studies for its prompt and timely diagnosis. A delayed diagnosis with subsequent delayed surgical treatment in OH cases with mechanical bowel obstruction may lead to intestinal strangulation, compromising intestinal viability [98, 99], thus adversely affecting morbidity and mortality rate as well as LOS [100]. Such a scenario of delayed diagnosis with its consequences may explain the significantly increased LOS in OH patients who were preoperatively submitted to plain abdominal radiographs as definitive imaging study. On the contrary, CT scan of the abdomen and pelvis has been demonstrated as the most sensitive and specific imaging modality for OH detection. Its usefulness was first reported in 1983 [11], with its accuracy being up to 85% [12], still outperforming all other imaging studies. In addition to the aforementioned diagnostic ability, the wider adoption of CT scan, always in conjunction with a detailed physical examination, may allow for a more effective preoperative diagnosis of occult hernias, especially occult contralateral OH, therefore enabling a simultaneous surgical correction and avoiding the risks of an undiagnosed OH. Despite its proven diagnostic efficacy, the association between CT results and patient prognosis was questioned in the literature [10, 94]. Although there are studies reporting that early surgical intervention is not sufficient by itself in reducing postoperative mortality rates [91], the results of the present study demonstrate that the accurate preoperative OH diagnosis by CT scan is associated with a significantly reduced postoperative mortality rate. This finding cannot be solely attributed to a timely surgical intervention, since an accurate preoperative OH diagnosis allows also for a more directed surgical operation, instead of an exploratory laparotomy. More studies with larger number of patients will undoubtedly shed more light on this topic.

Regardless of the operative approach chosen, the presence of strangulation necessitates resection of the affected bowel segment, with the previous reports having noticed that the presence of bowel strangulation negatively affects morbidity and mortality rates [100]. These data are in accordance with our results, which demonstrate that the performance of bowel resection is a statistically significant risk factor for increased postoperative morbidity and mortality rate as well as an increased LOS, further highlighting the importance of timely diagnosis and surgical intervention.

Several operative approaches and surgical techniques for OH reduction and hernia defect closure have been reported in the literature. Regarding operative approaches, intraperitoneal as well as totally extraperitoneal approaches have demonstrated successful outcomes in OH management. Intraperitoneal approach includes the traditional open laparotomy, usually via an infra-umbilical midline incision, or the laparoscopic transabdominal preperitoneal approach (TAPP) [62, 83, 101–103], whereas the extraperitoneal approach consists of either the trans-inguinal approach [64] or the TEP approach [90]. The major advantage of intraperitoneal approach is the ability to inspect the abdominal viscera as well as evaluate and treat a possible bowel strangulation, making it more suitable for emergent cases. Extraperitoneal approaches are favored in more elective OH cases, provided that the presence of a possible bowel necrosis can be ruled out with great accuracy preoperatively. In such cases, their advantages over intraperitoneal approaches, such as reduced rate of postoperative ileus, adhesion formation, and risk of injury to other abdominal viscera [104, 105] as well as the decreased LOS evidenced by the present study by far outweigh their limited ability of abdominal exploration. Therefore, the decision of performing either an intraperitoneal or an extraperitoneal approach is primarily based on the preoperative suspicion for bowel strangulation and the subsequent need for an enterectomy and secondarily on surgeon's familiarity and experience with either approach.

Various techniques have been described for closure of the hernia defect following reduction of hernia contents within the abdominal cavity. Apart from the traditional primary peritoneal closure with the use of stitches, other techniques include reconstruction using a tissue flap made from aponeurosis and periosteum and, finally, the use of permanent prosthesis, such as a surgical mesh or plug, aiming to a defect closure without tension [4, 90, 102, 106–108]. Each technique has its own indications, advantages, and disadvantages. Primary peritoneal closure with stiches is the method of choice in small OH, in which primary closure may be achieved without jeopardizing hernia recurrence due to extensive tension as well as in cases of a contaminated surgical field due to intestinal resection [62, 81, 109, 110]. On the contrary, the presence of a concurrent groin hernia also favors the use of a large mesh for covering all hernia orifices at the same surgical operation. According to our results, the use of mesh for OH correction is inversely associated with the perioperative morbidity rate as well as LOS, a fact which may be attributed to the demonstrated more frequent application of mesh in non-contaminated cases, such as cases without need for bowel resection, which are associated with fewer postoperative complications than their contaminated counterparts.

Irrespective of the intraperitoneal or the extraperitoneal approach and the utilization or not of a mesh for hernia defect closure, the laparoscopic approach has several advantages over the open approach, which include decreased postoperative pain, early mobilization, and shorter LOS, as well as decreased postoperative morbidity rates [7, 111, 112]. The present study demonstrated that 42 patients underwent a laparoscopic OH repair, with less than 10% of them having been converted to a laparotomy because of technical difficulties, with the laparoscopic repair demonstrating a significantly reduced postoperative morbidity rate, compared with the respective open repair. Furthermore, the mean LOS was significantly decreased in the laparoscopic repair group of patients, compared with the open group. Therefore, based on the present outcomes as well as current literature, laparoscopic approach seems to be the optimum treatment strategy for OH patients, especially in centers with broad experience in advanced laparoscopic surgery.

The present study has certain limitations. First of all, it is a retrospective study, without good uniformity between the included studies, regarding the method of reporting patients' data, accompanied by a significant percentage of missing data across these studies. Moreover, to date, there is paucity of data regarding the laparoscopic repair of the OH, especially the extraperitoneal approach (TEP). Nevertheless, this date already seems to demonstrate the significant advantages of the laparoscopic approach over the open repair, but the addition of more data leading to safer conclusions is definitely required.

In conclusion, despite their overall low incidence, OH tend to occur more frequently in elderly, slender, multiparous women, with the vast majority of patients presenting with mechanical bowel obstruction. They are not associated with specific symptoms and signs and are usually manifested with consistent abdominal pain. The pathognomonic Howship–Romberg sign is recognized in approximately half of the patients, implying that its absence cannot safely preclude OH presence. Timely and accurate diagnosis is the cornerstone of minimizing morbidity and mortality, and may be achieved by wide implementation of computed tomography, which remains the gold standard. Their operative repair is mandatory, since they are associated with high levels of bowel incarceration and strangulation, if left untreated, with most patients being operated on in an emergent setting. Their operative repair is accompanied by acceptable LOS as well as postoperative morbidity and mortality rates, with the laparoscopic approach demonstrating significant advantages over the open repair, thus seeming to be the optimum treatment strategy for these patients.

Compliance with ethical standards

Conflict of interest The authors declare that the present study was not funded and therefore have no commercial associations that might be a conflict of interest.

Ethical approval Approval from the institutional review board was not required for this study.

Human and animal rights This study does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this retrospective review, formal consent is not required.

References

1. Stamatiou D, Skandalakis LJ, Zoras O, Mirilas P (2011) Obturator hernia revisited: surgical anatomy, embryology, diagnosis, and technique of repair. Am Surg 77(9):1147–1157
2. Losanoff JE, Richman BW, Jones JW (2002) Obturator hernia. J Am Coll Surg 194(5):657–663. https://doi.org/10.1016/s1072-7515(02)01137-7
3. Green BT (2001) Strangulated obturator hernia: still deadly. South Med J 94(1):81–83
4. Maharaj D, Maharaj S, Young L, Ramdass MJ, Naraynsingh V (2002) Obturator hernia repair—a new technique. Hernia 6(1):45–47. https://doi.org/10.1007/s10029-002-0042-8
5. Bjork KJ, Mucha P Jr, Cahill DR (1988) Obturator hernia. Surg Gynecol Obstet 167(3):217–222
6. Gray SW, Skandalakis JE, Soria RE, Rowe JS Jr (1974) Strangulated obturator hernia. Surgery 75(1):20–27
7. Ng DC, Tung KL, Tang CN, Li MK (2014) Fifteen-year experience in managing obturator hernia: from open to laparoscopic approach. Hernia 18(3):381–386. https://doi.org/10.1007/s10029-013-1080-0
8. Bergstein JM, Condon RE (1996) Obturator hernia: current diagnosis and treatment. Surgery 119(2):133–136. https://doi.org/10.1016/s0039-6060(96)80159-0
9. Lo CY, Lorentz TG, Lau PW (1994) Obturator hernia presenting as small bowel obstruction. Am J Surg 167(4):396–398. https://doi.org/10.1016/0002-9610(94)90123-6
10. Yokoyama Y, Yamaguchi A, Isogai M, Hori A, Kaneoka Y (1999) Thirty-six cases of obturator hernia: does computed tomography contribute to postoperative outcome? World J Surg 23(2):214–216. https://doi.org/10.1007/pl00013176**(discussion 217)**
11. Cubillo E (1983) Obturator hernia diagnosed by computed tomography. AJR Am J Roentgenol 140(4):735–736. https://doi.org/10.2214/ajr.140.4.735
12. Chan KV, Chan CKO, Yau KW, Cheung MT (2014) Surgical morbidity and mortality in obturator hernia: a 10-year retrospective risk factor evaluation. Hernia 18(3):387–392. https://doi.org/10.1007/s10029-013-1169-5
13. Ijiri R, Kanamaru H, Yokoyama H, Shirakawa M, Hashimoto H, Yoshino G (1996) Obturator hernia: the usefulness of computed tomography in diagnosis. Surgery 119(2):137–140. https://doi.org/10.1016/s0039-6060(96)80160-7
14. Zheng LZ, Zheng CY, Zu B, Lin W (2020) Subacute bowel obstruction secondary to an obturator hernia. J Coll Physicians Surg Pak 30(2):210–212. https://doi.org/10.29271/jcpsp.2020.02.210
15. Herath M, Kanhere H (2020) Loin to groin pain—a case report of an intermittent obturator hernia mimicking ureteric colic. Int J Surg Case Rep 66:356–359. https://doi.org/10.1016/j.ijscr.2019.12.025

16. Zhou YX, Ji Y, Lv J (2019) Small bowel obstruction secondary to obturator hernia. ANZ J Surg. https://doi.org/10.1111/ans.15520
17. Saeed R, Ahmed M, Lara G, Mahmoud A, Nurick H (2019) Howship-Romberg sign and bowel obstruction: a case report. Cureus 11(7):e5066. https://doi.org/10.7759/cureus.5066
18. Rubay D, Ohanisian L, Shin R, Hristov B, Yeguez J (2019) Asynchronous bilateral obturator hernias: a suggested approach to reduce morbidity of obturator hernias. Cureus. https://doi.org/10.7759/cureus.5260
19. Rampersad F, Ramsundar A, Ramsumair R, Munro M (2019) Unusual cause of mechanical small bowel obstruction in a cachectic older multiparous woman. BMJ Case Rep. https://doi.org/10.1136/bcr-2019-230245
20. Ramkumar J, Lu D, Scott T (2019) Laparoscopic mesh repair of bilateral obturator hernias post-peritoneal dialysis. Perit Dial Int 39(1):95–97. https://doi.org/10.3747/pdi.2018.00203
21. Petrushnko W, Isaacs A, Hackland T, Ghusn M (2019) Case report: laparoscopic totally extraperitoneal repair of an obturator hernia with self-gripping mesh under spinal anaesthesia. Int J Surg Case Rep 62:14–16. https://doi.org/10.1016/j.ijscr.2019.07.048
22. Mnari W, Hmida B, Maatouk M, Zrig A, Golli M (2019) Strangulated obturator hernia: a case report with literature review. Pan Afr Med J 32:144. https://doi.org/10.11604/pamj.2019.32.144.14846
23. Memon ZA, Aisha M, Qadar LT, Ochani RK, Asghar SA (2019) Rare case of peritonitis due to ileal perforation secondary to richter's type of obturator hernia. Cureus. https://doi.org/10.7759/cureus.4289
24. Kwok AMF, Sarofim M (2019) Strangulated obturator hernia as an unusual cause of small bowel obstruction. ANZ J Surg 89(11):E538–E539. https://doi.org/10.1111/ans.14868
25. Joe C, Gowda V, Koganti S (2019) Laparoscopic assisted repair of strangulated obturator hernia—way to go. Int J Surg Case Rep 61:246–249. https://doi.org/10.1016/j.ijscr.2019.07.029
26. Jiang LL, Chen CC, Yang K (2019) Lessons learned from an unusual condition of incidental synchronous multiple hernias of indirect inguinal hernia, femoral hernia, and incarcerated obturator hernia. Niger J Clin Pract 22(2):281–284. https://doi.org/10.4103/njcp.njcp_200_18
27. Dhakre VW, Agrawal P (2019) 'Little old lady's hernia' (obturator hernia): a deceptive encounter. J Minim Access Surg 15(2):180–181. https://doi.org/10.4103/jmas.JMAS_21_18
28. Amiki M, Goto M, Tomizawa Y, Sugiyama A, Sakon R, Inoue T, Ito S, Oneyama M, Shimojima R, Hara Y, Narita K, Tachimori Y, Sekikawa K (2019) Laparoscopic transabdominal preperitoneal hernioplasty for recurrent obturator hernia: a case report. Asian J Endosc Surg. https://doi.org/10.1111/ases.12739
29. Yamazaki Y, Otowa Y, Kusano S, Nakajima K, Satake S, Yamasaki Y (2018) Incarcerated obturator hernia treated using a hybrid laparoscopic and anterior preperitoneal approach: a case report. Asian J Endosc Surg 11(3):277–279. https://doi.org/10.1111/ases.12453
30. Suresh A, Kandhasamy SC, Sahoo AK, Amaranathan A, Prasad NRV (2018) A masquerading and unconventional cause of dynamic intestinal obstruction: strangulated obturator hernia. Cureus. https://doi.org/10.7759/cureus.2124
31. Pavlidis E, Kosmidis C, Sapalidis K, Tsakalidis A, Giannakidis D, Rafailidis V, Koimtzis G, Kesisoglou I (2018) Small bowel obstruction as a result of an obturator hernia: a rare cause and a challenging diagnosis. J Surg Case Rep 2018(7):rjy161. https://doi.org/10.1093/jscr/rjy161
32. Otsuki Y, Konn H, Takeda K, Koike M (2018) Midline extraperitoneal approach for obturator hernia repair. Keio J Med 67(4):67–71. https://doi.org/10.2302/kjm.2017-0014-OA
33. Mitchell A, Morera DS, Holsten S (2018) Surgical management of an obturator hernia. Am Surg 84(9):e403–e404
34. Kordzadeh A, Charalabopoulos A (2018) The little old lady's hernia. Surgery 163(2):482. https://doi.org/10.1016/j.surg.2017.08.004
35. Hatipoğlu E, Dal F, Umman V, Demiryas S, Demirkıran O, Ertem M, Ergüney S, Pekmezci S (2018) Rare case of bilateral incarcerated obturator hernia: a case report. Ulus Travma Acil Cerrahi Derg 24(3):278–280. https://doi.org/10.5505/tjtes.2018.36559
36. Daskalopoulou D, Kankam J, Plambeck J, Ambe PC, Zarras K (2018) Intraoperative real-time fluorescence angiography with indocyanine green for evaluation of intestinal viability during surgery for an incarcerated obturator hernia: a case report. Patient Saf Surg 12:24. https://doi.org/10.1186/s13037-018-0173-1
37. Conti L, Baldini E, Capelli P, Capelli C (2018) Bowel obstruction in obturator hernia: a challenging diagnosis. Int J Surg Case Rep 42:154–157. https://doi.org/10.1016/j.ijscr.2017.12.003
38. Ayoub K, Mahli N, Dabbagh MF, Banjah B, Banjah B (2018) Left sided Richter type obturator hernia causing intestinal obstruction: a case report. Ann Med Surg (Lond) 36:1–4. https://doi.org/10.1016/j.amsu.2018.10.011
39. Sá NC, Silva VCM, Carreiro PRL, Matos Filho AS, Lombardi IA (2017) Rare case of incarcerated obturator hernia: case report and review of literature. Int J Surg Case Rep 37:157–160. https://doi.org/10.1016/j.ijscr.2017.06.024
40. Oviedo RJ, Molinari AHW (2017) Emergency incarcerated obturator hernia repair with biologic mesh in a male patient after ipsilateral hip disarticulation: a case report. Int J Surg Case Rep 37:41–44. https://doi.org/10.1016/j.ijscr.2017.06.003
41. Liu J, Zhu Y, Shen Y, Liu S, Wang M, Zhao X, Nie Y, Chen J (2017) The feasibility of laparoscopic management of incarcerated obturator hernia. Surg Endosc 31(2):656–660. https://doi.org/10.1007/s00464-016-5016-5
42. Kohga A, Kawabe A, Cao Y, Yajima K, Okumura T, Yamashita K, Isogaki J, Suzuki K (2017) Elective laparoscopic repair after reduction might be useful strategy for incarcerated obturator hernia: a case report. J Surg Case Rep 2017(9):rjx180. https://doi.org/10.1093/jscr/rjx180
43. Durgakeri P, Strauss P, Jones B (2017) Obturator hernia: the 'little old lady's hernia'. ANZ J Surg 87(5):412–414. https://doi.org/10.1111/ans.12903
44. Chen D, Fei Z, Wang X (2017) Bowel obstruction secondary to incarcerated obturator hernia. Asian J Surg 40(3):193–196. https://doi.org/10.1016/j.asjsur.2015.08.003
45. Caine EA, Newman TH, Marzouk O, Lynes K, Akhtar M (2017) Subacute bowel obstruction secondary to an obturator hernia: case report and a review of the literature. J Surg Case Rep 2017(4):rjx061. https://doi.org/10.1093/jscr/rjx061
46. Cahais J, Lupinacci RM, Valverde A (2017) Laparoscopic treatment for stranguled obturator hernia (with video). J Visc Surg 154(5):377–378. https://doi.org/10.1016/j.jviscsurg.2017.08.008
47. Xue H, Fu Y, Cui LG (2016) Small bowel obstruction secondary to obturator hernia preoperatively diagnosed by ultrasound. Chin Med J (Engl) 129(4):490–491. https://doi.org/10.4103/0366-6999.176078
48. Şenol K, Bayam ME, Duman U, Dilektaşlı E, Doğangün M, İnal A, Tihan DN (2016) Challenging management of obturator hernia: a report of three cases and literature review. Ulus Travma Acil Cerrahi Derg 22(3):297–300. https://doi.org/10.5505/tjtes.2015.17163
49. Santorelli C, Leo CA, Hodgkinson JD, Rossi P (2016) Coexisting incarcerated femoral and obturator hernia: a case report. G Chir 37(4):171–173. https://doi.org/10.11138/gchir/2016.37.4.171
50. Rangarajan K, Fernandes R, Venkatasubramaniam A (2016) Emergency laparoscopic repair of an incarcerated obturator

hernia—a video vignette. Colorect Dis 18(3):316–317. https://doi.org/10.1111/codi.13264

51. Malik MU, Connelly TM, Hamid M, Pretorius F (2016) Laparoscopic total extraperitoneal repair of preoperatively diagnosed bilateral obturator and incidental bilateral femoral herniae. BMJ Case Rep. https://doi.org/10.1136/bcr-2016-214978
52. Leitch MK, Yunaev M (2016) Difficult diagnosis: strangulated obturator hernia in an 88-year-old woman. BMJ Case Rep. https://doi.org/10.1136/bcr-2016-215428
53. Belli AK, Memiş G, Dere Ö, Koşan U, Nazlı O (2016) Obturator hernia should be considered in the differential diagnosis of hip and knee pain. Ulus Travma Acil Cerrahi Derg 22(6):575–577. https://doi.org/10.5505/tjtes.2016.91582
54. Wakasugi M, Masuzawa T, Tei M, Omori T, Ueshima S, Tori M, Akamatsu H (2015) Single-incision laparoscopic totally extraperitoneal obturator hernia repair in a patient on antiplatelet therapy: a case report. Asian J Endosc Surg 8(1):83–86. https://doi.org/10.1111/ases.12132
55. Wada Y, Ohtsuka H, Adachi K (2015) Laparoscopic views of obturator hernia. J Gastrointest Surg 19(10):1925–1926. https://doi.org/10.1007/s11605-015-2881-5
56. Seppälä TT, Tuuliranta M (2015) Coexisting ipsilateral right femoral hernia and incarcerated obturator hernia. BMJ Case Rep. https://doi.org/10.1136/bcr-2014-208361
57. Nazarian S, Narayanan A, Chang S (2015) Diagnosis of an obturator hernia by CT. BMJ Case Rep. https://doi.org/10.1136/bcr-2015-212239
58. Mitchell DE, Yunaev M (2015) Acute appendicitis within an obturator hernia. BMJ Case Rep. https://doi.org/10.1136/bcr-2015-211416
59. Kubo N, Yoshizawa Z, Hanaoka T, Nakamura K (2015) A case of a perforated obturator hernia with a femoral abscess treated a pectineus muscle flap. BMC Surg 15:107. https://doi.org/10.1186/s12893-015-0095-0
60. Killeen S, Buckley C, Smolerak S, Winter DC (2015) Small bowel obstruction secondary to right obturator hernia. Surgery 157(1):168. https://doi.org/10.1016/j.surg.2013.05.032
61. Jayant K, Agarwal R, Agarwal S (2015) Richter type of incarcerated obturator hernia; misery still continues. Pol Przegl Chir 86(10):490–492. https://doi.org/10.2478/pjs-2014-0087
62. Hayama S, Ohtaka K, Takahashi Y, Ichimura T, Senmaru N, Hirano S (2015) Laparoscopic reduction and repair for incarcerated obturator hernia: comparison with open surgery. Hernia 19(5):809–814. https://doi.org/10.1007/s10029-014-1328-3
63. Arif A, Abideen ZU, Zia N, Khan MA (2015) Perforated obturator Littr hernia in an elderly woman. Ann Saudi Med 35(4):324–326. https://doi.org/10.5144/0256-4947.2015.324
64. Togawa Y, Muronoi T, Kawaguchi H, Chiku T, Sano W, Hashiba T, Ueda A, Kaneoya K (2014) Minimal incision transinguinal repair for incarcerated obturator hernia. Hernia 18(3):407–411. https://doi.org/10.1007/s10029-013-1095-6
65. Tateno Y, Adachi K (2014) Sudden knee pain in an underweight, older woman: obturator hernia. Lancet 384(9938):206. https://doi.org/10.1016/s0140-6736(14)60883-7
66. Peter R, Indiran V, Kannan K, Maduraimuthu P, Varadarajan C (2014) Rare case of obturator hernia in a patient with Marfan's syndrome. Hernia 18(3):439–442. https://doi.org/10.1007/s10029-014-1216-x
67. Otowa Y, Kanemitsu K, Sumi Y, Nakamura T, Suzuki S, Kuroda D, Kakeji Y (2014) Laparoscopic trans-peritoneal hernioplasty (TAPP) is useful for obturator hernias: report of a case. Surg Today 44(11):2187–2190. https://doi.org/10.1007/s00595-013-0694-2
68. Khaladkar SM, Kamal A, Garg S, Kamal V (2014) Bilateral obturator hernia diagnosed by computed tomography: a case report with review of the literature. Radiol Res Pract 2014:625873. https://doi.org/10.1155/2014/625873
69. Kao SY, Lee TC, Weng ZC, Chen TH, Tsai PJ (2014) Treatment of obturator hernia in a patient undergoing peritoneal dialysis. Perit Dial Int 34(7):803–805. https://doi.org/10.3747/pdi.2013.00116
70. Gupta R, Singh H, Kang M, Singh R (2014) Strangulated obturator hernia. BMJ Case Rep. https://doi.org/10.1136/bcr-2014-207071
71. Blach O, Ghosh A (2014) 'Little old lady's hernia' causing small bowel obstruction in a man: a case report with a review of literature on the pathophysiology of obturator hernias. BMJ Case Rep. https://doi.org/10.1136/bcr-2014-206574
72. Watanabe M, Kou T, Kawamoto H, Yazumi S (2013) Obturator hernia. Intern Med 52(11):1269. https://doi.org/10.2169/internalmedicine.52.0307
73. Lynch NP, Corrigan MA, Kearney DE, Andrews EJ (2013) Successful laparoscopic management of an incarcerated obturator hernia. J Surg Case Rep. https://doi.org/10.1093/jscr/rjt050
74. Kulkarni SR, Punamiya AR, Naniwadekar RG, Janugade HB, Chotai TD, Vimal Singh T, Natchair A (2013) Obturator hernia: a diagnostic challenge. Int J Surg Case Rep 4(7):606–608. https://doi.org/10.1016/j.ijscr.2013.02.023
75. Karasaki T, Nakagawa T, Tanaka N (2013) Obturator hernia of the fallopian tube. Abdom Imaging 38(3):619–621. https://doi.org/10.1007/s00261-012-9962-7
76. Hodgins N, Cieplucha K, Conneally P, Ghareeb E (2013) Obturator hernia: a case report and review of the literature. Int J Surg Case Rep 4(10):889–892. https://doi.org/10.1016/j.ijscr.2013.07.012
77. Aydin I, Yucel AF, Pergel A, Sahin DA (2013) Obturator hernia: a rare case of acute mechanical intestinal obstruction. Case Rep Surg 2013:256062. https://doi.org/10.1155/2013/256062
78. Cai XY, Song XY, Cai XJ (2012) Strangulated intestinal obstruction secondary to a typical obturator hernia: a case report with literature review. Int J Med Sci 9(3):213–215. https://doi.org/10.7150/ijms.3894
79. Liao CF, Liu CC, Chuang CH, Hsu KC (2010) Obturator hernia: a diagnostic challenge of small-bowel obstruction. Am J Med Sci 339(1):92–94. https://doi.org/10.1097/MAJ.0b013e3181bc2129
80. Murai S, Akatsu T, Yabe N, Inoue Y, Akatsu Y, Kitagawa Y (2009) Impacted obturator hernia treated successfully with a Kugel repair: report of two cases. Surg Today 39(9):821–824. https://doi.org/10.1007/s00595-008-3922-4
81. Mantoo SK, Mak K, Tan TJ (2009) Obturator hernia: diagnosis and treatment in the modern era. Singapore Med J 50(9):866–870
82. Uludag M, Yetkin G, Kebudi A, Isgor A, Akgun I, Dönmez AG (2006) A rare cause of intestinal obstruction: incarcerated femoral hernia, strangulated obturator hernia. Hernia 10(3):288–291. https://doi.org/10.1007/s10029-006-0074-6
83. Chang SS, Shan YS, Lin YJ, Tai YS, Lin PW (2005) A review of obturator hernia and a proposed algorithm for its diagnosis and treatment. World J Surg 29(4):450–454. https://doi.org/10.1007/s00268-004-7664-1**(discussion 454)**
84. Shipkov CD, Uchikov AP, Grigoriadis E (2004) The obturator hernia: difficult to diagnose, easy to repair. Hernia 8(2):155–157. https://doi.org/10.1007/s10029-003-0177-2
85. Nakayama T, Kobayashi S, Shiraishi K, Nishiumi T, Mori S, Isobe K, Furuta Y (2002) Diagnosis and treatment of obturator hernia. Keio J Med 51(3):129–132. https://doi.org/10.2302/kjm.51.129
86. Haith LR Jr, Simeone MR, Reilly KJ, Patton ML, Moss BE, Shotwell BA (1998) Obturator hernia: laparoscopic diagnosis and repair. Jsls 2(2):191–193

87. Skandalakis LJ, Androulakis J, Colborn GL, Skandalakis JE (2000) Obturator hernia. Embryology, anatomy, and surgical applications. Surg Clin N Am 80(1):71–84. https://doi.org/10.1016/s0039-6109(05)70398-4
88. Callaghan CJ, Whitaker RH (2002) Obturator canal fat plug: a pre-hernial condition? Clin Anat 15(4):276–279. https://doi.org/10.1002/ca.10025
89. Perry CP, Echeverri JD (2006) Hernias as a cause of chronic pelvic pain in women. JSLS 10(2):212–215
90. Shapiro K, Patel S, Choy C, Chaudry G, Khalil S, Ferzli G (2004) Totally extraperitoneal repair of obturator hernia. Surg Endosc 18(6):954–956. https://doi.org/10.1007/s00464-003-8212-z
91. Rodriguez-Hermosa JI, Codina-Cazador A, Maroto-Genover A, Puig-Alcantara J, Sirvent-Calvera JM, Garsot-Savall E, Roig-Garcia J (2008) Obturator hernia: clinical analysis of 16 cases and algorithm for its diagnosis and treatment. Hernia 12(3):289–297. https://doi.org/10.1007/s10029-007-0328-y
92. WHO (2000) Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser., vol 894
93. Kammori M, Mafune K, Hirashima T, Kawahara M, Hashimoto M, Ogawa T, Ohta H, Hashimoto H, Kaminishi M (2004) Forty-three cases of obturator hernia. Am J Surg 187(4):549–552. https://doi.org/10.1016/j.amjsurg.2003.12.041
94. Nasir BS, Zendejas B, Ali SM, Groenewald CB, Heller SF, Farley DR (2012) Obturator hernia: the Mayo Clinic experience. Hernia 16(3):315–319. https://doi.org/10.1007/s10029-011-0895-9
95. J. A (1997) Hernia. In: Zinner MJSS, Ellis H (eds) Maingot's abdominal operation, 10th edn. Appleton and Lange, Connecticut, pp 479–580
96. Yokoyama T, Kobayashi A, Kikuchi T, Hayashi K, Miyagawa S (2011) Transabdominal preperitoneal repair for obturator hernia. World J Surg 35(10):2323–2327. https://doi.org/10.1007/s00268-011-1211-7
97. Yip AW, AhChong AK, Lam KH (1993) Obturator hernia: a continuing diagnostic challenge. Surgery 113(3):266–269
98. Young A, Hudson DA, Krige JE (1988) Strangulated obturator hernia: can mortality be reduced? South Med J 81(9):1117–1120. https://doi.org/10.1097/00007611-198809000-00013
99. Ziegler DW, Rhoads JE Jr (1995) Obturator hernia needs a laparotomy, not a diagnosis. Am J Surg 170(1):67–68. https://doi.org/10.1016/s0002-9610(99)80256-6
100. Fevang BT, Fevang J, Stangeland L, Soreide O, Svanes K, Viste A (2000) Complications and death after surgical treatment of small bowel obstruction: a 35-year institutional experience. Ann Surg 231(4):529–537. https://doi.org/10.1097/00000658-200004000-00012
101. Cueto-Garcia J, Rodriguez-Diaz M, Elizalde-Di Martino A, Weber-Sanchez A (1998) Incarcerated obturator hernia successfully treated by laparoscopy. Surg Laparosc Endosc 8(1):71–73
102. Miki Y, Sumimura J, Hasegawa T, Mizutani S, Yoshioka Y, Sasaki T, Kamike W, Ito T, Monta O, Nagai I (1998) A new technique of laparoscopic obturator hernia repair: report of a case. Surg Today 28(6):652–656. https://doi.org/10.1007/s005950050201
103. Tucker JG, Wilson RA, Ramshaw BJ, Mason EM, Duncan TD, Lucas GW (1995) Laparoscopic herniorrhaphy: technical concerns in prevention of complications and early recurrence. Am Surg 61(1):36–39
104. Felix EL, Michas CA, Gonzalez MH Jr (1995) Laparoscopic hernioplasty. TAPP vs TEP Surg Endosc 9(9):984–989. https://doi.org/10.1007/bf00188456
105. Deeba S, Purkayastha S, Darzi A, Zacharakis E (2011) Obturator hernias: a review of the laparoscopic approach. J Minim Access Surg 7(4):201–204. https://doi.org/10.4103/0972-9941.85642
106. Martinez Insua C, Costa Pereira JM, Cardoso de Oliveira M (2001) Obturator hernia: the plug technique. Hernia 5(3):161–163. https://doi.org/10.1007/s100290100018
107. Yau KK, Siu WT, Chau CH, Yang PC, Li MK (2005) Laparoscopic management of incarcerated obturator hernia. Can J Surg 48(1):76–77
108. Tchupetlowsky S, Losanoff J, Kjossev K (1995) Bilateral obturator hernia: a new technique and a new prosthetic material for repair—case report and review of the literature. Surgery 117(1):109–112. https://doi.org/10.1016/s0039-6060(05)80237-5
109. Karasaki T, Nomura Y, Tanaka N (2014) Long-term outcomes after obturator hernia repair: retrospective analysis of 80 operations at a single institution. Hernia 18(3):393–397. https://doi.org/10.1007/s10029-013-1159-7
110. Sawayama H, Kanemitsu K, Okuma T, Inoue K, Yamamoto K, Baba H (2014) Safety of polypropylene mesh for incarcerated groin and obturator hernias: a retrospective study of 110 patients. Hernia 18(3):399–406. https://doi.org/10.1007/s10029-013-1058-y
111. Wu JM, Lin HF, Chen KH, Tseng LM, Huang SH (2006) Laparoscopic preperitoneal mesh repair of incarcerated obturator hernia and contralateral direct inguinal hernia. J Laparoendosc Adv Surg Tech A 16(6):616–619. https://doi.org/10.1089/lap.2006.16.616
112. Hunt L, Morrison C, Lengyel J, Sagar P (2009) Laparoscopic management of an obstructed obturator hernia: should laparoscopic assessment be the default option? Hernia 13(3):313–315. https://doi.org/10.1007/s10029-008-0438-1