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What defines an incisional hernia as 'complex': results from a Delphi consensus endorsed by the European Hernia Society (EHS)

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Background

A 'complex' hernia is often referred to in the published literature, yet has not been clearly defined to date. 'Large' and 'giant' may also be used to describe a complex incisional hernia indirectly[1–3]. Meanwhile, a 'complex hernia' in reference to the technical surgical challenge of abdominal wall repair is different from a 'complex patient', the latter relating more to a patient's mental or physical health. Several risk scores have been developed and described in the literature[2,4–6]. Although hernia dimensions and defect characteristics alongside patient co-morbidities have demonstrated some correlation with poor surgical outcomes[1,3], postoperative complications alone should not define complexity[6,7].

Slater *et al.*[8] subsequently published criteria to define a complex abdominal wall hernia, comprising four categories: size and location, contamination/soft tissue condition, patient history/risk factors, and clinical scenario; three severity classes were defined, namely minor, moderate, and major. Although often referenced in publications, this definition has not been found to be an efficient working definition of a complex incisional hernia[4,9]. Furthermore, with increasing preoperative adjuncts and operative strategies available to manage incisional hernia[6,10], and increased surgical specialization in the field[2,10], a revised consensus definition is required.

This study aimed to provide a simple, practical definition of complex incisional hernia. It is expected that such a definition would ensure consistency and quality of reporting of published hernia studies in the future. Furthermore, a simple definition would facilitate standardization in referrals to abdominal wall specialists and units. Using a Delphi process under the auspices of the European Hernia Society (EHS), involving hernia experts and patients across Europe, the objective was to identify factors essential to the definition of a complex incisional hernia.

Methods

The Delphi method is an *a priori* structured communication technique in which a group of experts reaches a consensus on a topic through several rounds of answers with controlled feedback. To deliver the study, a Steering Committee (SC) was developed comprising nine general surgeons interested in abdominal wall surgery (B.E., A.D.B., M.P., G.M., S.C.G., A.S., E.B., F.A., S.R.) and a statistician (H.C.). Ethical approval and registration were not necessary[11]. The protocol for the present study was developed by one of the members of the SC and subsequently approved by the SC (*supplementary material*). The results of the present Delphi consensus have been reported according to the CREDES checklist[12].

Delphi contributors

A diverse panel of experts (PoE) with expertise in the treatment of complex hernia and resulting publication portfolio was invited to contribute, ensuring diversity in gender, geography, and age. A number of patients were invited to participate through e-mail invitation from the SC, with included patients having a say equal to that of the PoE in all Delphi rounds. In total, 44 expert surgeons and 6 patients were invited to participate in the Delphi process, with 43 surgeons and 5 patients agreeing to take part (*Table S3*).

Delphi development and composition

The SC developed an initial set of variables defining complex incisional hernia in an elective setting through a search of the published literature and group discussion, with subsequent input and revisions by the PoE. A custom questionnaire (EHS Delphi on Complex Abdomen Definition Form) was developed using Google Form survey software (Google™, Mountain View, CA, USA), ensuring anonymity of responses throughout the process.

Delphi methodology

In the first round, the PoE selected which variables would make abdominal wall repair more difficult to perform, rather than just influencing postoperative outcomes. After 5 weeks, members of the SC analysed responses to identify areas of agreement. Variables reaching at least 70 per cent agreement were included in further rounds.

In the second round, the PoE scored each variable included after the first round using a nine-point Likert scale (1–3, not important; 4–6, important but not critical; 7–9, critically important). For a variable to be carried forward, it required at least 70 per cent of respondents to score it as critically important and less than 15 per cent of respondents to score it as not important. Anonymized results were returned to the PoE.

In the third round, potentially relevant variables were reassessed (agreement 65–70 per cent in the second round and considered important by SC). In addition, appropriate variables were combined to create a single variable and rescored by the PoE using the nine-point Likert scale, and thresholds for continuous variables (BMI, hernia width) were defined.

At the end of the Delphi process, variables considered important with an agreement of at least 70 per cent after the second round and those refined during the third round were to be included in the definition.

Results

Complex incisional ventral hernia maximum data set

The SC proposed 102 variables, divided into 6 different categories: hernia-related (16), operation site-related (18), abdominal wall-related (15), patient-related (34), surgeon-related (8), and healthcare setting-related (11) variables. After input from the PoE, a complete list of 195 variables was derived (*Tables S1 and S2*).

First round of Delphi process

Forty-five members of the PoE (94 per cent) contributed to the first round, resulting in 34 included variables reaching the level of consensus (*Table 1*). After feedback from the PoE, it was agreed

that, although surgeon-related and healthcare setting-related variables could create a complex hernia, for example due to lack of skill or resources, these should not themselves define a complex hernia. Therefore, these two categories of variables were removed at this stage.

Second round of Delphi process

Thirty-nine members (81 per cent) of the PoE contributed to round 2, resulting in 22 included variables reaching the level of consensus (*Table 2*). SC review and discussion resulted in exclusion (*Table 3*) or rephrasing, for example to allow the development of thresholds for continuous variables.

Third round of Delphi process

All 39 members of the PoE contributing to the second round contributed to the third round, in which potentially relevant and continuous variables were further refined. The variables that reached consensus were: hernia width over 10 cm (77 per cent consensus); presence of skin defects/ulceration or mesh exposure (79 per cent); presence of stoma (79 per cent); and BMI at least 40 kg/m^2 (72 per cent).

At the end of the Delphi process, 18 variables were included in the definition of complex incisional hernia according to the greater than 70 percent agreement reached in the second or third round (*Fig. 1*): width over 10 cm; midline incisional hernia associated with a parastomal hernia; multiple recurrent hernia; loss of domain; presence of skin defects/ulceration; presence of fistula; current mesh infection; current abdominal wall infection; mesh erosion into the bowel; presence of stoma; previous open abdomen; previous anterior component separation; previous posterior component separation; previous transverse rectus abdominis myocutaneous flap reconstruction; loss of muscle/previous resection; incisional hernia after bone resection; BMI at least 40 kg/m^2; and cirrhosis with ascites.

Table 1 Variables included after first round

	% agreement
Hernia-related variables	
Width	96
Incisional lumbar hernia	84
Incisional flank hernia	80
Parastomal hernia	73
Parastomal hernia + midline hernia	91
Perineal hernia	91
Multiple recurrent hernia	87
No. of previous repairs	71
Loss of domain	96
Operation site-related variables	
Presence of fistula	98
Urostomyileostomy/colostomy	78/80/89
Stoma proximity to incision of repair	71
Mesh infection	98
Abdominal wall infection	93
Skin defects/ulceration	82
Mesh exposure to skin	80
Mesh erosion to hollow organs	84
Previous open abdomen + skin graft	87
Plan musculocutaneous flap	78
Area bone resection/deficient bone support	73
Abdominal wall-related variables	
Loss of muscles/previous resection	93
Previous anterior component separation	78
Previous posterior component separation	82
Previous deep inferior epigastric artery perforator flap	73
Previous transverse rectus abdominis myocutaneous flap	80
Abdominal wall tumour needing full-thickness resection	84
Patient-related variables	
BMI 40–50 kg/m^2	98
BMI > 50 kg/m^2	100
Cirrhosis with ascites	91
Malnutrition	76
Surgeon-related variables	
No. of incisional hernias/abdominal wall repairs per year	91
Medical facility-related variables	
Lack of ICU	73

Table 2 Variables included after second round

	% agreement
Hernia-related variables	
Width	90
Parastomal hernia	82
Parastomal + midline incisional hernia	97
Perineal hernia	77
Multiple recurrence	84
Loss of domain	92
Operation site-related variables	
Fistula presence	95
Current mesh infection	90
Current abdominal wall infection	85
Mesh erosion to hollow organs	95
Previous open abdomen	79
Plan for muscular flap	72
Hernia—earlier bone resection	74
Abdominal wall-related variables	
Loss of muscle/previous resection	77
Previous anterior component separation	74
Previous posterior component separation	77
Previous transverse rectus abdominis myocutaneous flap	72
Previous deep inferior epigastric artery perforator flap	72
Abdominal wall tumour with need for full-thickness abdominal wall resection	74
Patient-related variables	
BMI > 50 kg/m^2	90
Cirrhosis with ascites	77
Surgeon-related variables	
None	
Medical facility-related variables	
None	

Table 3 Variables excluded after revision by steering committee

Variables excluded	Reason
Perineal hernia	Already largely a specialist area of hernia surgery, and perhaps necessitates a definition of complexity in its own right
Abdominal wall tumour with need for full-thickness abdominal wall resection	Not an incisional hernia at the time of the surgery
Previous deep inferior epigastric artery perforator flap	Largely skin and subcutaneous loss rather than fascia/muscle
Parastomal hernia	Already largely a specialist area of hernia surgery, and perhaps necessitates a definition of complexity in its own right
Plan for muscular flap	A subjective indication with variation in use of such flaps for same hernia across Europe

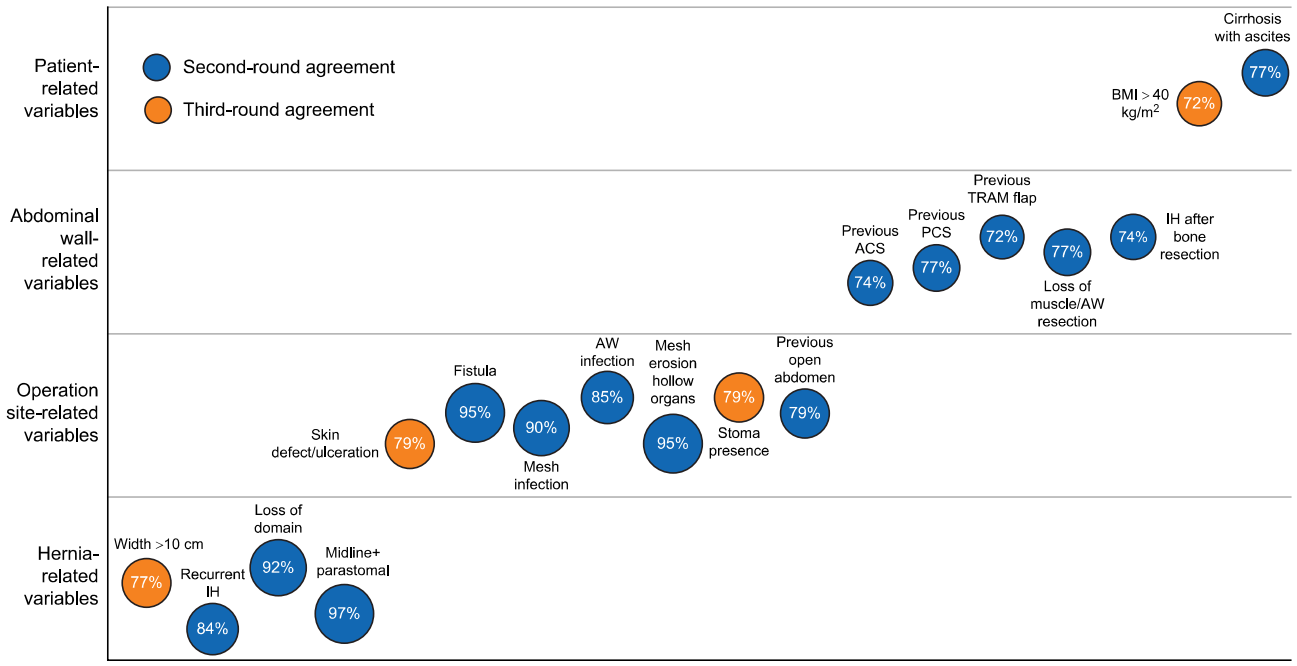

Fig. 1 Bubble plot representing variables included in final definition, category of each variable, percentage agreement, and round in which variables were included in definition

Percentage agreement for each variable is shown. IH, incisional hernia; AW, abdominal wall; ACS, anterior component separation; PCS, posterior component separation; TRAM, transverse rectus abdominis myocutaneous.

Discussion

The present study has identified a number of factors that signify a complex incisional hernia in the elective setting; the presence of one or more factors indicates a complex incisional hernia. The definition reflects both the potential complexity of surgical repair and also the risk of postoperative complications. The criteria should be used in future hernia studies to unify terminology, improve study reporting, and facilitate accurate comparison between separate studies[13].

Hernia width over 10 cm was considered an important cut-off for complexity. How this was measured was not considered, but the authors suggest it would be measured on cross-sectional imaging at rest in the supine position. Defect shape is relevant, as round defects are more challenging to close than elliptical defects, for example. Loss of domain is part of the definition of complex but also remains a difficult variable to define. A recent Delphi process on this topic alone added to the knowledge around this, but no percentage cut-off in loss of domain could be agreed on[14]. Several scores and calculations have been well described in the literature that can aid surgeons in quantifying the presence of loss of domain and predicting whether a component separation technique may be needed to facilitate abdominal wall repair[15–17]. It is also acknowledged that prehabilitation, preoperative adjuncts such as intra-abdominal botulinum toxin A, and progressive pneumoperitoneum[18], along with weight loss, can influence the calculation of both hernia width and loss of domain at the time of the surgery. The present study did not define a loss of domain cut-off percentage and this could be the subject of further studies.

Several factors were agreed in the definition related to operation site reflecting surgical wound classification (for example, clean/contaminated). Restoring gastrointestinal continuity may be the primary goal of the surgery, but the presence of these factors may limit mesh choice and decisions around component separation, and therefore were understandably included in the definition of complex incisional hernia.

A first-time recurrent incisional hernia *per se* did not reach consensus, but two or more previous repairs with further recurrence did. A number of factors relating to previous abdominal surgery, tissue harvest, tissue resection, and previous component separation techniques also met the consensus, which reflects the impact previous surgery might have on future hernia repair.

The only two patient-related factors that the PoE considered essential for defining a complex incisional hernia were BMI at least 40 kg/m^2 and cirrhosis with ascites, which have been identified previously as independent risk factors for poor postoperative outcomes[19]. Cirrhosis with ascites, suggesting advanced liver failure[20], indicates the need to ensure an intact peritoneum to prevent leakage of ascites, which supports its inclusion. There are well known limitations to BMI as an accurate indicator of subcutaneous and visceral adipose tissue, and in the current consensus process there was a strong debate around absolute values. Preoperative weight loss, for example a reduction in BMI from 55 to 40 kg/m^2, may allow incisional hernia repair to be achieved but is still suboptimal, and therefore needs detailed discussion with the patient and strategies to optimize weight before operation.

A number of patient-related variables known to increase postoperative morbidity, likelihood of hernia recurrence, and mortality did not reach consensus[21–23]. Similarly, a BMI threshold of 30 kg/m^2 may be associated with increased surgical-site infections and other adverse postoperative events[24,25]. Meanwhile, lateral incisional hernias and defects close to bony margins were not ultimately included, yet their importance is acknowledged; indeed, they have been considered to contribute to a complex hernia in previous studies[26]. Of note, removing patient votes resulted in hernias close to bony margin

reaching the consensus cut-off for complexity in the present study.

The limitations of a Delphi process are well known and recognized[27,28]. A consensus cut-off of 70 per cent was chosen and it is acknowledged that few factors had unanimous agreement. Scoring systems to help with decision-making are popular and often useful. It is unclear from this study how such a scoring system could be created regarding the management of complex incisional hernias. The independent or synergistic effect of multiple factors may preclude development of an accurate scoring/risk prediction model, and further work to study this question is required.

The patient panellists in the present study identified the importance of patient safety throughout the pathway, and emphasized the importance of surgeons' experience and interest and hospital facilities, as reported previously[29].

This study set out to define the complex incisional hernia, yet the authors acknowledge the potential for subjectivity in such a definition. Nevertheless, the features presented should influence referral practices to specialist hernia and abdominal wall surgeons. Although surgeon-related factors and hospital/facility-related factors were not included in the final definition, and do not themselves make an incisional hernia complex to repair, they are important in the context of patient care, especially in the complex patient with a non-complex incisional hernia[30]. Such factors may also affect referral practices or surgical decision-making.

This study has reported expert opinion on the definition of complex incisional hernia obtained through a Delphi process. Eighteen factors relating to the hernia and abdominal wall, the likelihood of a concomitant infection in the operative field, and patient co-morbidities were included in the definition. Continued research is required to add or remove factors as needed, and to consider how to translate such factors into a risk score. This new definition will help inform such studies, but should also be used across hernia research to improve quality and consistency in methodology and reporting.

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Supplementary material

Supplementary material is available at *BJS* online.

Data availability

All data supporting these findings are available on request to the corresponding author.

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