Hernia (2024) 28:839–846
https://doi.org/10.1007/s10029-024-02963-8

ORIGINAL ARTICLE

Delphi consensus statement for understanding and managing the subcostal hernia: subcostal hernias collaborative report (scholar study)

S. J. Baig[1] · G. V. Kulkarni[2] · P. Priya[1] · M. Y. Afaque[3] · J. Bueno-Lledo[4] · S. Chintapatla[5] · A. de Beaux[6] · J. A. Gandhi[7] · M. A. Garcia Urena[8] · T. M. Hammond[2] · D. Lomanto[9] · R. Liu[10] · A. Mehta[11] · M. Miserez[12] · A. Montgomery[13] · S. Morales-conde[14] · C. Palanivelu[15] · E. M. Pauli[16] · S. A. Rege[7] · Y. Renard[17] · M. Rosen[18] · D. L. Sanders[19] · V. K. Singhal[20] · D. A. J. Slade[21] · O. J. Warren[22] · S. Wijerathne[23]

Received: 4 October 2023 / Accepted: 5 January 2024 / Published online: 16 February 2024
© The Author(s), under exclusive licence to Springer-Verlag France SAS, part of Springer Nature 2024

Abstract

Introduction Subcostal hernias are categorized as L1 based on the European Hernia Society (EHS) classification and frequently involve M1, M2, and L2 sites. These are common after hepatopancreatic and biliary surgeries. The literature on subcostal hernias mostly comprises of retrospective reviews of small heterogenous cohorts, unsurprisingly leading to no consensus or guidelines. Given the limited literature and lack of consensus or guidelines for dealing with these hernias, we planned for a Delphi consensus to aid in decision making to repair subcostal hernias.

Methods We adopted a modified Delphi technique to establish consensus regarding the definition, characteristics, and surgical aspects of managing subcostal hernias (SCH). It was a four-phase Delphi study reflecting the widely accepted model, consisting of:

1. Creating a query.
2. Building an expert panel.
3. Executing the Delphi rounds.
4. Analysing, presenting, and reporting the Delphi results.

More than 70% of agreement was defined as a consensus statement.

Results The 22 experts who agreed to participate in this Delphi process for Subcostal Hernias (SCH) comprised 7 UK surgeons, 6 mainland European surgeons, 4 Indians, 3 from the USA, and 2 from Southeast Asia. This Delphi study on subcostal hernias achieved consensus on the following areas-use of mesh in elective cases; the retromuscular position with strong discouragement for onlay mesh; use of macroporous medium-weight polypropylene mesh; use of the subcostal incision over midline incision if there is no previous midline incision; TAR over ACST; defect closure where MAS is used; transverse suturing over vertical suturing for closure of circular defects; and use of peritoneal flap when necessary.

Conclusion This Delphi consensus defines subcostal hernias and gives insight into the consensus for incision, dissection plane, mesh placement, mesh type, and mesh fixation for these hernias.

Keywords Subcostal hernia · Ventral hernia · Complex hernia · L1 hernia · Delphi consensus

Introduction

Subcostal hernias are categorized as L1 based on European hernia society (EHS) classification but can frequently involve M1, M2, and L2 sites [1]. These are common after hepatopancreatic and biliary surgeries and a significant number present with loss of domain. Subcostal hernias are challenging to repair because of their proximity to the costal margin, diaphragm, heart, and lungs. This is particularly difficult due to the insertion of the lateral muscles in relation to the rectus which causes difficulty in creating extra peritoneal space mesh placement and fixation. Both open and minimal access surgery are used for subcostal hernias and the choice depends on

Extended author information available on the last page of the article

hernia characteristics and surgeon preference. There are many variations in the repair technique among surgeons related to incision, plane of dissection and mesh placement, mesh type, and mesh fixation for subcostal hernias. There is a lack of published literature, consensus and guidelines on the subject. We could not find any meta-analyses or systematic reviews specific for subcostal hernias. The existing literature comprises of case series, case reports and primarily focuses on differential techniques of surgical management for either subcostal hernias or subcostal hernias as a subgroup of 'lateral' or 'flank' hernias.

In view of the limited literature and lack of consensus or guidelines for dealing with these, we planned for a Delphi consensus to aid in decision making for the repair of subcostal hernias. We approached global experts and attempted to reach a consensus on important issues pertaining to subcostal hernia repair which we present in this paper. We have also discussed the areas of disagreements where future research may be focused.

Methods

This study adopted a modified Delphi technique [2] to establish consensus regarding definition, characteristics and surgical aspects related to the management of subcostal hernias (SCH). This was a four-phase Delphi study reflecting the widely accepted model which consists of the phases that are based on:

1. Creating a query
2. Building an expert panel
3. Executing the Delphi rounds
4. Analysing, presenting and reporting the Delphi results

The modified Delphi technique is similar in terms of procedure and intent but consists of beginning the process with a set of carefully selected items drawn from various sources including synthesized reviews of existing literature and unofficial interviews with selected content experts. These were selected based on prominence in international and regional hernia literature and no one was specifically asked regarding the number of subcostal hernias repaired in their career.

More than 70% agreement was defined as consensus for the purpose of this study which is similar to other collaborative efforts in published surgical literature using the Delphi process [3].

Phase I

A steering committee was formed consisting of three consultant surgeons from India performing high volume hernia surgery with publications in hernia literature (SJB, PP and MYA) and one senior fellow from the UK (GVK), with special interest in Abdominal wall reconstruction. All decisions in relation to methodology and analysis were agreed on a consensus basis and discussions were led by SJB as the senior member of the committee. Three members of the steering committee (GVK, PP, MYA) individually performed a literature search for evidence on subcostal hernias in March 2023 in Embase, PUBMED / MEDLINE, Web of Science and Google Scholar. The search items used were 'subcostal hernia', 'L1 hernia', 'transverse incision hernia', 'liver transplant AND hernia', 'hepatobiliary surgery AND hernia'. We could not find literature providing sufficient level of evidence on the subcostal hernia. We identified the potential areas of contention and controversies. These findings were converted into research questions for review. All members of the Indo-UK steering committee were invited to submit as many questions as felt necessary. The agreed upon questions were included in the First Round of Delphi process Questionnaire.

Phase II

During Phase II, experts were identified from across the world based on peer reviewed publications in hernia literature, having delivered prominent talks recently at hernia congresses on the topics related to lateral hernias, key members of esteemed hernia societies and corresponding lead authors of recent publications related to subcostal hernias specifically. A total of 32 experts were identified and invited individually via email to maintain anonymity and to avoid intrapanel discussions which could influence participation. We received confirmation from a total of 22 surgeons- 7 surgeons from UK, 6 from mainland Europe, 3 from USA and all 6 from Asia. The focus was strictly on the definition, characteristics and the elective (planned) repair of subcostal hernias.

Phase III

During the third Phase of the study, an online survey tool (Google Forms) was used to create a link with 31 multiple choice questions in Round one. Experts were asked to select the single closest response that reflects their practice. There was a free-text box provided at the end of each question for comments which were used along with the responses to formulate questions for Round 2 to get clarity on questions that did not achieve consensus in round one. Anonymity was maintained throughout the process and individual emails were sent to each of the invited experts to avoid interpersonal discussions which could influence responses. Following this the Steering Committee deliberated the results of the survey and questions which received consensus without any negative comments were removed from further iterations and stored separately.

For Round 2, the focus was on the questions which did not achieve consensus and those that attracted important comments. The comments were used for formulating the questions for Round 2. After round 2, Questions that received consensus were stored along with statements that achieved consensus in Round 1. The questions that did not achieve consensus or the ones with important comments were taken up for deliberation by the steering committee. After discussions it became evident from the pattern of responses that there were certain items in the aspects of surgical management of Subcostal hernias, which would not achieve consensus irrespective of the way the question could be framed, and these were removed as the expert panel was split evenly in both rounds. It was decided unanimously that there would be no advantage to pursuing these questions in a third round.

Phase IV

Data was analyzed using descriptive statistics and expressed as percentage agreement. Since this was a Delphi consensus of experts which did not involve any patient groups, no IRB approval or written consent was deemed necessary for its conduct. The steering committee wrote the findings of the paper and circulated amongst the experts prior to submission.

Results

The 22 experts who agreed to be a part of this Delphi process for Subcostal Hernias (SCH), comprised of 7 UK surgeons ((ACdeB, SC, AMM, DAJS, OW, DLS and TMH), 6 mainland European surgeons (MAGU, LB, MM, AM, SMC and YR), 4 Indian (CP, SAR, VS and JAG), 3 from the USA (MJR, EMP and RCL) and 2 from South East Asia (SW and DL). The response rates for both iterations of the questionnaires for each of the two rounds was 100% for all 22 panelists More than 70% agreement was defined as consensus (3).

Round 1

Tables 1 and 2 show results from Delphi rounds 1 (31 questions) and 2 (16 statements). There were 3 survey findings related to characteristics of SCH and 8 clinical-surgical questions that achieved consensus in Round 1 (Table 2). None of the procedure-related questions for W1 (<4 cm) or W2 (4–10 cm defect) hernias reached consensus in Round 1. So, they were rephrased for Round 2 based on expert comments and voting patterns. Opinion was split regarding use of intra peritoneal mesh or Minimal access surgical (MAS) techniques such as laparoscopy, IPOM,

Table 1 Combining the concept options from Round 1 to design a new definition for subcostal hernia

Concepts: Round 1: Number of experts who chose this option (%)
1. Only strictly L1 region defects 02 (09%)
2. All hernias with any part of the defect in L1 region 09 (41%)
3. Any hernia with the 'epicentre' or major part of the defect in L1 10 (45.5%)
4. Any hernia occupying L1 or M1 regions 01 (5%)
5. Either L2 or L1 hernias 0 (0%)
Definition designed by the facilitators for Round 2
"A hernia with a clinically significant part of the defect in the L1 region should be considered as a subcostal hernia."(95.5% consensus)

[a]The only panelist who disagreed with this also said they were 90% in agreement with the statement for definition except in case of a vertical para-median incision with clinically significant bulge in L1 region in which case they would not consider it a subcostal hernia

Table 2 Statements that achieved > 70% consensus regarding Surgical Management of Subcostal Hernias (SCH)

Statements from Round 1	Percentage consensus
1. Mesh should be used in all cases of elective repair of SCH.	(100%)
2. Sublay mesh repair (retrorectus/retromuscular/preperitoneal plane as per current ICAP nomenclature) is preferred during open repair and onlay repair of SCH is to be discouraged.	(95.5%)
3. Synthetic polypropylene, macroporous, medium-weight meshes are usually preferred for repair of SCH during sublay approach.	(86.3%)
4. In case of open approach, the subcostal incision or transverse approach is preferred.	(77.3%)
**Statement derived from comments- It is best not to take a midline incision if an incision does not already exist there.	(73%)
5. Horizontal axis is the preferred direction of closure in case of circular defects in the subcostal region.	(77.3%)
6. In minimal access surgery for SCH, defect closure is advisable.	(81.9%)
7. For repair of W2/W3 SCH requiring component separation, it is preferable to use Posterior Component Separation rather than Anterior Component Separation technique	(73%)
8. Open repair is the preferred approach for W3 (> 10 cm defect) SCH.	(86.3%)
Statements from Round 2	
1. In case of weak peritoneum or multiple peritoneal defects, an absorbable mesh can be considered in addition to a synthetic mesh while repairing SCH.	(77.3%)
2. Peritoneal flap/hernia sac can be selectively used during open repair of W2 or W3 subcostal hernias.	(95.5%)

robotic or endoscopic methods for repair of W1/W2 SCHs. There was no consensus regarding statements related to the need for fixation of mesh or techniques. Similarly, there was wide variation in responses garnered for statements related to use of peritoneal flap or coated mesh.

Round 2

Sixteen statements were presented to experts in round two with options of "Agree" or "Disagree" with free text available for comments after each question. Table 2 shows the statements agreed upon and Table 3 shows statements that did not receive any consensus.

Of note is a clinically relevant procedure-related statement—"For W2 Subcostal hernias, Minimal Access surgical (MAS) techniques can be used either as an adjunct to open surgery or as a stand-alone option in case significant expertise was available." This statement was agreed upon by 73% of the panel. However, the comments were quite unfavorable and 4 of the experts who had selected "Agree", remarked that employing open or MAS techniques for SCH were decisions that required tailoring to the individual patient. Two of them also mentioned that they had checked the "Agree" option since they had to select one answer instead of leaving it blank. Hence, we decided to mention the statement separately for the benefit of readers and not include it in consensus statements (Table 4).

For analyzing the results of Round 2, we divided the questions into two groups. The first group consisted of conceptual questions ($n = 5$) and second consisted of technical or procedural questions ($n = 11$) and used the number of "Agree" responses as the 'Scores' for obtaining a Coefficient of Variation (CV) in the pattern of responses by the experts. The CV value for the group of conceptual questions was 4.14 while the CV value for procedural questions was 16.77. A coefficient of variation lower than 5% is desirable. while CV values higher than 10% do not indicate confidence.

Table 3 Survey questions regarding special characteristics of Subcostal hernias, which achieved consensus

1. Subcostal or Kocher's incision (91% consensus) and the tri-radiate (Mercedes-Benz) incision (73% consensus) are the most common incisions leading to a subcostal hernia
2. Open cholecystectomy (86.3% consensus) and liver resections (68%) are the most common operations leading to subcostal hernias
3. Incidence of bridging should be lower than 10% for subcostal hernias as recurrence rates will be unacceptably high (91% consensus)
4. Subcostal hernias are usually incisional but rarely can be primary. (90.1%)
5. Biomechanics for subcostal hernias are different than midline hernias. (90.1%)

This is influenced by proximity to the costal margin, traction forces with different directional vectors and/or denervation from prior surgery

Table 4 Revised statements that did not achieve consensus (< 70% agreement) even in Round 2

1. Minimal Access Surgery (MAS) is the preferred option to manage most W1 (< 4 cm) subcostal hernias
2. For W2 subcostal hernias, MAS techniques can be used as either as an adjunct to open surgery or a stand-alone option in case considerable expertise is available
3. In Open repair of subcostal hernias in presence of a subcostal incision, it is acceptable to use the plane between the external oblique and internal oblique lateral to linea semilunaris and extend it to the retrorectus space without fear of denervation injury as the neurovascular bundles would have been divided already during prior surgery
4. During open repair of subcostal hernias, absorbable sutures can be used for fixing the mesh at discretion of the surgeon
5. IPOM Plus (intra peritoneal onlay mesh repair with defect closure) and sublay techniques are acceptable minimal access surgical techniques for W1 and W2 subcostal hernias where expertise is available
6. In case of bridging repair of subcostal hernias, microporous heavy weight mesh should be preferred over macroporous medium-weight mesh
7. Use of Robot may aid in cases of W1–W2 subcostal hernias where minimal access approaches are to be considered instead of open

Discussion

This Delphi study on subcostal hernias achieved consensus on the following areas— use of mesh in elective cases; the retromuscular position with strong discouragement for onlay mesh; use of macroporous medium-weight polypropylene mesh; use of the subcostal incision over midline incision if there are no previous midline incision; TAR over ACST; defect closure where MAS was used; transverse suturing over vertical suturing for closure of circular defects; and use of peritoneal flap when necessary. Surgeons agreed that the biomechanics for subcostal hernias are different from midline hernias, and this is due to proximity to the bone, denervation muscular atrophy due to the previous incision and different vectors of forces. This Delphi consensus also provides a definition for subcostal hernias (see Table 1).

The consensus was not achieved on the use of MAS and robotics in W1, W2 or W3 (>10 cm) hernias as well as fixation methods.

Literature search reveals many variations in terms of incision, mesh location, mesh type, and use of peritoneal flap for open subcostal hernia repair. Surgeons have used midline [4] or pre-existing subcostal incision [5–7]. The experts gave various reasons where using a midline incision was justified—presence of concomitant midline hernia, familiarity with the midline incision, and approaching from the nonscarred areas to reach the right plane. However, subcostal incision (transhernial) has the advantage of direct access to the sac and the defect as well as avoiding another incision into the abdominal wall [5]. In this study, we received consensus for preferring a subcostal or a transverse incision for repair of a subcostal hernia.

The location of mesh placement in subcoastal hernia repair has been reported as onlay/ retromuscular/ intraperitoneal [8–11]. However, recent guidelines based on current evidence advocate a retromuscular placement of mesh whenever technically feasible [12] and we saw the same reflected in the consensus as well (Table 2).

Surgeons have reported different planes of dissection lateral to linea semilunaris. Many use the TAR plane or preperitoneal plane [4, 7, 13, 14]; the plane between the external oblique and internal oblique (EO/IO plane) has also been reported [6, 9, 15, 16]. Using the TAR plane seems theoretically advantageous since it allows building the space up to the diaphragm cranially and also spares the neurovascular bundles. However, surgeons using the EO/IO plane argue that thoracoabdominal nerves are already divided from the previous incision and therefore there is little significance [5]. In this Delphi consensus, however, the experts voted in majority for the TAR plane. This might be also because of significant familiarity with the TAR plane and since it is relatively bloodless compared to the plane between the obliques.

The meshes reported in literature are polypropylene [4, 16, 17], polyester [4, 6] and biological [18]. Polyester have mesh has been associated with more central mesh fracture and higher recurrence [4]. In this consensus, the majority of experts voted in favor of polypropylene as the mesh of choice for subcostal hernia repair.

One study on use of peritoneal flap/hernia sac has shown encouraging results [15]. In this study, surgeons voted for its selective usage in W2/ W3 hernias. However, whether peritoneal flap/ hernia sac should be considered a reconstruction or a bridging repair was not addressed in this study.

The use of MAS for subcostal hernias and use of robots in general elicited variable responses and did not lead to any consensus in this study. This is interesting because it reveals the controversial nature of this issue. Clearly, this issue needs further examination and future research should be focused on this.

We could also get a definition on subcostal hernia—"A hernia with a clinically significant part of the defect in the L1 region should be considered as a subcostal hernia." Experts agreed that these hernias are usually incisional but rarely can be primary. During Round 1, none of the suggested five definitions of SCH achieved consensus. Panelists made 18 comments which were used to rewrite a potentially acceptable definition statement for Round 2 and re-presented to the experts.

Panelists also agreed that the biomechanics for SCH were different than midline hernias, and various reasons were given for the different biomechanics. The many different reasons given were "associated with denervation injury", "different vectors of force", "rib cage forms a boundary of the hernia", "costal margin is in close proximity" and "I don't think they are well understood since they are not midline hernias".

When we analyzed the results of round 2 we found that the CV value for the group of conceptual questions was 4.14 while the CV value for procedural questions was 16.77. A coefficient of variation lower than 5% is desirable. while CV values higher than 10% do not indicate confidence. So, it is apparent that when it comes to SCH, it is difficult for experts to come to consensus for technical and procedural related questions. At the same time statements related to concepts, characteristics and definitions garner consensus easily despite both sets of questions being changed after considering Round 1 responses and comments from the same group of experts.

The limitation of this study is that while expert consensus could be established by refined opinions and serial questioning, it is not backed by high-quality data. This is an inherent limitation of most Delphi processes. While we tried our best to include as many experts as possible from all over the world, there are many experts in the field who could not be a part of the study and therefore the consensus may be skewed in one or the other direction.

Conclusion

This Delphi study on management of SCH achieved consensus on use of retromuscular repair, subcostal incision, polypropylene mesh, TAR, and selective use of peritoneal flap in large sized hernias. However, there is a lack of unanimity regarding the use of MAS/ robotics and the fixation technique.

Conflict of interest

De Beaux A, declares conflicts of interest not directly related to the submitted work; has received paid honoraria for lectures from Medtronic, BBraun and CMR; he is General Secretary for European Hernia Society, co-treasurer of UEMS Abdominal Wall section and co-producer of online Hernia Basecamp learning platform. Montgomery A, declares conflicts of interest not directly related to the submitted work; speaker for Bard BD. Morales-Conde S, declares conflicts of interest not directly related to the submitted work; speaker for Bard BD; educational work for Medtronic, Ethicon, Storz Medical, Olympus, Stryker Corporation and WL Gore; and consultancy work for Dipro Medical. Liu R, declares conflicts of interest not directly related to the submitted work; consultancy work for Intuitive Surgical. Renard Y, declares conflicts of interest not directly related to the submitted work and educational grants from Bard BD, Hartmann. Sanders DL, declares conflicts of interest not directly related to the submitted work; educational grant, speakers fee and fee for post-market surveillance from Medtronic; and speakers fee and consultant for Bard BD; Slade DAJ, declares conflicts of interest not directly related to the submitted work, in the last year has received speaker bureau fees from Medtronic, WL Gore Ltd. And Cook Biotech.

Rosen M, declares conflict of interest not directly related to the submitted work, he receives salary support as medical director of the nonprofit Abdominal Core Health Quality Collaborative and serves as a board member with stock options for Ariste Medical. Urena MAG, declares conflict of interest not directly related to the submitted work; has received speaker fees from Gore, Medtronic and Dynamesh. Miserez M, reports research grants from FEG Textiltechnik, Medtronic, BD and Grunenthal NV, consultancy fees from Tissium SA, payment for webinars for Bard Benelux NC and Medtronic AG, membership of the European Commission Expert Panel in the field of Medical Devices for 'General and Plastic Surgery and Dentistry' and being Vice Chair of the Subgroup 'Surgical Implants and General Surgery'. E.M. Pauli reports having received speaker honorarium from Becton Dickinson, Medtronic, Ovesco and Boston Scientific, consultancy fees from Boston Scientific, Actuated Biomedical, Baxter, Wells Fargo, Cook Biotech, CMR Surgical, Neptune Medical, Surgimatix, Boehringer Laboratories, Allergan and Noah Medical and royalties from UpToDate and Springer. Baig SJ, Kulkarni GV, Priya P, Afaque MY, Bueno Lledo J, Chintapatla S, Mehta A, Gandhi J, Hammond TM, Lomanto D, Palanivelu C, Rege SA, Singhal VK, Warren OJ and Wijerathne S declare no conflict of interest for this manuscript, the Delphi process or the subject matter.

Acknowledgements The authors wish to acknowledge the contribution of Ms Anne-Marie Howell in the phase of questionnaire development of this Delphi process.

Data availability Data availability statement is not applicable for this study.

References

1. Muysoms FE, Miserez M, Berrevoet F, Campanelli G, Champault GG, Chelala E, Dietz UA, Eker HH, El Nakadi I, Hauters P, Hidalgo Pascual M, Hoeferlin A, Klinge U, Montgomery A, Simmermacher RKJ, Simons MP, Smietański M, Sommeling C, Tollens T, Vierendeels T, Kingsnorth A (2009) Classification of primary and incisional abdominal wall hernias. Hernia 13:407–414. https://doi.org/10.1007/s10029-009-0518-x
2. Custer RL, Scarcella JA, Stewart BR (1999) The modified Delphi technique – a rotational modification. J Career Tech Educ 15. https://doi.org/10.21061/JCTE.V15I2.702
3. Parker SG, Halligan S, Liang MK, Muysoms FE, Adrales GL, Boutall A, de Beaux AC, Dietz UA, Divino CM, Hawn MT, Heniford TB, Hong JP, Ibrahim N, Itani KMF, Jorgensen LN, Montgomery A, Morales-Conde S, Renard Y, Sanders DL, Smart NJ, … Windsor ACJ (2020) Definitions for loss of domain: an international Delphi consensus of expert surgeons. World J Surg 44(4):1070–1078. https://doi.org/10.1007/s00268-019-05317-z
4. Tastaldi L, Blatnik JA, Krpata DM, Petro CC, Fafaj A, Alkhatib H, Svestka M, Rosenblatt S, Prabhu AS, Rosen MJ (2019) Posterior component separation with transversus abdominis release (TAR) for repair of complex incisional hernias after orthotopic liver transplantation. Hernia 23:363–373. https://doi.org/10.1007/s10029-019-01918-8
5. Nielsen MF, de Beaux A, Damaskos D, Tulloh B (2019) Peritoneal flap hernioplasty for reconstruction of transverse incisional hernias. Hernia. https://doi.org/10.1007/s10029-019-02099-0
6. Veyrie N, Poghosyan T, Corigliano N, Canard G, Servajean S, Bouillot JL (2013) Lateral incisional hernia repair by the retromuscular approach with polyester standard mesh: topographic considerations and long-term follow-up of 61 consecutive patients. World J Surg 37:538–544. https://doi.org/10.1007/S00268-012-1857-9
7. San Miguel-Méndez C, López-Monclús J, Munoz-Rodriguez J, de Lersundi ÁRV, Artes-Caselles M, Blázquez Hernando LA, García-Hernandez JP, Minaya-Bravo AM, Garcia-Urena MÁ (2021) Stepwise transversus abdominis muscle release for the treatment of complex bilateral subcostal incisional hernias. Surgery 170:1112–1119. https://doi.org/10.1016/J.SURG.2021.04.007
8. Ahmed M, Mehboob M (2019) Comparisons of onlay versus sublay mesh fixation technique in ventral abdominal wall incisional hernia repair. J Coll Physicians Surg Pak 29:819–822. https://doi.org/10.29271/JCPSP.2019.09.819
9. Stumpf M, Conze J, Prescher A, Junge K, Krones CJ, Klinge U, Schumpelick V (2009) The lateral incisional hernia: anatomical considerations for a standardized retromuscular sublay repair. Hernia 13:293–297. https://doi.org/10.1007/S10029-009-0479-0
10. Moreno-Egea A, Carrillo-Alcaraz A (2012) Management of nonmidline incisional hernia by the laparoscopic approach: results of a long-term follow-up prospective study. Surg Endosc 26:1069–1078. https://doi.org/10.1007/S00464-011-2001-X
11. Lal R, Sharma D, Hazrah P, Kumar P, Borgharia S, Agarwal A (2014) Laparoscopic management of nonmidline ventral hernia. J Laparoendosc Adv Surg Tech A 24:445–450. https://doi.org/10.1089/LAP.2013.0381
12. Holihan JL, Nguyen DH, Nguyen MT, Mo J, Kao LS, Liang MK (2016) Mesh location in open ventral hernia repair: a systematic review and network meta-analysis. World J Surg 40:89–99. https://doi.org/10.1007/s00268-015-3252-9
13. Nevo N, Goldstein AL, Yakubovsky O, Biesse R, Nizri E, Lahat G, Karin E (2021) How-we-do it: the repair of postoperative ventral hernias after a Mercedes abdominal incision. Langenbeck's Arch Surg 406:2117–2123. https://doi.org/10.1007/S00423-021-02087-Y
14. Medina Pedrique M, Avilés Oliveros A, Morejon Ruiz S, San Miguel Méndez C, Muñoz Rodriguez J, López Monclus J, De Robin Valle De Lersundi A, García-Ureña MÁ (2023) OC 021 Transversus abdominis muscle release for the treatment of complex bilateral subcostal incisional hernias. Br J Surg 110. https://doi.org/10.1093/BJS/ZNAD080.028
15. Nielsen MF, de Beaux A, Stutchfield B, Kung J, Wigmore SJ, Tulloh B (2022) Peritoneal flap hernioplasty for repair of incisional hernias after orthotopic liver transplantation. Hernia 26:481–487. https://doi.org/10.1007/S10029-021-02409-5
16. Zuvela M, Galun D, Bogdanovic A, Bidzic N, Zivanovic M, Zuvela M, Zuvela M (2022) P-073 The modified sublay technique for the management of major subcostal incisional hernia: long-term follow-up results of 41 consecutive patients. Br J Surg 109. https://doi.org/10.1093/BJS/ZNAC308.171
17. de Peres MA, O, Aguiar HR, Andreollo NA, (2014) Surgical treatment of subcostal incisional hernia with polypropylene mesh – analysis of late results. Rev Col Bras Cir 41:82–86. https://doi.org/10.1590/S0100-69912014000200002
18. Schaffellner S, Sereinigg M, Wagner D, Jakoby E, Kniepeiss D, Stiegler P, Haybäck J, Müller H (2016) Ventral incisional hernia (VIH) repair after liver transplantation (OLT) with a biological mesh: experience in 3 cases. Z Gastroenterol 54:421–425. https://doi.org/10.1055/S-0042-103249

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.

Authors and Affiliations

S. J. Baig[1] · G. V. Kulkarni[2] · P. Priya[1] · M. Y. Afaque[3] · J. Bueno-Lledo[4] · S. Chintapatla[5] · A. de Beaux[6] · J. A. Gandhi[7] · M. A. Garcia Urena[8] · T. M. Hammond[2] · D. Lomanto[9] · R. Liu[10] · A. Mehta[11] · M. Miserez[12] · A. Montgomery[13] · S. Morales-conde[14] · C. Palanivelu[15] · E. M. Pauli[16] · S. A. Rege[7] · Y. Renard[17] · M. Rosen[18] · D. L. Sanders[19] · V. K. Singhal[20] · D. A. J. Slade[21] · O. J. Warren[22] · S. Wijerathne[23]

✉ S. J. Baig
docsarfarazbaig@gmail.com

[1] Department of Minimal Access Surgery, Belle Vue Clinic, Digestive Surgery Clinic, Bellevue Hospital Kolkata, Kolkata 700017, India

[2] Department of Colorectal Surgery, Broomfield Hospital (Mid and South Essex NHS Trust), Essex, UK

[3] Department of Surgery, J N Medical College, AMU, Aligarh, Uttar Pradesh 202002, India

[4] Hospital Universitari I Politecnic La Fe, Universidad de Valencia, Valencia, Spain

[5] Department of General Surgery, York Abdominal Wall Unit (YAWU), York & Scarborough Teaching Hospitals NHS Foundation Trust, Wigginton Road, York, UK

[6] Spire Murrayfield Hospital, Edinburgh, UK

[7] Department of Surgery, King Edward Memorial Hospital, Parel, Mumbai 400012, India

[8] Department of Surgery, Hospital Universitario del Henares, 28822 Madrid, Spain

[9] Minimally Invasive Surgical Centre, National University Hospital, Singapore 119074, Singapore

[10] Med Director Robotic Surgery, Alta Bates Summit Medical Center, Oakland, CA 94609, USA

[11] Department of Colorectal Surgery, St. Mark's Hospital, London, UK

[12] Department of Abdominal Surgery, University Hospital Gasthuisberg, KU Leuven, Louvain, Belgium

[13] Department of Surgery, Skåne University Hospital, Malmö, Sweden

[14] Unit of Innovation in Minimally Invasive Surgery, Department of General and Digestive Surgery, University Hospital Virgen del Rocio, University of Sevilla, Seville, Spain

[15] GEM Hospital and Research Centre, Coimbatore, India

[16] Division of Minimally Invasive and Bariatric Surgery, Department of Surgery, Penn State Milton S. Hershey Medical Center, 500 University Drive, Hershey, PA 17033, USA

[17] Reims Champagne-Ardennes, Department of General, Digestive and Endocrine Surgery, Robert Debré University Hospital, Reims, France

[18] Department of Surgery, Center for Abdominal Core Health, Cleveland Clinic Foundation, Cleveland, OH, USA

[19] Department of Abdominal Wall Surgery, Royal Devon University Foundation Trust, North Devon District Hospital, Barnstaple, UK

[20] Department of GI Surgery, Medanta Medicity Hospital, Gurugram, Haryana, India

[21] Department of Colorectal Surgery, Salford Royal NHS Foundation Trust, Salford, UK

[22] Department of Surgery, Chelsea and Westminster Hospital NHS Foundation Trust, London, UK

[23] Department of General Surgery, Alexandra Hospital, National University Health System), Singapore, Singapore