



## Original research

## Combined inguinal hernia in the elderly. Portraying the progression of hernia disease



Giuseppe Amato <sup>a</sup>, Antonino Agrusa <sup>a, \*</sup>, Vito Rodolico <sup>b</sup>, Roberto Puleio <sup>c</sup>,  
Giuseppe Di Buono <sup>a</sup>, Silvia Amodeo <sup>a</sup>, Eliana Gulotta <sup>a</sup>, Giorgio Romano <sup>a</sup>

<sup>a</sup> Department of General Surgery and Emergency, University of Palermo, Italy

<sup>b</sup> Department of Pathologic Anatomy and Histology, University of Palermo, Italy

<sup>c</sup> Department of Pathologic Anatomy and Histology, IZSS Palermo, Italy

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## ABSTRACT

**Introduction:** Identification of a combined hernia is a common occurrence in the course of inguinal hernia repair. This type of protrusion disease seems to affect the elderly, in particular. Very few investigations have been carried out to ascertain the structural changes that occur in the groin affected by this clinical condition.

**Method:** Analysis of intraoperative findings of combined inguinal hernias evidenced in the elderly, from the most recent 100 groin hernia repair procedures carried out by a single operator, represents the basis of the article. Protrusions that presumably represent the forerunner of this type of hernia were also analyzed: double ipsilateral inguinal hernias composed of a direct and an indirect protrusion. The gross anatomical, as well as histological, modifications occurring during the development of combined protrusions were also evaluated.

**Results:** Combined hernia was the most frequent protrusion in patients over 65 years, accounting for 36% of the total in this patient group. In the same patient cohort, double inguinal hernia further involves 22% of elderly subjects. Macroscopically, progressive disruption of the inguinal back wall and degenerative reabsorption of the inferior epigastric vessels were evidenced. Histologically, inflammatory infiltrate, significant nerve and vascular injuries, along with severe muscle degeneration were recognized.

**Conclusions:** The results seem to confirm that inguinal hernia is an unremitting progressive disease caused by chronic compressive structural damage. Combined hernias represent a frequent clinical condition in the elderly consequent to long-term degenerative damage. Therapy of combined protrusions must consider the impact of visceral vector forces.

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### 1. Introduction

Combined inguinal hernia is a frequent, pathological entity with unclearly defined anatomical characteristics. Notwithstanding the different classification methods that over the decades have tried to rationalize the typing of hernia protrusions [1–5], many grey areas characterize the classification of combined hernias which involves both the medial inguinal fossa, the internal inguinal ring and, often,

the supravescalis fossa. Nevertheless, the explanation as to how a combined protrusion grows through the inguinal floor is somewhat obscure. The data acquired in the present study show that one of the characteristics of combined hernia is that it expands over time, confirming that inguinal hernia is not a permanent condition but rather a progressive disease. This also explains because this protrusion type frequently involves elderly individuals. To date, there have been few attempts to clarify this topic, which is seldom discussed within the scientific community, despite direct and combined hernia being amongst the most difficult types to treat, showing a high recurrence rate [6,7,8]. Consequently, this condition often represents a source of complications and recurrences. The purpose of this article is to expand knowledge on gross anatomical features as well as histological evidence of the structural changes of the groin connected with the development of combined hernia.

\* Corresponding author. Department of General Surgery, Urgency and Organ Transplantation, University of Palermo, Via L. Giuffrè, 5, 90127, Palermo, Italy.

E-mail addresses: [amatomed@gmail.com](mailto:amatomed@gmail.com) (G. Amato), [antonino.agrusa@unipa.it](mailto:antonino.agrusa@unipa.it) (A. Agrusa), [vito.rodolico@unipa.it](mailto:vito.rodolico@unipa.it) (V. Rodolico), [g.dibuono@libero.it](mailto:g.dibuono@libero.it) (G. Di Buono), [giorgio.romano@unipa.it](mailto:giorgio.romano@unipa.it) (G. Romano).

This approach could be helpful in understanding the pathway of this type of hernia, showing how it progresses over time. The outcomes of the study may be of great help in developing more effective therapeutic strategies for an adequate treatment of this complex surgical condition.

## 2. Material and methods

The article describes the intraoperative features of combined inguinal protrusions observed in elderly patients who underwent primary inguinal hernia repair. For the study, a case series including the most recent 100 groin hernia repair procedures performed by a single operator was considered. The median age of the patients was 55.04 years (range 23–82), median BMI 26.81 (range 23–35). Protrusions were categorized using the Nyhus classification. Forty-six indirect hernias were reported in total: (two Nyhus 1 and 44 Nyhus 2, of which two congenital), 24 direct hernias (Nyhus 3a), 12 double or multiple hernias (one Nyhus 1 and eleven Nyhus 2 + twelve Nyhus 3a), 17 combined hernias with complete back wall defect (Nyhus 3b) and 1 tricomponent hernia with separate protrusion composed of one direct + one indirect + one hernia of the fossa suprapubic (Table 1). In the elderly patient cohort, subjects over 65 years were considered. In this cohort, 33 patients were enlisted, with a median age of 68.86 years (range 65–82) and median BMI reaching 27.96 (range 24–35). In this group, eleven (33.3%) indirect hernias (all Nyhus 2), three (9.1%) direct hernias (Nyhus 3), six (18.2%) double hernias (Nyhus 2 + Nyhus 3a), twelve (36.4%) combined hernias with complete back wall defect (Nyhus 3b) and one (3%) tricomponent (separate direct + indirect + fossa suprapubic hernias) were reported (Table 2).

As a supplementary note, additional combined hernias were reported in five patients less than 65 years; one 51 years, and the remaining four ranging from 57 to 61 years. No patient less than 50 years presented combined hernias. Concerning the six patients less than 65 years with double direct + indirect hernias, median age was 57.3 years (range 55–61 years). All patients underwent hernia repair with an adequately sized 3D dynamic implant (produced under license by Inshightra Medical Inc. Irvine, CA – USA).

Photographic documentation, arranged in progressive sequence, is used to describe the development of the hernia protrusions over time. To further identify specific modifications of groin structural damage, full thickness excisions or needle biopsy (5 in each patient) were carried out at a distance of 1 cm from the hernia opening in the elderly patient cohort with combined hernia, in order to incorporate tissue specimen which was distant from the hernial defect. In five of the six elderly patients with double ipsilateral hernia, the divisor septum containing the inferior epigastric vessels and separating the two protrusions was manifestly altered by degenerative damage. In these individuals, the septum was ligated and excised by means of Hoquet's manoeuvre, then histologically

examined. In the remaining elderly subject with double ipsilateral hernia, the divisor septum showed no significant sign of macroscopic structural damage, therefore, the diaphragm was not removed but five needle biopsies were carried out. All excised tissue samples were fixed in 10% neutral buffered formalin for at least 12 h. After routine tissue processing, sections were cut at 4–6 mm and stained with Azan–Mallory, Weigert van Gieson, NSE and Hematoxylin-Eosin.

### 2.1. Histopathological assessment

To achieve an adequate comparison of the damage evidenced in the elderly patient group, and in order to assess the degenerative injuries of the groin structure, 2 subsets of patients were generated. In the first group, the histological results of the biopsy samples excised in patients with double hernias were evaluated, while in the second group, the histological outcomes of the other subjects with combined hernias were evaluated.

### 2.2. Statistics

Histological samples of the two patient groups were examined by light microscopy at high power to perform semi-quantitative histological analysis evaluating the degenerative damage suffered by the inguinal structures. Five non-overlapping fields at 20 × magnification were scored according to Table 3. Fatty dystrophy of muscle was determined to be the most important factor indicating degeneration of the inguinal arrangement. Therefore, muscle fatty dystrophy score was evaluated in the two patient subsets with double ipsilateral and combined hernias. Significant effects ( $p < 0.05$ ) were determined using non parameter test: Mann–Whitney *U* test. SAS software (version 9.3. SAS) was used for the analyses.

### 2.3. Digital image analysis

Images of stained slides were captured using a Leica DMR microscope equipped with a Leica DFC 320 digital camera (Leica Microsystems, Wetzlar, Germany).

## 3. Results

The series of images collected during open inguinal hernia repair showed several types of double ipsilateral hernias (direct + indirect) and combined inguinal protrusion highlighted at different stages of development. Macroscopically, among the group of elderly patients, one extremely rare variant of non-confluent hernias was reported: the tricomponent protrusion of the inguinal floor; a hernia of the suprapubic fossa plus a direct and an indirect hernia characterizes this clinical condition (Fig. 1A). In this

**Table 1**  
Patient cohort and hernia details (cumulative).

| Total patients enrolled  | Nr.                       | %   |
|--|---------------------------|-----|
|  | 100                       | 100 |
| Age (median)   | 55.04 years (range 23–82) |     |
| BMI (median)   | 26.81 (range 23–35)       |     |
| Hernia types   |                           |     |
| Indirect   | 46                        | 46  |
| Direct   | 24                        | 24  |
| Double (direct + indirect)   | 12                        | 12  |
| Combined   | 17                        | 17  |
| Tricomponent (three separate protrusions: direct + indirect + fossa suprapubic hernia) | 1                         | 1   |

**Table 2**  
Elderly patients and hernia details.

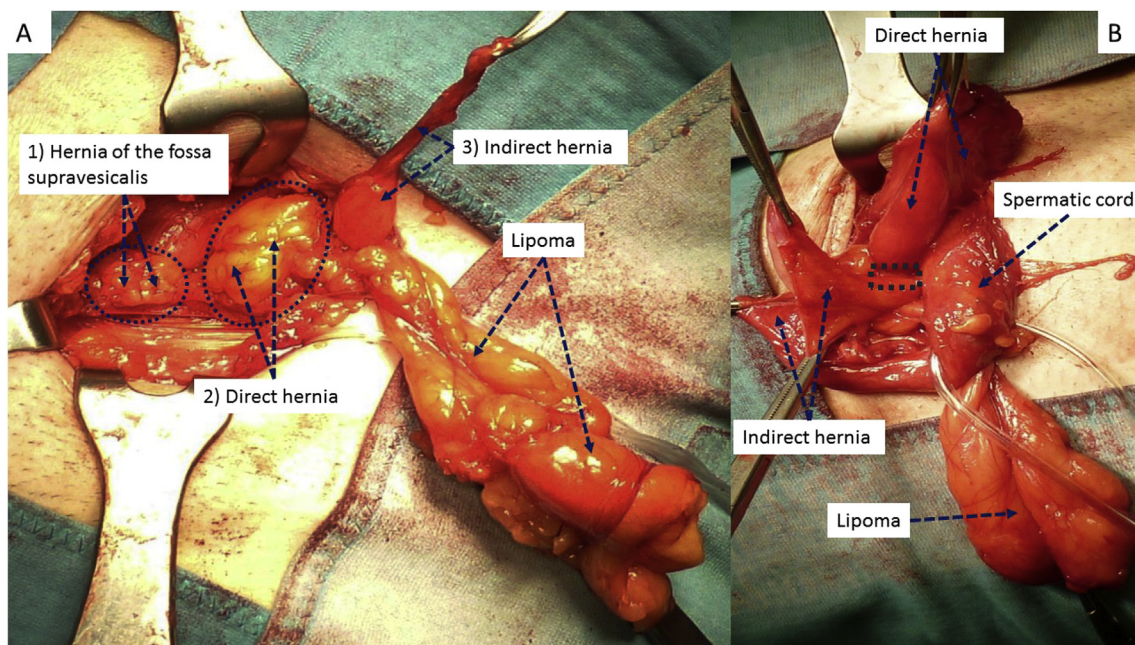
| Elderly patients (>65 years)  | Nr.                       | %    |
|---|---------------------------|------|
|   | 33                        | 100  |
| Age (median)  | 68.86 years (range 65–82) |      |
| BMI (median)  | 27.96 (range 24–35)       |      |
| Hernia types  |                           |      |
| Indirect  | 11                        | 33.3 |
| Direct  | 3                         | 9.1  |
| Double (direct + indirect)  | 6                         | 18.2 |
| Combined  | 12                        | 36.4 |
| Tricomponent (three separate protrusions: direct + indirect + fossa supravesicalis) | 1                         | 3    |

**Table 3**  
Scoring criteria defining fatty dystrophy evidenced by means of histological data.

| Scoring criteria of fatty dystrophy in groin biopsy: histological analysis |                    |  |  |  |
|--|--------------------|--|--|--|
| Score  | Grade 0            | Grade 1  | Grade 2  | Grade 3  |
| Fatty dystrophy  | No fatty dystrophy | Retention of fascicular pattern with replacement of less than 20% of muscle by fatty dystrophy | Structural change of fascicular pattern with replacement of more than 20% and less than 50% of muscle by fatty dystrophy | Severe change of fascicular pattern with replacement of more than 50% of muscle by fatty dystrophy |

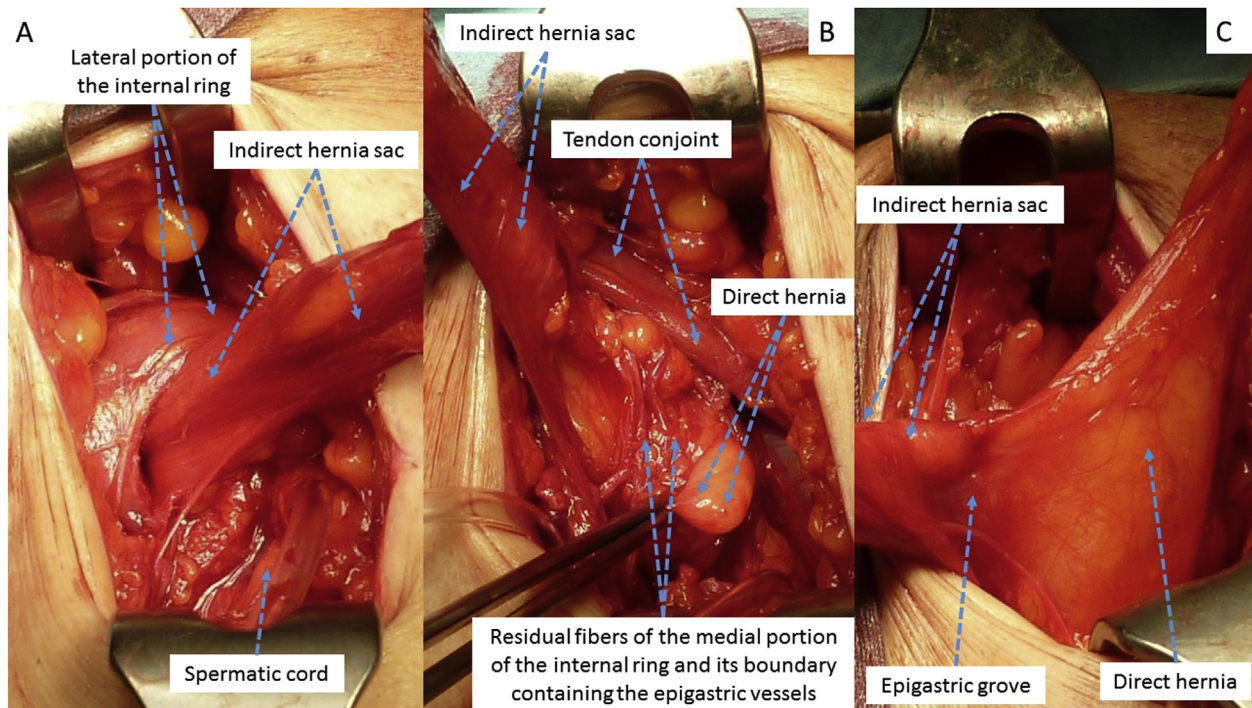
case, three independent protrusions, divided by a small tissue diaphragm, affect the entire inguinal floor. This complex hernia was managed with the elimination of the divisor septum opening wide the entire inguinal backwall. The defect was then fully obliterated with a double connected 3D dynamic implant. From analysis of the macroscopical data in the elderly patient cohort, six non-confluent double hernias (Nyhus 2 + Nyhus 3a) were also detected. In these patients, the medial portion of the internal ring and the portion of the backwall containing the inferior epigastric vessels separated the protrusions (Fig. 1B). The photographic sequences of Figs. 2 and 3 show further anatomical aspects of double ipsilateral hernia. In

2A, the typical arrangement of the lateral part of the internal ring is seen and an indirect hernia sac is evident. Nevertheless, by laterally displacing the hernia sac, it can be evidenced that the medial portion of the internal ring evidently shows a significant degree of degenerative damage. In addition, also the visibly detectable epigastric vessels appear macroscopically affected by degenerative sufferance, while an additional direct hernia protrudes medially from these structures (Fig. 2B). After removal of the dividing fragment between the two hernias, the convergence of the two protrusions is clearly documented. Of note, the groove of the epigastric vessels manifestly limits both hernias (Fig. 2C). Fig. 3A and B

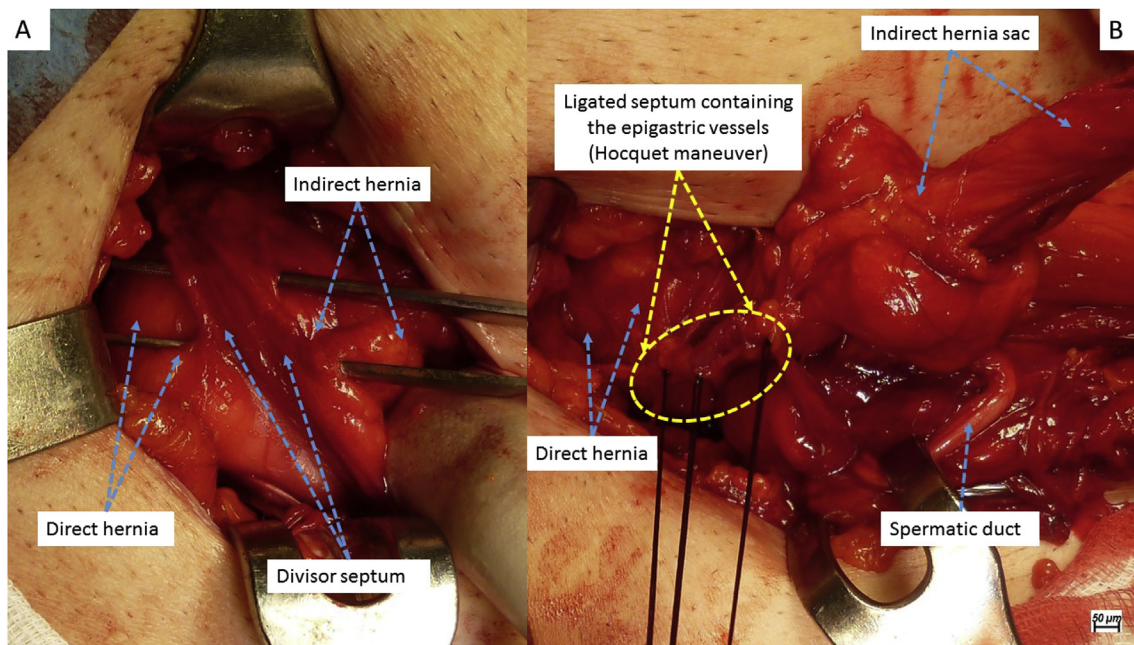


**Fig. 1.** A): Tricomponent multiple ipsilateral hernia composed by a hernia of the fossa supravesicalis, a direct hernia + an indirect hernia. The three protrusions are independent, not connected, and appear as distinct hernias separated by a small backwall strip. In addition, a lipoma is detectable. B): double ipsilateral inguinal hernia composed by one direct and one indirect hernia (with opened sac). The medial aspect of the internal ring and the small portion of the backwall containing the inferior epigastric vessels (blue rectangle) divide the two protrusion. A preperitoneal lipoma is also detectable. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)





**Fig. 2.** Double inguinal hernia: indirect + direct. - A): the lateral aspect of the internal ring is well arranged. Medially of it arises a large indirect hernia sac.- B): by lateral displacement of the hernia sac, the medial part of the internal ring shows manifest degenerative damage in progress. Macroscopically, also the inferior epigastric vessels appear in degenerative sufferance. A small direct hernia protrudes medially from these structures. - C): The confluence of the two protrusions after excision with the Hoquet maneuver of the residual medial portion of the internal ring connected with the fragment of backwall containing the epigastric vessels. The groove of the epigastric vessels dividing both hernias is well evident.

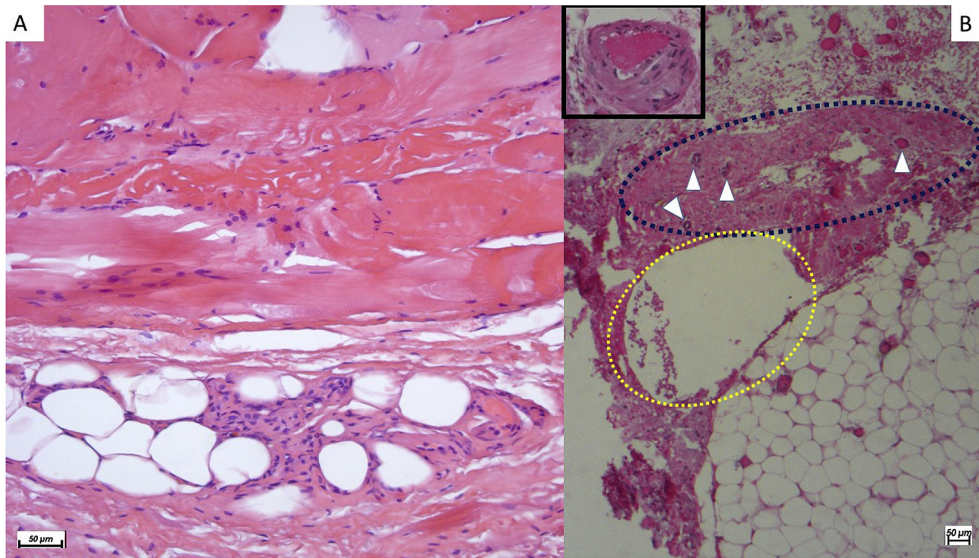


**Fig. 3.** A): The divisor septum that separates the direct and the indirect protrusions in a case of double ipsilateral inguinal hernia. - B): The Hocquet maneuver: ligature and removal of the septal arrangement including the epigastric vessels.

highlights the preparation and ligature of the septal arrangement carried out with the Hoquet manoeuvre. Regarding the group with double hernias, histological examination of the needle biopsies and the excised septum showed a progressive amount of degenerative damage involving the inguinal structures. It concerns degeneration

of the muscular arrangement from fibro-hyaline to massive fatty degeneration of the myocytes with surrounding chronic inflammatory infiltrate (Fig. 4A). Severe structural damage of the inferior epigastric vessels could also be microscopically identified. In this respect, the virtually complete occlusion of the inferior epigastric

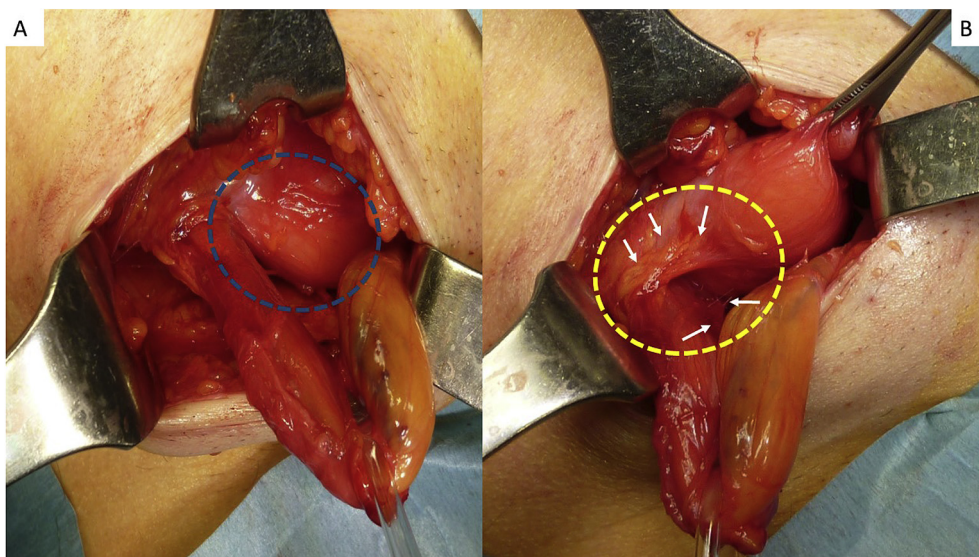




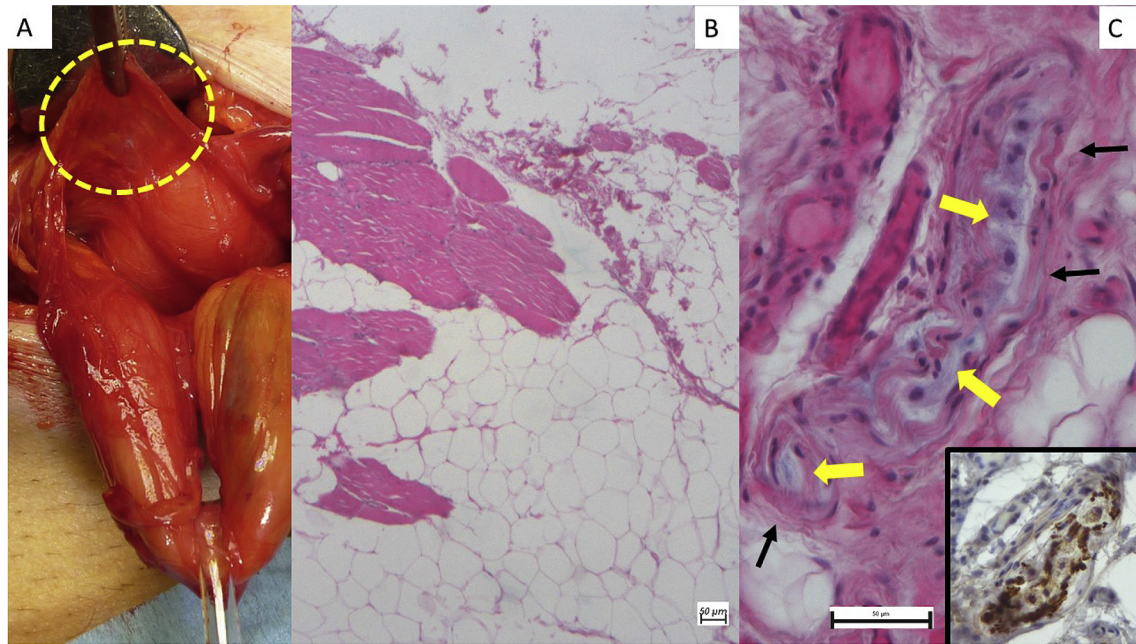
**Fig. 4.** A): Histology of biopsy specimen from the divisor diaphragm between double ipsilateral hernias excised by means of the Hocquet's maneuver. The microphotograph shows slight fat deposition (white circular spots) surrounded by inflammatory clusters (dark spots) mainly composed by lymphocytes and plasmacells. An evident fibrohyaline dystrophy affects the remaining muscular arrangement where elements of chronic inflammation infiltrate the muscle bundles. Statistically the degenerative damage of the muscular structure can be enlisted as grade 1 of the scoring system, showing a muscle replacement by fatty dystrophy of less than 20%. Hematoxylin-eosin 20X–B): Histological study of the removed myofibrotic septum containing the epigastric vessels: epigastric artery (blue circle) with hyaline degeneration of smooth muscle cells of the tunica media, virtually occluded by parietal fibrosis, probably consequent to organized thrombus as a result of chronic compression. Of note, the small spots of arterial re-canalization (white arrowhead) among the fibrotic muscular arrangement of the artery. Ectasia of the epigastric vein (yellow circle). Below the vascular structures is found a broad area of fatty muscular dystrophy (white small rings). The great amount of fatty degenerated muscular fibers make this sample enlisted in the group 3 of the scoring system. EE 5X–In the inset: arteriolar structure showing noteworthy concentric hypertrophy of the tunica media and evident congestion due to reduced blood flow. EE40X.

artery represents a significant finding (Fig. 4B). The convergent expansion of the two elements (direct and indirect) of the combined hernia appears to continue with the destruction of the anatomical integrity of the internal ring. Actually, the degeneration of the medial portion of the internal ring, probably stressed by the expansion of the protrusion, is evident (Fig. 5A). The wing shaped outline of the superior and inferior border of the internal ring, consequent to the dissolution of the medial portion, conspicuously embodies this occurrence. The degenerative damage of the concentric muscular structure is clearly visible in the form of yellow-orange bands of fatty degeneration contextually evidenced

together with the complete dissolution of the inferior epigastric vessels (Fig. 5B). Degenerative damage is confirmed by histological examination of the excised wing-shaped residue of the internal ring and the needle biopsy samples. Fibro-hyaline degeneration and fatty dystrophy of muscle bundles was a constant finding. (Fig. 6B). However, histology highlighted a broad spectrum of progressive damage involving all components of this area of the abdominal wall. Inflammatory infiltrate, mostly composed of lymphocytes and plasmacells, severe modifications of the vascular structures and significant damage of the nerves were the most important outcomes of the histological investigation (Fig. 6B–C).



**Fig. 5.** A): Combined hernia involving the medial inguinal fossa and reaching the internal ring (blue circle). - B): The internal ring is completely lacking in its medial aspect (yellow circle). The residual fibers of the internal ring, arranged as wings of the protrusion, macroscopically show a noteworthy fatty degeneration (white arrows).



**Fig. 6.** A): excision of the residual, wing-shaped, portion of the internal ring for histological study. Of note the complete absence of the epigastric vessels - B & C): Microphotographs of the excised specimen. - B): Severe fatty dystrophy of the muscle fibers (white spots) interspersed among residual muscle bundles (in red) showing hyaline degeneration with amorphous pale pink substances replacing the muscle fibers. The massive replacement of more than 50% of muscle by fatty dystrophy allows the classification of this sample as grade 3 of the scoring criteria. Hematoxylin-eosin 5X. - C): Motor nerve with thickened myelin sheath (black arrows) as well as fibrotic degeneration and Wallerian degeneration (yellow arrows) of the nerve axons. Hematoxylin-eosin 20X. - In the inset: immunohistochemistry microphotograph of same nervous structure confirming the degenerative damages of the axons and the thickening of the myelin sheath. NSE40x.

Development of the combined hernia seems to progress until all components of the inguinal floor are devastated, opening wide the entire inguinal floor, thus allowing the progression of broader visceral contents through the abdominal wall. The wide tri-component combined hernia merging into a single protrusion, depicted in figure series 6–7, describes this. Related photographic documentation shows a hernia of the fossa supravesicalis and a direct hernia simply limited by the groove of the medial umbilical fold. (Fig. 6A–B). Furthermore, the direct hernia protrusion expands into the former internal ring until the lateral side of the ring is reached, thus resembling the convergence between a direct and indirect hernia (Fig. 7A). Repositioning of the broad hernia content into the abdominal cavity shows the wide extent of the hernia opening and demonstrates the absence of the medial side of the internal ring as well as the complete disappearance of the inferior epigastric vessels (Fig. 7B). This clinical condition can be envisaged as the ultimate destiny of the tri-component hernia highlighted in Fig. 1A, following complete destruction of the inguinal floor over time.

### 3.1. Statistical analysis

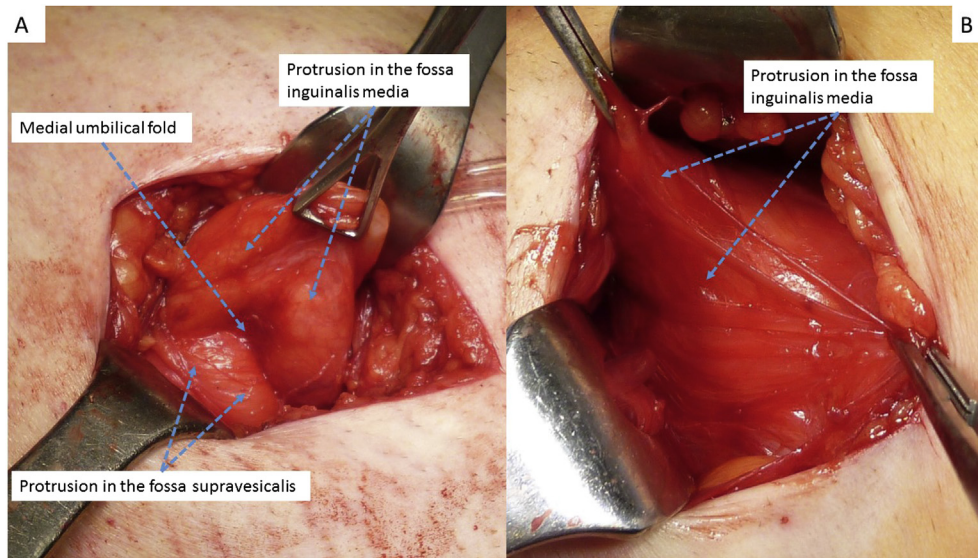
Median scores of fatty dystrophy of muscle were compared with Mann-Whitney *U* test in double ipsilateral hernias and combined hernias. The median scores showed statistically significant differences ( $p < 0.01684$ ) according to Table 4.

## 4. Discussion

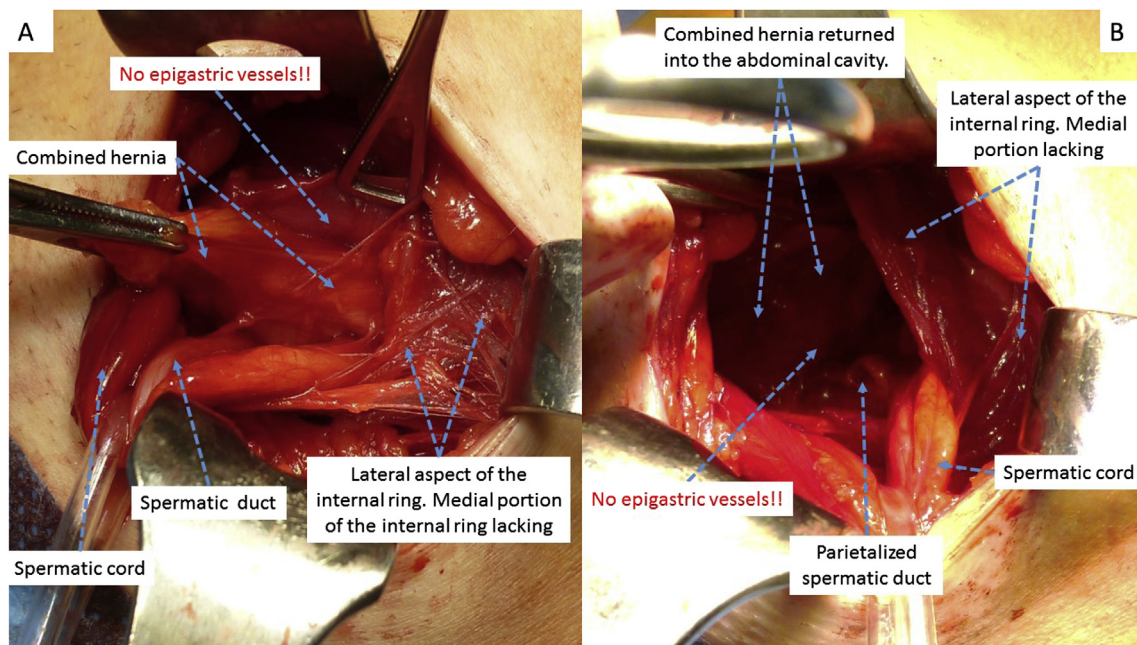
During the past decades, there have been several attempts to classify inguinal hernia protrusions. The present article has not finalized updating these classifications; moreover, it should be pointed out that in all earlier attempts the characteristics of combined inguinal hernias were not well defined. Currently, in the

Aachener classification, Schumpelick describes the characteristics of direct hernia, identifying hernia types by position and dimension, giving combined hernia a specific entity: “MC” (medial combined) [9]. Nyhus categorizes combined hernia as IIIB, which includes large indirect hernias that develop medially protruding through the posterior inguinal wall or direct inguinal fossa [10], that is, a protrusion with back wall defect and convergence of indirect and direct hernia in one single protrusion. Based upon Gilbert’s classification, Zollinger defines the pantaloan hernia as a combined protrusion, regardless of whether these hernias are non converging [11]. The recent classification of the European Hernia Society (EHS) embodies a fruitful effort that simplifies the morphological evaluation of groin protrusions [12]. However, EHS characterization of combined hernia remains quite vague and is subject to personal evaluation. It must be noted that the simplification achieved by the EHS classification leads to the exclusion of rare hernias, such as those of the supravesicalis fossa that seem to be embedded in the great family of direct hernias. In the light of these considerations, it would appear that the surgical community, to date, does not have a shared classification method concerning the anatomical entity, combined hernia. As a consequence, a certain degree of confusion currently exists. This implies some inadvertent underestimation of many aspects related to the features and progression of this anatomical condition, which could have a role in the development of adverse events after the repair of combined inguinal hernia. A similar point of view can be taken concerning the incidence of combined of hernia related to the total amount of inguinal hernia protrusions. Few reports deal with this, despite representing an important indicator. It is worth noting a study by Bittner and coll [13], that reports a 9% incidence of combined hernia, even though our institutional datasheet reaches a frequency of 17%. This difference is probably consequent to an inaccurate recording of combined hernia in the group of direct hernias. Another aspect of this issue, concerns the detection of multiple





**Fig. 7.** A, B): Tricomponent combined hernia composed by an external hernia of the fossa supravesicalis (separated by the medial umbilical fold) and a hernia of the fossa inguinalis media confluent into an indirect hernia (see Fig. 8).



**Fig. 8.** Same patient of Fig. 7b): the extent of the combined hernia reaches the lateral aspect of the internal ring, whose medial portion has disappeared. In addition, the epigastric vessels are lacking. B): The combined protrusion is set back into the abdominal cavity. The hernia defect involves the entire inguinal floor. Of note: the absence of the epigastric vessels is confirmed.

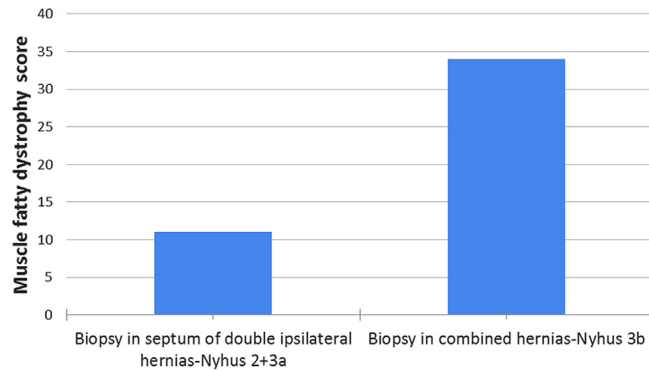
ipsilateral hernias contextually protruding in same groin. Through the years, our group has collected specific experience in evidencing unforeseen additional protrusions through meticulous dissection of the inguinal floor. It should be stressed that multiple ipsilateral hernias are more frequent than most herniologists imagine, and that would probably find more if they had adequate attention. Therefore, in the course of open hernia repair, the search for additional hernias beyond the main protrusion is crucial to avoid postoperative complications [14].

After this necessary premise concerning the past and present of hernia classification attempts, in the upcoming section we try to describe development as portrayed by the iconographic data of this

article. By analysing the photographic sequence, it appears evident that the inguinal protrusion has no permanent outline but progresses over time, causing irreversible damage to the inguinal floor. The anatomical condition described as double ipsilateral hernia composed of an indirect and one direct, separate protrusions, would appear to be the origin of the combined hernia. Further images show the development of the hernia that medially involves the inguinal floor and disrupts the back wall. In addition, the internal ring is being forced by the expansion of the indirect hernia and, following compression exerted by the hernia content, the medial aspect gradually degenerates and completely disappears, over time. At this stage, only a small diaphragm separates the two

**Table 4**

Total median scores in double ipsilateral hernias and combined hernias. The graph demonstrates that fatty degeneration in the biopsy samples of combined hernia specimen is much more significant than in the divisor septum of double ipsilateral hernia.



protrusions: a longitudinal strip that contains the inferior epigastric vessels and its anterior muscular coverage. But, gradually, also this narrow barrier begins to show signs of structural sufferance. First, the anterior muscle layer covering the epigastric vessels progressively regresses into a visible fatty dysplasia until it totally disappears. Contemporarily, also the inferior epigastric vessels start to modify structure under the push of the visceral content. The final result is the rupture of the entire Hesselbach triangle and the medial portion of the internal inguinal ring. Only the lateral portion of the ring is preserved, even though occasionally a residual quota of the superior and inferior part may be maintained, acquiring a wing-shaped aspect. The epigastric vessels seem to be reabsorbed, possibly due to degenerative damage. In some patients, the expansion of the protrusion reaches the supravesical fossa provoking an external prolapse and converges with the direct hernia arising from the fossa inguinalis media.

Further considerations emerge from analysis of demographic data. Among the entire cohort of patients with combined hernia (17 subjects = 17% of total), 12 were over 65 years. Of the five remaining patients, one was 51 years old and four from 57 to 61 years. Therefore, it appears obvious that combined hernia is a type of protrusion that affects aged patients and is extremely rare before the fifth decade. A similar condition emerges from the demographics of the 12 patients with double hernia (direct and indirect). All were over 55 years and six aged over 65 years. Another point worth noting is the very small percentage of direct hernias reported in the elderly patient group compared to the total. While direct hernia accounts for 24 units (24%) of the total (21 patients of the younger population), in the elderly patient, this figure dramatically decreases to only 3 subjects. This seems to demonstrate that a protrusion involving just the fossa inguinalis media, in time, expands and tends to disrupt the entire backwall. Another concern involves the relationship between the double ipsilateral protrusion and the combined hernia described above. From the study of the macroscopical, as well as histological, data it seems that the development of the combined hernia is strictly connected with that of the double ipsilateral hernia. All double hernias evidenced in the research show a progressive worsening of the inguinal backwall, in this case solely embodied by the divisor diaphragm between the two protrusions. Gross anatomical inspection, as well as histological evidence, seems to confirm that the degenerative damage involving the septal arrangement is progressive. It concerns all components of the backwall including the epigastric vessels, which, at the end of the process, simply dissolve. Effectively, all gross anatomical modifications find precise microscopic correspondence. Histological microphotographs clearly document

all stages of degenerative damage within the muscle bundles, from fibro-hyaline degeneration to fatty dystrophy. These findings describe the degenerative sufferance of the muscular structure of the internal ring well. Structural worsening and inflammatory infiltration involves all typical components of the groin, and can be seen as a result of progressive damage. Fibrotic or even Wallerian degeneration of the nerve axons, as well as thickening of the myelin sheath, are typical findings in these specimens. Significant modifications affect inferior epigastric vessels, especially the artery. Initially, a concentric medial hyperplasia involves the arterial muscular arrangement, which progresses until the lumen is nearly completely occluded. The arterial flow may appear seriously reduced, facilitating a thrombotic obstruction. Consequent hypoxia accelerates the degeneration of the small septum that divides Hesselbach's triangle from the internal ring, thus determining the convergence of the protrusions. It is worth noting that the depicted degenerative damage involving the epigastric vessels and its muscular shield are not a direct consequence of the compression exerted by the hernia sac and its content, but rather seems to be the result of the chronic impact of the still non-herniated abdominal viscera. All described modifications are characteristic of chronic compressive damage. It is envisaged that there is no other source of chronic compression in this district except visceral impact. This occurrence serves as additional evidence supporting the hypothesis that chronic visceral compression seems to be the cause of hernia genesis [15–19]. Statistical data based upon assessment of the fatty degeneration of the inguinal backwall shows that this kind of peculiar degeneration increases starting from the (relatively) younger double hernia patients. Statistical assessment appears to demonstrate that the degenerative insult of the backwall occurs during the double hernia stage, continues until its disappearance, is at the basis of the combined protrusion in the (older) subjects. Concerning the surgical treatment, in the case of double hernia separated by a divisor septum that macroscopically do not suffer degenerative damage, our recommendation is not to remove it. Instead, the ligation and excision of the septal arrangement by means of Hoquet's manoeuvre should be considered. This produces a single hernia opening, converting the double defect in the typical combined hernia. The wide opening of the defect allows control of the posterior lower abdominal wall and the preperitoneal space. Surgical repair of combined hernia should contemplate a customized onlay-inlay repair with two large overlapping meshes. One mesh is intended to cover a broad portion of the posterior lower abdominal wall and the preperitoneal space. This posterior mesh should be combined with another layer of mesh placed in the anterior aspect of the groin acting as anterior reinforcement.



Alternatively, the deployment of a preformed implant of this type could be considered [20]. In the case that open pure tissue repair is preferred, Shouldice repair is to be taken into consideration. If an open posterior approach or a laparoscopic TAP or TEPP procedure is being planned, the placement of a large mesh that broadly overlaps the hernia gap in the posterior abdominal wall should be mandatory. Recently, another hernia repair concept has been developed, concerning the obliteration of the hernia opening by means of 3D dynamic responsive implants [21–29]. The results of this technique seems to be effective in the treatment of combined hernia thanks to the probiotic biologic response that seems to address the degenerative pathogenesis of the inguinal protrusions [30].

## 5. Conclusion

In the light of the considerations made above, it can be stressed that these types of complex protrusions almost exclusively affect older patients. From analysis of the depicted data, it emerges that the effect of visceral impact upon the groin area is the main factor to consider when deciding on the surgical strategy to adopt to repair these complex hernias. By considering the powerful effect of the visceral impact as the source of the complete disruption of the inguinal floor, it appears evident that combined hernia cannot be repaired as a common protrusion. The impact of the visceral vector forces upon the groin area is often undervalued and this underestimation can lead to the wrong choice of surgical approach or to placement of an inadequate implant. Much more care in dissecting the inguinal components, followed by meticulous evaluation of surgical anatomy and a rational reflection upon the physiopathology of the lower abdominal wall are mandatory in properly managing this intriguing condition.

The analysis of macro and microscopic data provided herewith would appear to confirm that hernia is a progressive disease, which does not stop developing. The study also proves that combined hernia is the most frequent protrusion in elderly patients. 36.4% of combined hernias in total in this patient group, together with 18.2% of those with double inguinal protrusions and 3% of tricomponent combined hernia in the same patient cohort forms the considerable amount of 57.6% elderly patients suffering from complex hernia disease. Therefore, the search for new therapeutic strategies and devices for the treatment of this aspect of hernia disease should take into account the described evidence.

## Ethical approval

Patients gave their informed consent to participate in the study.

## Sources of funding

Agrusa Antonino and other co-authors have no study sponsor.

## Author contribution

Amato Giuseppe: study design, data collections, data analysis and writing.

Agrusa Antonino: study design, and writing.

Rodolico Vito: data collections and data analysis.

Puleio Roberto: data collections and data analysis.

Di Buono Giuseppe: study design, data collections, data analysis and writing.

Amodeo Silvia: data collections and data analysis.

Gulotta Eliana: data collections and data analysis.

Romano Giorgio: study design and writing.

## Conflicts of interest

Agrusa Antonino and other co-authors have no conflict of interest.

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