EURASIAN JOURNAL OF EMERGENCY MEDICINE
Review
DOI: 10.4274/eajem.galenos.2019.21033
Eurasian J Emerg Med. 2019;18(3): 157-65

Heimlich Maneuver Complications: A Systematic Review

Mohsen Ebrahimi[1], Amir Mirhaghi[2]

[1]Department of Emergency Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
[2]Nursing and Midwifery Care Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

Abstract

Aim: Life-threatening complications have been reported due to the widespread use of the Heimlich maneuver. As the extent of associated injuries has not been well established, a systematic review of the complications of the Heimlich maneuver was conducted.

Materials and Methods: Studies were identified through literature search in MEDLINE, Web of Science and SCOPUS up to August, 2018 with keywords related to "Heimlich maneuver" and "Abdominal thrust". The inclusion criteria were defined as case reports reporting complications due to the Heimlich maneuver and case reports with documented injuries. Original studies, reviews, conference proceedings, commentaries, and case reports with incomplete data were excluded. The CARE (CAse REport) guideline was used to assess the quality of case reports

Results: Forty-eight eligible studies involving 51 cases were included. Patient median age was 62 years and 35% of them were female. Dyspnea and abdominal pain were the most common symptoms. Gastric rupture was more likely to be associated with hospital admission, but mortality was most associated with aorta injury. Twenty-five percent of cases with organ damage survived.

Conclusion: According to case reports, the Heimlich maneuver is associated with serious complications especially in elderly patients. Life threatening injuries associated with the Heimlich maneuver suggest that this procedure should be substituted with a safer procedure such as chest thrusts or chest compressions. Investigation of an alternative procedure to remove foreign body airway obstruction is recommended in further studies.

Keywords: Heimlich maneuver, abdominal thrust, chocking, first aid

Introduction

The Heimlich maneuver was introduced in 1974 in order to prevent death from food asphyxiation (1). It is clear that any person informed on the procedure can perform the maneuver by not needing any special instrument. The elderly as a vulnerable population are predominantly affected by the Heimlich maneuver (2). Elderly patients are highly susceptible to choking due to neuromuscular disorders such as age-related changes of the nervous system, muscular dystrophy and dental problems which put them into a riskier situation during swallowing. Defective laryngeal closure, failure of bolus containment, transitional phase dissociation, and incomplete bolus transport are the main oropharyngeal abnormalities that are associated with choking episode (3). The elderly people may be even accompanied by frailty and comorbidity (2). Therefore, elderly patients received Heimlich maneuver more commonly than any other populations. Soon after, "a quick upward thrust" (abdominal thrust) became the weakest link due to excessive force directed to internal organs especially in the elderly. Although the American Medical Association endorsed the Heimlich maneuver in 1975 (4), the aggressive nature of the Heimlich maneuver raised concern about the safety measures among academic community. Despite the widespread use due to the fact that it was simple to learn and effective to save lives, academic community remained suspicious (5). They conducted research on choking animals and even humans to examine the underlying mechanism (6-8), and also published case reports of serious complications. One year later, a case of

Corresponding Author: Amir Mirhaghi, Nursing and Midwifery Care Research Center, Mashhad University of Medical Sciences, Mashhad, Iran
Phone: +98 51 38591511 **E-mail:** mirhaghi@mail.com **ORCID ID:** orcid.org/0000-0002-4482-1156
Cite this article as: Ebrahimi M, Mirhaghi A. Heimlich Maneuver Complications: A Systematic Review. Eurasian J Emerg Med. 2019;18(3):157-65.

Received: 06.08.2019
Accepted: 22.08.2019

ruptured stomach was the first documented life threatening complication. Since then,complications of the Heimlich maneuver have been reported in a consistent manner each year up to now (9). Injuries to the stomach, intestine, pancreas, aorta, esophagus and ribs were reported in the literature (2,10). Despite the poor generalizability and weak cause-effect relationship, case reports have a unique ability to be novel and hypothetic as well as explanatory (11). The educational merit of case report is also remarkable. Growing evidence of serious complications suggests that there is a genuine need to perform a systematic review on the case reports of the Heimlich maneuver. In addition, the Heimlich maneuver is mainly supported by editorial and commentaries and also it suffers from lack of evidence, so case reports are the most reliable evidence in this situation. The study aimed to systematically review the case reports on the Heimlich maneuver complications.

Materials and Methods

MEDLINE, Web of Science, and Scopus were searched beginning from their starting date to August, 2018. The search keywords were detailed asHeimlich maneuver, Heimlich manoeuvreand abdominal thrust. Duplicated citations were removed. Abstracts were initially screened to reveal relevant case reports. The inclusion criteria were defined as (1) case reports reporting complications due to the Heimlich maneuver and (2) case reports with documented injuries. Original studies, reviews, conference proceedings, commentaries, and case reports with incomplete data were excluded. All abstracts published in English were retrieved. The citation lists of included case reports were screened to discover additional case reports which might have been missed in primary search. Search strategy was illustrated in Figure 1.

Data including first author, year of publication, sex, age, event, chief complaint, type of the Heimlich maneuver intervention, role of caregiver who performed the Heimlich maneuver, main complications, comorbidity, treatment plan, and mortality status were collected. Two independent researchers (A.M. and M.E.) reviewed studies. Disagreements were resolved by consensus. The CARE (CAse REport) guideline was used to assess the quality of case reports (12). Systematic data collection according to the CARE guideline provides evidence to evaluate case reports which have been published in medical literature.

Results

Two hundred potential studies through Medline, 205 through Web of Science and 331 through Scopus were identified. Three hundred and twenty-eight of them were excluded due to duplication. Initial screening excluded 317 abstracts because they were unrelated, original research, commentary and review studies. As a result, full-text analyses of 91 remaining studies were performed. Secondary screening excluded 47 articles. Four articles were retrieved from reference list. The final inclusion covered 48 articles (Figure 1). The characteristics of all included studies are summarized in Appendix A. All relevant case reports met minimum requirements to be included in regard to the quality assessment.

The median age of the patients was 62 years and it ranged from 3 to 93 years and 31% were older than 75 years. Thirty-five percent of patients were female. The most common chief complaints were dyspnea and abdominal pain. Patients had generally received the Heimlich maneuver from bystanders rather than health care providers. Gastric rupture was more likely to be associated with hospital admission, but mortality was most associated with aorta injury. Forty-one percent of cases suffered from comorbidities. Forty percent of cases underwent surgery to repair injuries. Twenty-five percent of cases who had organ damage survived. The details of injures are presented in Appendix A. A summary of injuries associated with the Heimlich maneuver is detailed in Table 1.

Discussion

The most common injury was gastric rupture, which is reported by academic community. The lesser curvature of the stomach is ruptured in most cases. Weak abdominal muscles, especially

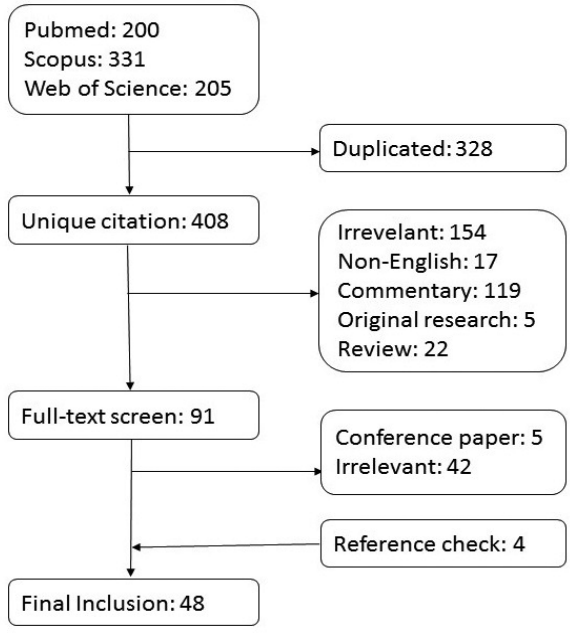

Figure 1. Flowchart of the litarature search and exclusion process

Table 1. Summary of reported injuries associated with Heimlich maneuver

Organs	Studies (Sample size)	Gender	Age	Common symptoms	Complication	Treatment	Mortality
Lung							
Edema 7,12,24,43,44,47*	5 (6)	1 F: 5 M	13 (5-50)	Dyspnea; emesis; altered mental status	Post-obstructive pulmonary edema; diffuse patchy lobular airspace disease	Supportive care	0
Pneumomediastinum 1,14,22	3 (3)	3 M	3, 19, 39	Sore throat;dyspnea; collapsed	Pneumomediastinum	Surgery; CPR	1
Emphysema 38	1 (1)	1 M	56	Dyspnea	Emphysematous bulla in apical region	Surgery	0
Ribs							
Fracture 16,18,30	3 (3)	3 F	72, 79, 90	Chest pain; pleuritic pain	Rib fractures	Supportive	0
Diaphragm							
Rupture 26,48	2 (2)	2 F	85, 85	Dyspnea	Hiatal hernia	Surgery	0
Esophagus							
6	1 (1)	1 F	45	Subcutaneous emphysema	Pharyngoesophageal perforation	Surgery	0
25,28,37,41	4 (4)	2 F: 2 M	16,56, 61,62	Odynophagia; dyspnea and chest pain	Perforation of the esophagus	Surgery	0
Stomach							
Lesser curve 4,5,9,13,17,19,23,34,50,51	9 (10)	4 F: 3 M	74 (57-93)	Abdominal pain	Gastric rupture along the lesser curvature of the stomach	Surgery	3
Volvulus 36	1 (1)	1 F	10	Abdominal pain	Mesenteroaxial gastric volvulus	Surgery	0
Pancreas							
20,29	2 (2)	2 M	3, 11	Abdominal pain	Transection; cystic mass	Surgery	0
Liver							
39,46	2 (2)	2 M	84, 88	Abdominal pain	Laceration in the hepatic lobe	Surgery	0
Small intestine							
42	1 (1)	1 M	22	Vomiting	Jejunum perforation	Surgery	0
Spleen							
8	1 (1)	1 M	83	Unconscious	Laceration of spleen	CPR	1
Aorta							
Thrombosis 2,27,32,33,35,35	5 (6)	2 F: 4 M	80 (69-84)	Paraplegia	Thrombosis and occlusion in aorta	Surgery	5
Tear 15,21,49	3 (3)	2 F: 1 M	61, 76, 78	Dyspnea; unconscious; abdominal pain	Dissection of aortic wall	Surgery	3
Valve 10,40	2 (2)	1 F: 1 M	74, 86	Dyspnea	Acute aortic regurgitation	Surgery; supportive	0
Stent displacement 31	1 (1)	1 M	63	Abdominal discomfort	Proximal type 1 endoleak	Surgery	0
Vertebra							
11	1 (1)	1 F	80	Back pain	Acute compression deformities at L1-2 levels	Kyphoplasty	0
Shoulder							
3	1 (1)	1 M	48	Shoulder pain	Rotator cuff tear	Surgery	0

*Numbers in Table 1 are associated with reference list in Appendix A

in the elderly patients cannot protect internal organs compared to those in adults. It is expected that the lesser curvature of the stomach is the most common site of involvement because it directly receives the force generated by abdominal thrust. Upward thrust above the novel generates excessive force toward the stomach. Heimlich stated that "place your fist (thumb side against the victim's abdomen) slightly above the novel and below the rib cage and grasp your fist with your other hand and press into the victim's abdomen with a quick upward thrust.", so there is a great possibility of the lesser curvature injury especially when the stomach is distended after eating a meal (1). The missing link is the fact that no instruction about how much force is required to dislodge the foreign body is given. An adult is able to produce an excessive force through an abdominal thrust which is unbearable for a senior adult or a child, resulting in fatal internal injury. A hypothesis that a choking person may benefit most from the Heimlich maneuver which is adjusted for a person at the same age may arise. There is a necessity to address this issue in further studies.

It is argued that the Heimlich maneuver may not always be the procedure of choice in all situations (13). For example, a large piece of meat can likely be dislodged by the Heimlich maneuver than more viscous materials such as peanut butter. In such situation, finger sweep technique may be more effective than the Heimlich maneuver to resolve choking especially in children. The Heimlich maneuver may not be the procedure of choice in case of esophageal impaction either. Esophageal impaction may happen in individuals who are able to vocalize during the choking. There is great possibility that untrained people may not distinguish a pseudo-choking state from an airway obstruction episode (14). In such situation, the application of abdominal thrust causes an increase in intraluminal pressures in internal organs. Impacted food in esophagus deteriorates the situation because it does not allow the pressure to be diminished and weak structure of esophagus escalates injury to a life threatening condition (4). Many scholars argued that untrained rescuers may be a part of this puzzle.

This review shows that patients may suffer from serious injuries in spite of professional help received from trained people such as nurses. Razaboni et al. (15) reported a case of jejunum perforation, who received abdominal thrust from a trained rescuer. It implies that excessive force may play a greater role than proper technique in developing injuries. The risk is much higher in choking persons with comorbidities, suggesting that individual characteristics are influential indeed. In addition, experimental studies have indicated that the intrathoracic pressure induced by upward abdominal thrust does not differ from backward abdominal thrust significantly; implying that rescuers may not require to perform the Heimlich maneuver in upward direction necessarily (16). In this way, Roehm et al. (17) argued that abdominal thrust without any upward motion may result in an increased risk of trauma to the abdominal aorta. Therefore, it can be concluded that excessive force apart from upward or backward direction is strongly associated with internal organ damage.

Alternative maneuvers: WhileAmerican Red Cross and European Resuscitation Council endorse abdominal thrusts to manage foreign body airway obstruction (FBAO) (18), the Australian and New Zealand Committee on Resuscitation (ANZCOR) does not recommend abdominal thrusts in the management of FBAO due to life-threatening complications (ANZCOR) (19). Instead, back blows and chest thrusts have been endorsed by ANZCOR. Apart from life threatening complications associated with the Heimlich maneuver, literature suggests that chest compression may produce more peak airway pressure than the Heimlich maneuver. Langhelle et al. (6) indicated that chest compression was more effective than the Heimlich maneuver in managing FBAO in unconscious patients. They showed that peak airway pressure was significantly lower with abdominal thrusts compared to chest compressions (26.4±19.8 versus 40.8±16.4 cmH_2^o) among 12 unselected cadavers. In this way, Guildner et al. (20) concluded both the chest thrusts produced significantly better results than did the abdominal thrust on six adult male anesthetized volunteers and introduced chest thrust as technique of choice. Therefore, it raises concern about widespread interest and popularity of the Heimlich maneuver. In fact, experiments show that chest thrusts are more effective than abdominal thrust in terms of generating higher peak airway pressure.

In addition, several studies have been performed on airway peak pressure in different positions to simulate choking episode. Pavitt et al. (16) indicated that self-administered thrusts over the back of a chair delivered significantly greater pressure than the Heimlich maneuver did and it might increase the chance of injury, too. A manikin study revealed that the lying down abdominal thrust was associated with higher peak pressures than the standing abdominal thrust (22.6±2.8 versus 11.5±2.6) (7). However, another study indicated that abdominal thrusts produced greater airway pressure than chest thrusts among pigs (13.8±6.7 versus 6.5±3), the major difference in the chest anatomy between human and pig weakens the generalizability of findings (21,22). Finally, Blain et al. (23) proposed the table maneuver as a safer alternative to the Heimlich maneuver. It is performed by giving sharp blows in a choking person who has been laid down on a table in the prone position with the head facing downwards and the arms hanging over the side of the table. They argued that this maneuver was associated with better results than the Heimlich maneuver.

Appendix A. Reported complications associated with Heimlich maneuver

No	Study	Sex	Age	Event	Compliant	Intervention	Caregiver	Complication	Comorbidity	Treatment plan	Mortality
1	Agia & Hurst (1979) (1)	Male	19	Airway obstruction due to food	Retrosternal discomfort and dyspnea	Heimlich maneuver	Bystander	Pneumomediastinum	-	Pharmacological treatment	No
2	Ayerdi et al. (2002) (2)	Male	70	Airway obstruction due to food	Paralysis of both legs	Heimlich maneuver	Bystander	Thrombosed 4.5 cm abdominal aortic aneurysm and right common iliac artery aneurysm	Right femoral bypass graft	Exploratory laparatomy	No
3	Baker & Mullet (2015) (3)	Male	48	Performed Heimlich maneuver on a fellow restaurant dinner	Left shoulder pain having begun 3 month ago	Heimlich maneuver	Bystander	Rotator cuff tear	-	Subacromial decompression and arthroscopic rotator cuff repair	No
4	Bintz & Cogbill (1996) (4)	-	-	Airway obstruction due to food	Abdominal pain	Heimlich maneuver	Bystander	Full-thickness gastric rupture along the lesser curvature of the stomach	-	Surgery	Yes
5	Bintz & Cogbill (1996) (4)	-	-	Airway obstruction due to food	Abdominal pain	Heimlich maneuver	Bystander	Full-thickness gastric rupture along the lesser curvature of the stomach	-	Surgery	No
6	Bouayed et al. (2015) (5)	Female	45	Airway obstruction due to food	Subcutaneous emphysema	Heimlich maneuver	Nurse	Pharyngoesophageal perforations and right piriform sinus fracture	Mentally disabled	Exploratory cervicotomy	No
7	Casoni et al. (2010) (6)	Male	13	Airway obstruction due to candy	Blood stained sputum	Heimlich maneuver	Bystander	Post-obstructive pulmonary edema	-	Supportive	No
8	Ceccheto et al. (2011) (7)	Male	83	Airway obstruction due to food	Unconscious	Heimlich maneuver as well as CPR	Nurse	Acute laceration of spleen	-	CPR protocol	Yes
9	Chao et al. (2012) (8)	Female	59	Airway obstruction due to food	Post CPR admission	Heimlich maneuver as well as CPR	EMT	Gastric perforation	-	Exploratory laparotomy	No
10	Chapman et al. (1983) (9)	Male	86	Airway obstruction due to food	Sever shortness of breath progressingover five days	Heimlich maneuver	Bystander	Acute aortic regurgitation	Mild aortic insufficiency	Pharmacologic treatment	No
11	Chillag et al. (2010) (10)	Female	80	Airway obstruction due to food	Incapacitating pain in back	Heimlich maneuver in two days earlier	Bystander	Acute compression deformities at L1-2 levels	Osteoporotic thoracic vertebral fractures	Kyphoplasty	No
12	Chien et al. (2007) (11)	Male	49	Airway obstruction due to food	Dyspnea	Heimlich maneuver	Bystander	Post-obstructive pulmonary edema	-	Supportive	No
13	Cowan et al. (1987) (12)	Male	74	Airway obstruction due to food	Abdominal discomfort	Heimlich maneuver as well as CPR	Bystander	Gastric perforation	Parkinson`s disease	Exploratory laparotomy	No

Appendix A. Contiuned

14	Croom (1983) (13)	Male	39	Airway obstruction due to food	Collapsed	Heimlich maneuver as well as CPR	Bystander	Pneumomediastinum	Cerebral palsy	CPR protocol	Yes
15	Desai et al. (2008) (14)	Female	78	Airway obstruction due to food	Unconscious	Heimlich maneuver	Nurse aid	Laceration and dissection of an atherosclerotic abdominal aortic wall	Schizophrenia	Exploratory laparotomy	Yes
16	Drinka (2009) (15)	Female	90	pseudochoking	Pleuritic pain	Heimlich maneuver	Nurse aid	Rib fracture	Hear failure	Monitoring	No
17	Dupre et al. (1993) (16)	Male	93	Airway obstruction due to food	Abdominal pain	Heimlich maneuver	Bystander	Gastric rupture	-	Exploratory laparotomy	No
18	Entel & Hakki (1996) (17)	Female	79	Airway obstruction	Chest pain	Heimlich maneuver	Bystander	Multiple rib fracture	-	Supportive treatment	No
19	Fearing & Harrison (2002) (18)	Female	74	Airway obstruction	Abdominal pain	Heimlich maneuver on supine	Bystander	Gastric rupture along the lesser curvature of the stomach	-	Surgery	No
20	Feeney et al. (2007) (19)	Male	11	Seizure	Abdominal pain	Heimlich maneuver	Bystander	Transection of the pancreas	-	Distal pancreatectomy	No
21	Feldman et al. (1986) (20)	Male	61	Airway obstruction due to food	Sharp chest pain and dyspnea progressed over five days	Heimlich maneuver	Bystander	Transverse tear of the aortic root	-	Surgery	Yes
22	Fink & Klein (1989) (21)	Male	3	Airway obstruction due to plastic toy	Sore throat	Heimlich maneuver	Bystander	Pneumomediastinum	-	Pharmacological treatment	No
23	Gallardo et al. (2003) (22)	-	-	Airway obstruction	-	Heimlich maneuver	-	Perforation of the lesser gastric curvature	-	Laparoscopic surgery	No
24	Galster et al. (2014) (23)	Female	50	Airway obstruction	Altered mental status	Heimlich maneuver	Bystander	Post-obstructive pulmonary edema	-	Pharmacological treatment	No
25	Haynes et al. (1984) (24)	Female	61	Airway obstruction due to food	Dyspnea and chest pain	Heimlich maneuver	Bystander	Perforation of the esophagus resulting in hydropneumothorax	-	Surgery	No
26	Herman et al. (2018) (25)	Female	85	Airway obstruction due to food	Dyspnea and pleuritic chest pain	Heimlich maneuver in supine position	Medical staff	Diaphragmatic rupture and hiatal hernia	-	Laparotomy	No
27	Kirshner & Green (1985) (26)	Male	69	Airway obstruction due to food	Unable to move leg	Heimlich maneuver	Bystander	Acute aortic occlusion due to thrombosis	Abdominal aortic aneurysm	Surgery	Yes
28	Koss et al. (2018) (27)	Male	16	Airway obstruction due to food	Throat pain and odynophagia in 5 days later	Heimlich maneuver	Bystander	Esophageal perforation	-	Surgery	No

Appendix A. Contiuned

29	Lee et al. (2002) (28)	Male	3	Airway obstruction due to food	Abdominal pain	Heimlich maneuver	Bystander	Cystic mass with a pancreatic pseudocyst	-	Percutaneous drainage of the pseudocyst	No
30	Lette et al. (1990) (29)	Female	72	Airway obstruction	Sharp chest pain	Heimlich maneuver	Bystander	Multiple rib fracture	-	Supportive treatment	No
31	Lin et al. (2003) (30)	Male	63	Airway obstruction due to food	mild abdominal discomfort	Heimlich maneuver	Bystander	proximal type I endoleak	Endovascular abdominal aortic aneurysm (AAA) repair with modular stent-graft devices	Surgery	No
32	Mack et al. (2002) (31)	Female	80	Airway obstruction due to food	Mottled from the umbilicus caudad with absent distal pulses	Heimlich maneuver on a prone	Bystander	Complete infrarenal aortic occlusion	debilitated	Surgery	Yes
33	Mack et al. (2002) (31)	Male	84	Airway obstruction due to food	Mottled from the groin distally	Heimlich maneuver on a prone	Bystander	Athrosclerotic infrarenal aorta with mural thrombus	debilitated	Surgery	Yes
34	Majumdar & Sedman (1998) (32)	Female	57	Airway obstruction due to food	Apneic arrest	Heimlich maneuver	Bystander	Injury in lesser curve of stomach	Metallic aortic valve	laparotomy	Yes
35	Martin et al. (2007) (33)	Male	81	Airway obstruction due to food	Low back pain	Heimlich maneuver	Bystander	Complete occlusion of the infra-renal abdominal aorta	Chronic obstructive pulmonary disease	Pharmacologic treatment	Yes
36	Matharoo et al. (2013) (34)	Female	10	Airway obstruction	Chest pain and abdominal pain	Self-administered Heimlich maneuver	Bystander	Mesenteroaxial gastric volvulus	-	Surgery	No
37	Meredith & liebowitz (1986) (35)	Male	62	Airway obstruction due to food	Chest pain and mild dyspnea	Heimlich maneuver	Bystander	Laceration on the right posterior esophagus	-	Surgery	No
38	Olenchock et al. (2004) (36)	Male	56	Airway obstruction	Dysphagia and shortness of breath	Heimlich maneuver	Bystander	Emphysematous bulla in the right apical region	Emphysema	Surgery	No
39	Otero Palleiro (2007) (37)	Male	88	Airway obstruction	Abdominal pain	Heimlich maneuver	Bystander	Laceration in the left hepatic lobe	-	Pharmacologic treatment	No
40	Passik et al. (1987) (38)	Female	74	Airway obstruction	Dyspnea	Heimlich maneuver	Bystander	Aortic valve insufficiency	Aortic valve replacement	Surgery	No
41	Pederson (2010) (39)	Female	56	Airway obstruction due to tablet	mild dyspnea	Heimlich maneuver	Bystander	Perforation of esophagus	-	Surgery	No
42	Razaboni et al. (1986) (40)	Male	22	Airway obstruction due to food	Vomiting	Heimlich maneuver	Bystander	Pneumoperitoneum due to jejunum perforation	Mentally retarded	Surgery	No

Appendix A. Contiuned

43	Ringold et al. (2004) (41)	Male	5	Airway obstruction due to food	Dyspnea	Heimlich maneuver as well as CPR	Bystander	Pulmonary edema	Reactive airway disease	CPR protocol	No
44	Ringold et al. (2004) (41)	Male	13	Airway obstruction due to food	Emesis	Heimlich maneuver	Bystander	Diffuse patchy lobular airspace disease	-	Pharmacologic treatment	No
45	Roehm et al. (1983) (42)	Male	62	Airway obstruction due to food	Pain in the lower extremities	Heimlich maneuver	Bystander	Completely occluded distal aorta	Pseudoaneurysm	Laparotomy	Yes
46	Tashtoush et al. (2015) (43)	Male	84	Airway obstruction due to food	unresponsiveness	Heimlich maneuver	Bystander	Hepatic rupture	-	Supportive care	No
47	Toukan et al. (2016) (44)	Male	12	Airway obstruction due to food	unconsciousness	Heimlich maneuver	Bystander	Post-obstructive pulmonary edema	-	Supportive	No
48	Truong et al. (2017) (45)	Female	85	Airway obstruction due to food	Dyspnea	Heimlich maneuver	Nurse	Increased hiatal hernia	Knee arthroplasty	Laparotomy	No
49	Valero (1986) (46)	Male	76	Airway obstruction due to tablet	Abdominal and leg pain	Heimlich maneuver on supine	Bystander	Tear in the root of mesentery	-	CPR	Yes
50	Van der Ham & lange (1990) (47)	Female	76	Airway obstruction due to food	Cyanosis	Heimlich maneuver on prone	Nurse	Rupture along the lesser curvature of the stomach	Depression	Laparotomy	Yes
51	Visintine & Baick (1975) (48)	Male	74	Airway obstruction due to food	Comatose	Heimlich maneuver	Bystander	Rupture along the lesser curvature of the stomach	-	Surgery	No

While case reports studies suffer from poor generalizability, systematic review of case series reveals cumulative effect of widespread application of the Heimlich maneuver. It is important because the Heimlich maneuver is mostly supported by editorial and there are a few studies on the efficacy of FBAO removal technique. Medical follow-up as well as alarming signs and symptoms must be considered as a key part of the Heimlich maneuver instruction. In this case, a correct estimation of complications of the Heimlich maneuver can be achieved. The Heimlich maneuver was introduced in 1974. Some journals were not published electronically in the 1970 decade, so there is a probability that some case reports would not be accessible to the electronic search.

Conclusion

Heimlich maneuver is associated with serious complications especially in elderly patients. Organ damage, especially abdominal aorta injury is the most common fatal injury. Life threatening injuries associated with Heimlich maneuver suggest that this procedure must be substituted with a safer procedure such as chest thrusts or chest compressions. Investigation of an alternative procedure to remove FBAO is recommended in further studies.

Ethics

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: N/A.

Concept: A.M., Design: A.M., M.E., Data Collection or Processing: A.M., M.E., Analysis or Interpretation: A.M., M.E., Literature Search: A.M., M.E., Writing: A.M., M.E.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. The Heimlich maneuver. Occupational health nursing. 1976;24:20-1.
2. Chillag S, Krieg J, Bhargava R. The Heimlich maneuver: breaking down the complications. South Med J. 2010;103:147-50.
3. Feinberg MJ, Ekberg O. Deglutition after near-fatal choking episode: radiologic evaluation. Radiology. 1990;176:637-40.
4. Valero V. Mesenteric laceration complicating a Heimlich maneuver. Ann Emerg Med. 1986;15:105-6.
5. Redding JS. The choking controversy: critique of evidence on the Heimlich maneuver. Critical care medicine. 1979;7:475-9.
6. Langhelle A, Sunde K, Wik L, Steen P. Airway pressure with chest compressions versus Heimlich manoeuvre in recently dead adults with complete airway obstruction. Resuscitation. 2000;44:105-8.
7. Sanuki T, Sugioka S, Son H, Kishimoto N, Kotani J. Comparison of two methods for abdominal thrust: a manikin study. Resuscitation. 2009;80:499-500.
8. Ichikawa M, Oishi S, Mochizuki K, Nitta K, Okamoto K, Imamura H. Influence of body position during Heimlich maneuver to relieve supralaryngeal obstruction: a manikin study. Acute Medicine & Surgery. 2017;4:418-25.
9. Visintine RE, Baick CH. Ruptured stomach after Heimlich maneuver. JAMA. 1975;234:415.
10. Fearing NM, Harrison PB. Complications of the heimlich maneuver: case report and literature review. J Trauma. 2002;53:978-9.
11. Nissen T, Wynn R. The clinical case report: a review of its merits and limitations. BMC Res Notes. 2014;7:264.
12. Gagnier JJ, Kienle G, Altman DG, Moher D, Sox H, Riley D. The CARE guidelines: consensus-based clinical case reporting guideline development. BMC Res Notes. 2013;7:223.
13. Brauner DJ. The Heimlich maneuver: procedure of choice? J Am Geriatr Soc. 1987;35:78.
14. Ekberg O, Feinberg M. Clinical and demographic data in 75 patients with near-fatal choking episodes. Dysphagia. 1992;7:205-8.
15. Razaboni RM, Brathwaite CE, Dwyer WA, Jr. Ruptured jejunum following Heimlich maneuver. J Emerg Med. 1986;4:95-8.
16. Pavitt MJ, Swanton LL, Hind M, Apps M, Polkey MI, Green M, et al. Choking on a foreign body: a physiological study of the effectiveness of abdominal thrust manoeuvres to increase thoracic pressure. Thorax. 2017;72:576-8.
17. Roehm EF, Twiest MW, Williams RC, Jr. Abdominal aortic thrombosis in association with an attempted Heimlich maneuver. JAMA. 1983;249:1186-7.
18. American Red Cross. Adult First Aid/CPR/AED. 2011.
19. The Australian and New Zealand Committee on Resuscitation (ANZCOR). ANZCOR Guidline 4 - Airway 2016 [Available from: https://resus.org.au/guidelines/#.
20. Guildner CW, Williams D, Subitch T. Airway obstructed by foreign material: the Heimlich maneuver. JACEP. 1976;5:675-7.
21. Lippmann J, Taylor DM, Slocombe R, McDonald CF, Walker T, Nolan G. Lateral versus anterior thoracic thrusts in the generation of airway pressure in anaesthetised pigs. Resuscitation. 2013;84:515-9.
22. Rottenberg EM. Could there ever be evidence to support using lateral chest thrusts in humans with the victim lying on their side to clear upper-airway obstruction? Resuscitation. 2013;84:e69.
23. Blain H, Bonnafous M, Grovalet N, Jonquet O, David M. The table maneuver: a procedure used with success in four cases of unconscious choking older subjects. Am J Med. 2010;123:1150.e7-9.