

# Closure Versus Non-Closure of Hernia Defect in Laparoscopic Ventral Hernia Repair with Mesh: A Systematic Review

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## Research Article

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# Abstract

## Purpose

There is a controversial premise about choosing a surgical approach in ventral hernia using laparoscopic repair. Some surgeons prefer to use mesh with closure while others prefer to use mesh without closure. This study aims to compare mainly the rate of recurrence in mesh repair with and without closure.

## Methods

A wide range of electronic bibliographic databases such as PubMed, Embase, and ERIC was searched. Based on the eligibility criteria, all studies which compared the results after hernia repair from 2010 to 2020, were incorporated. Following screening the abstracts, we ended up reviewing seven full-text articles, and data were extracted on important parameters such as demographic attributes of participants, sample size, and recurrence rate of hernia.

## Results

Of the total studies that were reviewed, three were randomized controlled trials (RCT's) and four retrospective observational studies. The sample size of all included studies varied between 80 to 176. The findings appear promising for the fascial closure as it showed an evidence of significant reduction in the recurrence rate with  $P = 0.047$  in one out of the three RCT's and in the retrospective observational studies reaching up to 16.7 % recurrence reduction rate. Likewise, there is also a reduction in the bulging, surgical site infection and seroma formation with higher patient's satisfaction and quality of life score.

## Conclusion

Primary fascial closure appears to be effective as it can decrease the rates of recurrence, seroma formation, bulging and improve patient's satisfaction and quality of life. Given the dearth of studies, mainly randomized controlled trials, there is a need to carry out large randomized controlled trials with enough follow-up.

# Introduction

Ventral hernias are widespread and difficult-to-treat surgical ailments [1]. Surgical repair is performed for most symptomatic umbilical hernias and can be done by different techniques, such as using mesh with and without closure. Many challenges have been faced by surgeons and patients in augmenting treatment regardless of the type of surgical procedure [2]. Surgeons debate the best possible treatment for managing ventral hernias. Currently, almost all surgeons prefer to use laparoscopic procedures rather than open surgery. Surgical repair for ventral hernias is often associated with surgical wound infection and hernia recurrence [3]. Although hernia repair using laparoscopic techniques has a lower incidence of surgical-site infection and a shorter length of stay, the incidence of wound-related problems and hernia recurrence has not improved. More specifically, complications, such as pain after surgery, admission to the hospital, surgical-site infection, and haematoma and seroma formation, are widely prevalent and considered the most common challenges after hernia repair [4]. Several researchers have reported better outcomes using laparoscopic surgery to repair ventral hernias, as it leads to fewer issues, minimizes the operative duration, reduces the length of stay, decreases the need for pain killers, and allows faster recovery to routine tasks than open surgery [5, 7]. Furthermore, it has been observed that surgeons prefer to use mesh to further reduce recurrence [8]. Some researchers have endorsed defect closure before laparoscopic mesh positioning to reconstruct the wall of the abdomen [9, 10]. However, others prefer to use only mesh without closure. Based on this evidence, to repair ventral or umbilical hernias, surgeons prefer to use a laparoscopic technique using mesh with or without defect closure. There is an increasing trend of repairing most ventral hernias using a laparoscopic technique and retaining an intraperitoneal onlay mesh, which effectively bridges the defect after reduction of the contents of the hernia but leaves the hernial pouch in situ [11].

However, there is still controversial evidence regarding the choice of the two procedures in terms of reducing the rate of recurrence or other complications. Thus, it is ambiguous which surgical technique should be considered best to repair an umbilical hernia. There have been very few observational and experimental studies comparing the outcomes of laparoscopic hernia repair using mesh with and without defect closure. However, the findings of those experimental and retrospective observational studies have not been synthesized by a systematic review. Therefore, we carried out this systematic review to answer the question of whether hernia repair using mesh with closure is better than hernia repair using mesh without closure. The purpose of this review was to synthesize the findings of existing studies comparing the outcomes of laparoscopic procedures with mesh for ventral hernia repair with and without defect closure.

# Material And Methods

We conducted a systematic review to evaluate, synthesize, and combine existing evidence on the findings of laparoscopic procedures using mesh with and without closure. The PRISMA guidelines were used to carry out this systematic review [12].

## **Inclusion and Exclusion Criteria**

To answer the study question, a study was eligible for inclusion if it aimed to compare the rate of recurrence or other complications after repair using a mesh with and without closure and was published in English between 2010 and 2020 anywhere in the world. Observational, analytical, and experimental studies were eligible for inclusion. Cross-sectional studies (or qualitative studies) and studies without the full text available were excluded. Studies consisting of opinions, criticisms of older research studies, and editorials were not included. The full text of studies that compared the outcomes of the two surgical procedures (mesh repair with and without closure) were scrutinized.

## **Information sources and search strategy**

We started and completed a systematic search of published articles in 2021. A wide range of electronic bibliographic databases, such as PubMed, Embase, and ERIC, were searched. We explored the references of pertinent reviews along with the database searches. An independent search was carried out by two authors who also scanned the results for potentially appropriate studies followed by retrieving the full-text articles. The primary endpoint of the review was the rate of hernia recurrence after the two procedures, and the secondary endpoints were surgical-site infection, bulging, pain, and seroma formation. We pre-piloted the search strategies without any restrictions by the year of publication, geographic area, or other socio-demographic characteristics.

We identified a blend of Medical Subject Heading (Mesh) keywords and text words. We clustered these into four major groups based on the population, intervention, outcome, and setting as categories. The most prevalent search terms found in abstracts and titles were “hernia repair,” “hernia repair using mesh,” “hernia repair using a mesh with and without closure,” and “laparoscopic surgical procedure using mesh repair with and without closure.” Furthermore, we consulted with a librarian to generate a search in four different parts. The first part was restricted to search terms specific to the primary outcome, such as “recurrence rate after mesh repair,” the second part was restricted to terms specific to defect closure, including “mesh with and without closure;” the third part was restricted to terms relevant to the surgical technique, such as “laparoscopic vs open repair;” and the last part was related to the location of the hernia, i.e., “ventral hernia”.

In addition, we considered using diverse phrases for the main concepts, such as practices of closure and non-closure using mesh repair, to obtain pertinent research papers. This was followed by combining these major concepts using combinations (AND, OR) relevant to the research question. Moreover, to identify more research articles, we used truncation (\*) with the same root word. We used truncation to ensure that all potential variants of search terms were retrieved. We also applied search limits or filters to restrict the language (English), publication period, age group, and type of study included in the search.

## **Data abstraction**

We imported all appropriate research studies into the reference manager software (Endnote™) file, where each study was reviewed, and we screened titles for duplicates in this software. We did not consider abstracts that did not explicitly explore the study objective for further review. Finally, we obtained and examined the full text of the remaining relevant articles. This was followed by abstracting and summarizing data from the articles that met the eligibility criteria using a standardized protocol. Thus, after the process of removing duplicates and screening titles and abstracts, we removed papers that were beyond the scope of this review as guided by the inclusion criteria. In addition, the bibliography of the remaining studies was verified and examined to avoid missing any useful studies. This process of searching the articles was carried out independently by the reviewers, and their judgements and extracted summaries were matched to identify and resolve differences accordingly.

Independent reviewers filled out a standardized data extraction sheet for the eligible research articles. The reviewers compared the tables of extracted data to ensure that the imperative findings of the eligible studies were included and pilot tested the data extraction sheet before starting the process of data extraction. In addition, prevailing research articles on the chosen topic were reviewed to describe objects of the data extraction sheet. Any discrepancies between the two reviewers were solved by agreement between the two reviewers. The abstracted data comprised the author, reference, year of publication, type of study, total study size or population, average age and range, sex, surgical group (with or without closure), rate of recurrence, major study findings, and conclusion of the study.

## **Results**

### **Findings of the search strategy**

As a result, our initial search identified 1525 citations in different databases; however, 25 articles were duplicates that were removed. Of the remaining 1500 unique studies, we reviewed the titles and abstracts and found 1232 relevant abstracts. Upon reviewing these abstracts, 249

articles did not meet the eligibility criteria, and 12 did not meet the eligibility criteria after reviewing the full text. Hence, we were able to retrieve the full text for 7 articles, which were incorporated in the review, as shown in Fig. 1.

## **Characteristics of the eligible studies**

Of these seven studies, four were observational retrospective studies, and three were randomized controlled trials. The sample size of all included studies varied from 80 to 176, with a similar distribution between patients who underwent a laparoscopic procedure for hernia repair utilizing mesh with and without defect closure. All studies included both sexes, and study participants were between the ages of 18 and 80 years (Table 1). One study was performed in 2012, two in 2013, one each in 2014 and 2018, and two were recently conducted in 2020. Of these seven studies, the randomized controlled trials were conducted recently, from 2018 to 2020, while retrospective studies were conducted in previous years, as illustrated in Table 1.

Table 1  
Characteristics of the studies included in the systematic review

Study	Study Year	Study Design	Sample Size	Surgical procedure	Group 1	Group 2	Age	Male: Female
Christoffersen et al (18)	2020	RCT	40 in each group	Elective laparoscopic umbilical hernia repair	Closure of the fascial defect prior using Mesh	no-closure	54 (30–75) for intervention and 55 (30–77) for control	22: 18 for (I) and 29: 11 for (C)
Ahonen-Siirtola et al(19)	2018	RCT	193	Laparoscopic incisional ventral hernia repair	Hybrid repair (laparoscopic operation laparoscopic operation combined with a fascial closure	conventional laparoscopic mesh repair	18 to 80 years 57 (SD 11.4) for laparoscopic group and 60 (SD 12.8) for hybrid group	Females in laparoscopic group 54 (59.3) and 54 (61.4) in hybrid group
Zeichen et al (20)	2013	Retrospective	93 patients in the non-closure group and 35 patients in the closure group	Percutaneous and intracorporeal closure of the defect	closure group	non-closure group	Mean age: 63 Y (range 26–91)	M:38 and F: 55
Bernardi et al (21)	2020	RCT	129 patients	laparoscopic ventral hernia repair	Primary fascial closure	non-closure group	49.6 (SD 11.7)	F: 63.5% and M: 36.5
Banerjee et al (22)	2012	Retrospective observational study	193 patients	laparoscopic repair of the fascial defect with mesh underlay, and laparoscopic primary suture repair and mesh underlay	primary suture repair and mesh underlay	laparoscopic repair of the fascial defect with mesh underlay	17–81	Not reported
Clapp et al(17)	2013	retrospective study	176	laparoscopic ventral hernia repair	trans-cutaneous closure of central defects in Laparoscopic ventral hernia repair	Standard Laparoscopic ventral hernia repair (without closure)	53.9 ± 2.0 in closure group and 58.0 ± 2.0 in non-closure group	M: 19 (52.8 %) in closure group and 23 (63.9 %) in non-closure group.
Gonzalez et al (23)	2014	retrospective	134	laparoscopic ventral hernia repair	Laparoscopic ventral hernia repair with primary closure of the defect	laparoscopic ventral hernia repair without primary closure of the defect	55.0 ± 13.2 in non-primary closure of the defect group and 56.6 ± 14.5 in closure group	F: 46(68.6%) in non-primary closure of the defect and 41(61.2%) in closure group

## Comparison of the outcomes of mesh repair with and without closure

### Findings from randomized controlled trials (RCTs)

Three randomized controlled trials revealed positive findings for mesh repair with closure compared to that without closure. For example, Christoffersen et al performed a double-blinded randomized controlled trial in 2020 in 80 patients (40 per group) using an elective laparoscopic procedure for ventral hernia repair. One group underwent closure of the fascial defect using mesh, while the other group

underwent repair using mesh without closure. The study revealed that the cumulative recurrence rate at the end of two years was significantly smaller in the closure group than in the non-closure group ( $P = 0.047$ ). Likewise, the authors found a reduced rate of seroma formation in the closure group compared to the non-closure group ( $p = 0.043$ ). However, there was no significant difference in post-operative pain.

Conversely, another RCT was conducted by Bernardi et al in 2020 in 129 patients who underwent laparoscopic umbilical hernia mesh repair with and without closure. Unlike Christoffersen et al, these authors did not find any discrepancies in terms of surgical-site infection, eventration, or recurrence between the two groups. However, patients treated with primary fascial closure showed a higher increase in quality of life than those treated without closure. The authors recommended closing the fascial defect using mesh in patients undergoing an elective laparoscopic procedure for ventral hernia repair, as depicted in Table 2.

Table 2

Summary of the findings related to the recurrence of hernia and other findings from the reviewed studies.

Study	Study Year	Findings for Recurrence	Other Findings	Main conclusion
Christoffersen et al (1)	2020	Recurrence rate of hernia after two years was decreased in the closure group: 5 of 36 as compared to 12 of 37 for no closure (P = 0.047)	There were no statistically significant differences in post-surgical pain except for initial weakness which was greater in the closure group. Formation of seroma at the end of one month was significantly reduced after closure as opposed to no closure (P = 0.043)	Closure of the fascial defect in during laparoscopic procedure significantly reduced early creation of seroma and long-term recurrence of hernia without adverse effects such as pain.
Ahonen-Siirtola et al(2)	2018	Patients underwent the hybrid method had meaningfully less rate for formation of seroma with lesser size of seroma.	Bulging was observed with a greater rate in laparoscopic group as opposed to hybrid group (p = 0.022). There were more and bigger seromas on ultrasound examination among patients undergoing laparoscopy as opposed to hybrid technique. Adhesiolysis was more complex in the prior than later group (p = 0.028). Patients in hybrid group reported more pain on the first day of surgery (p = 0.019).	Fascial defect closure and excision of the hernia sack decrease formation of seroma. In hybrid operations, the probability of enterotomy appears to be smaller as compared to its counterpart.
Zeichen et al (3)	2013	There was 15.1 % recurrence rate in the non-closure group. There was difference in recurrence rates of 19.18 % in the non-closure group as opposed to 6.25 % in the other group.	The rate of formation of seroma was 4.3 % in the non-closure group as opposed to 11.4 % in the closure group.	The variation in the rate of recurrence between two groups was statistically insignificant.
Bernardi et al (4)	2020	No statistically significant differences in infections at surgical site, eventration, or recurrence of hernia between two groups (with and without closure).	A12-point greater improvement in quality of life among patients treated with primary fascial closure as opposed to group without closure.	Among patients undergoing elective laparoscopic procedure to repair hernia it is recommend to close the fascial defect.
Banerjee et al	2012	The rate of recurrence among patients treated with primary suture repair and mesh underlay was 3% when compared to 4.8% related to mesh alone.  The recurrence of hernia in the group, treated with mesh only was 10.5% than 4.8% among patients treated with primary suture repair and mesh.		Primary laparoscopic repair along with mesh placement to treat ventral hernia is successful as depicted by the reduced rate of recurrence in closure group as opposed to non-closure group.
Clapp et al(5)	2013	In the non-closure group, the rate of recurrence was 16.7 % while there was zero rate of recurrence in the closure group.	The rate of bulging was 69.4 % in the non-closure group and 8.3 % in other group.  The rate of infections at the surgical site was 13.9 % in the non-closure group and 8.3 % in the closure group. The rate of formation of seroma was 27.8 % in the non-closure group as opposed to 5.6 % in other group.	The rate of formation of seroma, mesh and tissue eventration, and recurrence of hernia was substantially lower in closure group than its counterpart.
Gonzalez et al (6)	2014	The rate of hernia recurrences was seen in 7.5% of patients in non-closure group than 1.5% in closure group (p = 0.095).		Primary defect closure has lengthier time for surgery, however, a propensity in terms of obstacles and recurrences was observed supporting the primary closure of the defect group.

A third multicentre RCT was conducted by Ahonen-Siirtola et al in 2018 in 193 patients undergoing laparoscopic hernia repair with or without closure. The authors of the study found a lower rate of seroma formation in patients treated with the surgical technique using mesh repair with closure than in those who underwent the same procedure but without closure. The authors noted significantly more bulging in the closure group than in the non-closure group ( $p = 0.022$ ). There was also more complicated adhesiolysis noted in the non-closure group than in the closure group ( $p = 0.028$ ). However, patients in the closure group had higher levels of pain on the first day after surgery ( $p = 0.019$ ), as shown in Table 2.

## Findings from retrospective observational studies

A retrospective study conducted by Zeichen et al compared non-closure with closure in mesh repair over an average of 26 months of follow-up. The authors reported both percutaneous and intracorporeal defect closure. The authors found a higher rate of recurrence (19.18%) in the non-closure group than in the closure group (6.25%); however, this difference was not statistically significant. The authors also noted a higher rate of seroma formation (4.3%) in the non-closure group than in the closure group (11.4%) (Table 2).

Another study carried out by Banerjee et al. compared 126 patients in the non-closure group to 67 patients in the closure group, and patients were followed up for an average of 10.5 months after the surgical procedure to determine the rate of recurrence. The authors noted a slightly higher rate of hernia recurrence in the non-closure group (4.8%) than in the closure group (3.0%). These findings were confirmed by another study conducted by Gonzalez et al in 134 patients, in which the authors found a higher rate of recurrence in the non-closure group (7.5%) than in the closure group (1.5%) ( $p = 0.095$ ), as shown in Table 2.

Likewise, another study analysed the consequences of defect closure after adjusting the risk according to the follow-up duration, which was 24 months on average. The authors found that the closure group had a recurrence rate of zero as opposed to 16.7% in the non-closure group. Moreover, the rate of bulging was greater in the non-closure group (69.4%) than in the closure group (8.3%); the rate of surgical-site infection was also greater rate in the non-closure group (13.9%) than in the closure group (8.3%). The rate of seroma formation was 27.8% in the non-closure group and 5.6% in the closure group. Unlike other studies, this study also reported outcomes related to patient satisfaction, which were again higher in the closure group than in the non-closure group, as depicted in Table 2.

## Discussion

We performed this review to examine outcomes, mainly the rate of hernia recurrence and other post-operative complications, among patients undergoing laparoscopic ventral hernia repair using a mesh with or without defect closure. Although there is controversial evidence regarding the rate of recurrence using the two different techniques, the majority of the studies, consisting of both observational and randomized controlled trials, suggested performing closure in mesh repair to achieve better surgical outcomes and a lower rate of recurrence. More specifically, the findings suggest that the primary closure of fascial defects during laparoscopic procedures using mesh yields encouraging results. Compared to traditional laparoscopic procedures using mesh, primary fascial closure was found to produce a reduced incidence of recurrence of ventral hernia and bulging. Furthermore, patients who underwent closure were found to have improved quality of life with higher satisfaction and a lower rate of surgical-site infection than their counterparts.

The findings of this review suggest that hernia defect closure is advised for successful outcomes after repair, as supported by the literature [13]. This is because in contrast to the inguinal region, where the repair margins are fixed and without tension, the ventral wall of the abdomen is under continuous physiological pressure, with flexible margins. Failure to restore the wall of the abdomen to its usual anatomical place will increase the chances of a malfunctioning abdomen [14]. Mesh repair along with fascial closure rebuilds the natural structure by reapproximating the wall of the abdomen under physiological pressure, which might re-establish its physiology and prevent bulging. A central malfunctioning section of the wall of the abdomen behaves as a “sail in the wind” and is susceptible to protrusion [15]. Additionally, by abolishing the dead space, the rate of seroma formation and other problems related to the wound might be reduced.

Furthermore, mesh repair with primary defect closure decreases the rate of hernia recurrence because closure of the fascial defect permits broader lateral mesh overlap. The majority of mesh products for laparoscopic procedures are available in typical sizes. For instance, a fragment of mesh 15 × 20 cm in size may be preferred to allow  $\geq 5$  cm of mesh overlap while repairing a hernia defect 5 × 8 cm in size. Using closure, the mesh could cover 7.5 cm laterally and 6.0 cm vertically. However, it is crucial to note that not all ventral hernias are suitable for fascial closure; rather, suitability depends upon the size of the hernia defect. For tiny defects, especially those similar to Swiss cheese in morphology, closure of the fascial defect might not be appropriate until a certain size is reached (e.g., at least three centimetres wide). Closing defects more than six to ten centimetres wide might be challenging [4, 6]. Evidence suggests that surgeons have used closure to fix defects 12 cm wide [16, 17]. Although there is no recognized method for assessing the compliance and elasticity of the abdominal wall, walls that are easily distensible are more responsive to primary fascial closure. Additionally, suitability for closure might also be affected by the location of the defect and patient characteristics, such as BMI, sex, and age. For example, hernias close to immovable structures may not be suitable for

repair using fascial closure. It is also important to screen patients for comorbidities and functional status before deciding on defect closure because patients with a poor status and comorbidities might not be considered suitable for defect closure.

## Strengths And Limitations

This review is the first of its kind and compares the outcomes of hernia repair techniques using mesh with and without closure. The findings have important implications for the field of surgery, mainly for those who plan to repair a ventral hernia. The systematic review is limited by the scarcity of available evidence. Generally, there is a dearth of studies on this topic, with very few experimental studies, which indicates the need for further research in this area. Although there is a plethora of research on laparoscopic ventral hernia repair using other techniques, very few randomized controlled trials and retrospective studies have been conducted to compare the specific surgical techniques of interest, i.e., mesh repair with and without closure. In this review, we also found variation in the definition of outcomes across studies, as well as variation in the follow-up duration, which might result in missing instances of recurrence in the longer term.

## Conclusion

Primary fascial closure during laparoscopic hernia repair seems promising and safe, as it can decrease the rate of recurrence, seroma formation, and bulging and can improve patient satisfaction and quality of life. Nevertheless, it is imperative to screen patients for demographic and clinical characteristics, such as functional status and comorbidities, before deciding on primary defect closure. The size of the defect is also a factor in deciding whether to perform primary defect closure in mesh repair. Given the dearth of studies, especially randomized controlled trials, there is a need to carry out large randomized controlled trials with sufficient follow-up to accurately estimate the rate of hernia recurrence.

## Declarations

### Ethics and Consent to Participate

Ethical approval was not sought for the present study because it is a systematic review of published literature. For this type of study, formal consent is not required. The PRISMA guidelines were used to carry out this systematic review.

### Consent for publication

Not applicable

### Availability of data and materials

Not applicable

### Competing interests

The author has no conflicts of interest to declare.

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### Authors' contributions

EA designed the study hypothesis regarding the role of defect closure before mesh fixation. EA performed the data collection and drafted the manuscript. All authors read and approved the final manuscript.

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## Figures

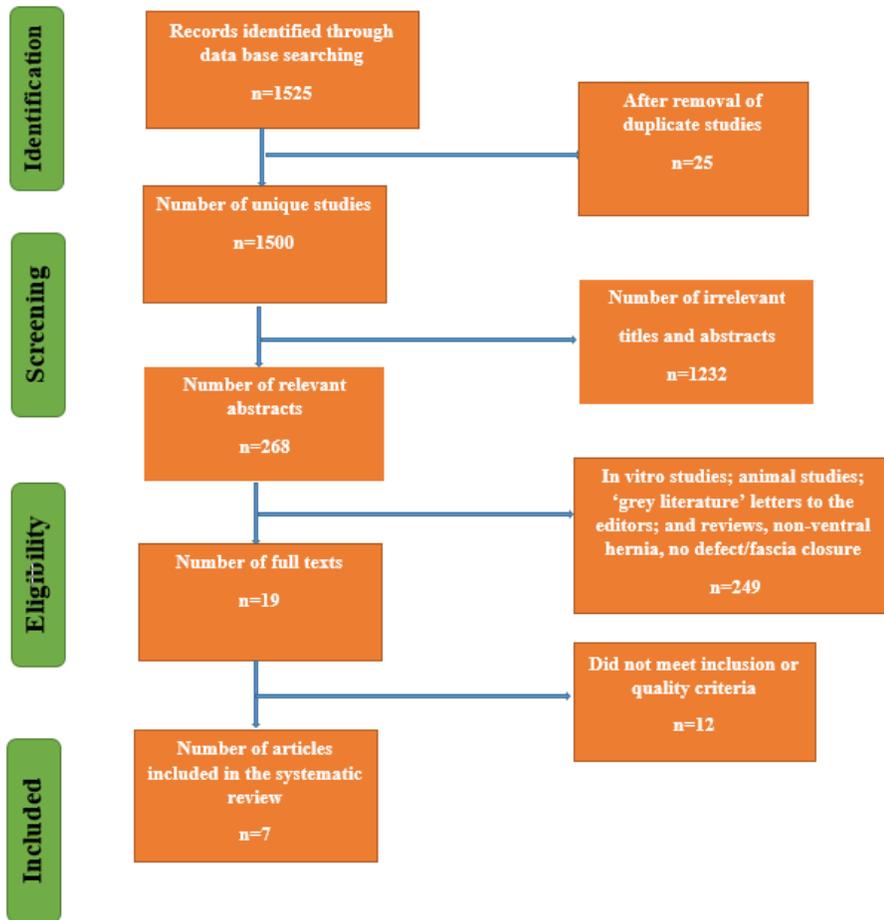


Figure 1

Flow chart summarizing the identification and selection of papers for systematic review