Review Article

Access this article online

Quick Response Code:

Website:
www.herniasurgeryjournal.org

DOI:
10.4103/ijawhs.ijawhs_59_21

# The open anterior component separation technique for large ventral and incisional abdominal wall reconstruction

**Frederik Berrevoet, Mathias Allaeys**

**Abstract:**

Large defects in the abdominal wall have been a challenge for traditional surgical techniques. Over several decades, the development of what is now known as the anterior component separation technique (CST) has evolved to reduce tension through release of the lateral abdominal wall muscles. Initially, Albanese and later Ramirez described and popularized this technique.

In this procedure, the space between the external oblique muscle and the internal oblique muscle is dissected immediately lateral to the rectus compartment, that is, at the level of the linea semilunaris. To reach this area, an extensive dissection of the subcutaneous tissue and bilateral dissection of the aponeurosis of the external oblique muscle is mandatory in an open standard approach. Unfortunately, this extensive dissection comes at the cost of higher wound morbidity rates.

Herein, the surgical technique, the indications as well as the complications will be discussed and a short overview of the results of the latest systematic reviews will be presented, comparing the anterior CST with other surgical options to achieve fascial closure in large abdominal wall defects.

**Keywords:**
Anterior, component separation technique, large ventral hernia, myofascial release, open technique

## Introduction

The component separation technique (CST) was introduced for abdominal wall reconstruction to treat large abdominal wall defects and allows for primary midline fascial closure. After initial publication of the technique by first Albanese[1] and later Ramirez in the early nineties of last century,[2] its use was rather limited during more than 10–15 years. However, during the years thereafter, reports on its use increased and a more general interest in repair of these challenging hernias with large diameter, regularly associated with loss of domain, was observed with more than 400 publications over the last 10 years.

The CST does no longer only involve the open technique with anterior release of the aponeurosis of the external oblique muscle, but several different CSTs have been described since then.

Considering the separation of components, a distinction has to be made between the release using an anterior versus a posterior approach. Furthermore, endoscopic variants of the anterior and posterior CST have been developed as well. All techniques have now been reported using open, laparoscopic, and robotic surgical armentarium.

So far, most of the evidence regarding the use of CSTs is derived from single-center experiences, mostly retrospective and often using non-comparative data. Only recently,

*Department of General and HPB Surgery and Liver Transplantation, University Hospital Ghent, Gent, Belgium*

**Address for correspondence**:
Prof. Frederik Berrevoet, Department of General and HPB Surgery and Liver Transplantation, Ghent University Hospital, Ghent, Belgium.
E-mail: frederik.Berrevoet@UGent.be

Submitted : 31-08-2021
Revised : 04-09-2021
Accepted : 10-09-2021
Published : 23-02-2022



**How to cite this article:** Berrevoet F, Allaeys M. The open anterior component separation technique for large ventral and incisional abdominal wall reconstruction. Int J Abdom Wall Hernia Surg 2022;5:2-7.

an analysis of the Spanish registry on incisional hernia repair was published, reporting on the use of CSTs by general surgeons in the everyday setting.[3] In this overview, we will focus on the surgical technique of the open anterior CST, the current indications, possible pitfalls and complications as well as outcomes and we will provide a short reflection on the existing literature regarding this abdominal wall release technique.

## Surgical Technique Step by Step

The procedure aims to divide the relatively fixed external oblique aponeurosis and muscle, to elevate the rectus abdominis muscle from its posterior rectus sheath, and then mobilize the myofascial flap consisting of the rectus, internal oblique, and transversus abdominis muscles medially. In anatomical studies, Ramirez *et al*.[2] showed "that the external oblique muscle can be separated from the internal oblique muscle in a relatively avascular plane." By doing so, the muscular block of the rectus muscle, as well as the internal oblique and transversus abdominis muscles, can be advanced approximately 8 cm around the waistline. Shestak *et al*.[4] showed that, although the abdominal wall structures are frequently attenuated or displaced, it is often possible to mobilize each rectus muscle unit for 8 cm around the waistline on each side of the abdominal wall, when surgical separation of the external and internal oblique muscles is performed to the posterior axillary line. Subsequent separation of the rectus muscle off the posterior rectus fascia above the arcuate line yields another 2 cm of medial muscle advancement at each level. This may in most situations lead to a maximum medial advancement of 6, 10, and 8 cm at the epigastric, periumbilical, and suprapubic levels, respectively.

During surgery, patients are positioned supine with arms out. Appropriate monitoring devices are placed by the anesthesia team. Hair is removed from the operation site with clippers and the skin is prepped. The field is widely prepped and draped from nipples to upper thigh and to the level of the bed over each flank. Thromboembolic prophylaxis with sequential compression devices on the lower extremities is necessary.

The operation usually starts with a full midline laparotomy followed by an extensive adhesiolysis of all tissue and viscera from the abdominal wall. It is important to have a completely freed abdominal wall to optimize medial advancement. We would advise you to keep the hernia sac in the beginning of the procedure to allow for posterior wall closure, or to even convert to the so-called peritoneal flap technique in case primary fascial closure seems not possible despite anterior release. Some surgeons advocate a split of the hernia sac in the midline,[5,6] but we prefer to cut the peritoneum at the side of the most retracted anterior fascia. This gives the advantage to be able to keep the anterior fascia at that side as long as possible. This implicates that the rectus sheath of the rectus abdominis muscle can be incised slightly posteriorly on that same retracted side and slightly anterior at the opposite side, where the posterior sheath is kept long (including the hernia sac).

In case a previous, non-infected mesh is present in an intraperitoneal or retromuscular position, this mesh can be salvaged and used to close the posterior sheath later on and should not be necessarily removed in all cases. Removal is of course necessary in case of infection, but most probably this will include removal of peritoneum, after which closure of the posterior wall might no longer be possible.

After finishing both the adhesiolysis and incision of both the rectus sheaths, the intraperitoneal phase can be ended and an antiseptic gauze can be placed over the intra-abdominal viscera to protect them from injury and to decrease intraoperative contamination and possible infection during these long surgical procedures.

Subsequently, the subcutaneous dissection can be started. A meticulous dissection is necessary with preservation of at least some of the major perforating vessels, although smaller ones can be safely sacrificed. The edges of the rectus sheath are grasped with Kocher clamps and pulled bilaterally toward the midline in order to determine how much advancement is necessary to recreate the linea alba. This will decide on uni- or bilateral release of the external oblique aponeurosis. Identification of the true lateral fascial edge of the rectus muscle is often difficult in the presence of dense scar tissue, and careful dissection is needed to locate the rectus sheath. As the abdomen is opened, it is very helpful to roll the lateral edge of the rectus muscle between your fingers to effectively localize the lateral border and the semilunar line. Dissection proceeds in the subcutaneous plane just above the rectus fascia to a point of 1–2 cm lateral to the border of the rectus sheath, from the costal margin superiorly to the anterior superior iliac spine (ASIS) inferiorly. It is only till that level the surgeon should mobilize the subcutaneous tissue. Further dissection will inevitably lead to increased wound morbidity.

The next step is determined by the size of the defect to be reconstructed. Most commonly for defects over 10 cm in width, recreation of the linea alba will not be possible without component release. An anterior component separation is then performed. The fascial edge of the side to be released is grasped with a Kocher and retracted toward the midline. Counter-traction is applied by the assistant who retracts the skin edge. The external oblique aponeurosis is then slowly and superficially incised

at this lateral point. Using small mosquito clamps the external aponeurosis can be lifted up and the avascular plane between the external and internal oblique muscle can be created over a short distance, just to confirm you are performing the correct separation of components. If so, the incision of the aponeurosis of the external oblique muscle can be extended along the entire length of the dissection. When uncertain, you should be careful to extend the dissection as both the external and internal oblique aponeurosis might be incised, which will leave a very thin abdominal wall with only the aponeurosis of the transverse abdominis muscle and transversalis fascia looking after the strength of the abdominal wall, possibly leading to abdominal wall rupture or invalidating and complex lateral bulging and recurrence [Figure 1]. As this occurs relatively frequent in unexperienced hands,[7] another possible check can be done by examining the orientation of the underlying muscle fibers. Obliquely oriented fibers of the internal oblique muscle should be visible.

Further dissection then proceeds in the avascular plane between the internal and external oblique laterally to the mid-axillary line. For hernias located in the subxiphoidal or epigastric region, extension of the release of the aponeurosis is mandatory to obtain the maximum medial mobilization. Therefore the release can be performed 5 cm on top of the ribs.

If a tension-free closure of the midline fascia is now possible, bilateral component release is not necessary. This preserves this plane for future procedures and decreases the likelihood of seroma formation, wound dehiscence and lateral bulge. If tension-free approximation is not possible with unilateral external oblique release, a bilateral release is warranted.

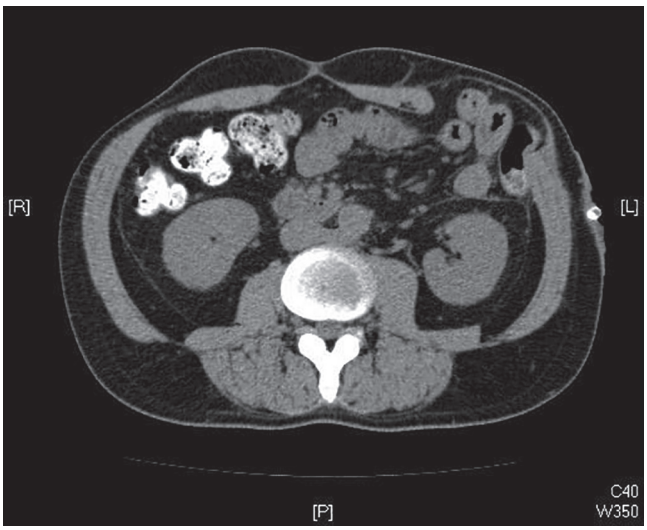


**Figure 1:** Technical error during performance of anterior CST leading to excessive bulging

It has been shown by several groups that an anterior release reinforced with mesh has a lower rate of recurrence than a non-reinforced repair and should therefore be recommended, specifically in clean surgical fields.[8,9] However, the position for mesh placement is still under debate. Both onlay, sublay and intraperitoneal meshes have been used,[7,10,11] in which retromuscular mesh positioning will not reinforce possible weaknesses created during the release technique. In case of a retromuscular or onlay mesh technique, closure of the posterior layer is performed using resorbable sutures. Our preference in clean surgical fields is to use an intraperitoneal composite synthetic mesh with anti-adhesive barrier to reinforce the abdominal wall far to the lateral sides, but in case of a bowel resection or presence of a stoma an onlay large pore synthetic mesh might be a safe alternative, probably at the cost of some extra seroma formation. Once the mesh is in place, the medial edges of the rectus sheath may be sutured together over the mesh using a PDS 2/0 in running fashion. Subcutaneous closed suction drains are essential and will be placed and brought out through the inferior skin lateral to the laparotomy incision.

## Indications

Although there is an ongoing discussion on what is the best separation technique, there are certainly some arguments to choose one over the other regarding outcomes. In cases a surgeon does not want to bridge a large defect with a retromuscular mesh without being able to close the anterior fascia, the anterior CST using an intraperitoneal mesh or an onlay mesh reinforcement will do the job. Most surgeons agree that the medial fascial advancement of the anterior fascia seems to be somewhat more extensive using an open anterior CST than with using a transverse abdominis release (TAR).[12] However, there are also reports that noted greater anterior fascial medicalization after TAR than after open anterior release in a cadaveric model.[13] In our opinion, most of the large incisional hernias with a diameter <15 cm probably can be closed in the midline with a large retromuscular mesh using bilateral TAR. In extreme situations with loss of domain and larger hernias, the anterior release + the use of botulinum toxin A and even the use of progressive pneumoperitoneum can achieve acceptable results.[14]

In patients with large midline abdominal incisional hernias in clean-contaminated, contaminated or infected fields, the anterior CST can be a good alternative to mesh repair, although results might be inferior to using mesh in these circumstances.[15,16] Tong *et al.*[17] showed that patients who had an open anterior myofascial release with mesh appeared to do better than those who had open CST alone and was associated with fewer hernia recurrences (16.7% with mesh versus 27% without). In

a qualitative systematic review for treatment of giant incisional hernias the authors concluded that mesh repair appeared to be superior to CST without mesh with regard to recurrence rates.[18]

## Complications

Unfortunately, standard anterior CST is associated with significant wound complication rates.[19,20] An extensive lateral dissection is needed to approach the lateral border of the rectus muscle and large subcutaneous skin flaps have to be created. When surgeons do not adequately consider preservation of the precious abdominal wall vascular supply, wound dehiscence, necrosis of both fat and skin and seroma formation might occur in this large dead space. Wound infection rates have been shown to range from 20% to more than 70%.[21,22] Against a background of this high complication rate associated with the anterior open CST, guidelines recommend alternative techniques for myofascial release, such as a perforator sparing technique, an endoscopic approach or a posterior CST technique.[23] However, considering the endoscopic anterior CST, medial advancement might be a little more limited, specifically caused by a limited subcutaneous mobilization, whereas perforator sparing CST might prevent skin necrosis, but does not specifically limit the dead space. Other tools to try to limit postoperative wound morbidity might involve talcage of the subcutaneous space, leading to a drastic reduction of seroma formation,[24] whereas others reported negative results of talc use in this setting.[25,26] Quilt sutures have also been mentioned to help reduce seroma formation.[27] Gandhi *et al*.[28] reported on the role of indocyanine green (ICG) to mitigate wound complications they showed that perfusion mapping by ICG was effective to determine potential areas of decreased perfusion and minimize wound complications by removal of at-risk tissue. More recently closed incision negative pressure therapy (ciNPT) was proposed to help in prevention of postoperative surgical site occurrences and a recent systematic review showed that mainly surgical site infection rates dropped with its use, more than other SSOs like seroma and hematoma formation.[29,30] Further studies using ciNPT in abdominal wall reconstruction have to focus on this more extensively.

## Discussion

When we look at the currently available systematic reviews that compared different CSTs, Cornette *et al*.[31] was one of the first to compare both the classical anterior component, the laparoscopic or endoscopic approach, the perforator preserving approach and the transverse abdominis approach. They focused on giant hernias and hernias with loss of domain. Giant ventral hernias were defined as ventral hernias larger than 10 cm in width with or without loss of domain. In their search, they found 36 articles for data analysis, with 22 concerning the open anterior technique (1,348 cases), 8 using the transversus abdominis release (761 cases), 13 using an endoscopic anterior approach (193 cases), whereas only 5 studies included at that time used the perforator preserving approach (242 cases). Based on these included studies, their surgical site occurrences was 21.4% for the open anterior CST group, versus 23.7% for TAR, 20.3% for the endoscopic technique and 16.0% for the perforating sparing patients. This was not statistically different with $P = 0.092$. The same was true for recurrence rates in those studies: the pooled analysis showed a total 11.9% recurrences after 22 months of follow-up, whereas the TAR showed 40 recurrences (5.3%) over a mean follow-up time of 17 months. The endoscopic group presented 12 recurrences in 171 cases (7.0%) over a mean follow-up time of only 11 months and 6.5% of recurrences were observed in the perforator sparing group, again over an average 22 months of follow-up. This was statistically significant in favor of both TAR and perforator sparing techniques. It could be argued that this analysis was performed in the early days of TAR and therefore the results might have significant bias, as it is rather surprising that the SSO rate was not significantly better in the TAR patients compared to the open anterior CST patients, despite the fact it was also shown by Hodgkinson *et al*.[32] and more recently by Pereira-Rodriguez *et al*.[3] The lower recurrence rates for TAR can possibly be explained by the myofascial advancement with the possibility of much wider mesh overlap as was also suggested by Wegdam *et al*.[33] In addition, the placement of mesh between the abdominal musculature and peritoneum during TAR may facilitate ingrowth as a result of placement in a well-vascularized space.

Recently, Balla *et al*.[34] compared minimally invasive (MI) anterior CST versus TAR and included 28 studies in total. Hybrid procedures, with MI anterior CST but closure of the midline defect by laparotomy were analyzed separately and involved 196 patients, versus 120 patients with complete MI anterior approach and 236 patients with MI TAR procedure. In their analysis, it was concluded that the hybrid procedure showed the worst results with 31.2% of surgical complications, versus 15.8% and 17.8% for the other groups, respectively. However, quality assessment of the included articles was performed, but also studies reported as poor quality were included in the analysis. Furthermore, complications were reported per study but the overall SSO and SSI rates were not specifically analyzed, nor differentiated for seroma, hematoma etc.

In conclusion, although various surgical techniques have now been made available for treatment of large abdominal wall defects, the open anterior CST still

remains a good option for obtaining primary fascial closure. Despite the higher incidence of wound related morbidities, several tools and devices can now be used to limit those down-sides.

## Financial support and sponsorship

Nil.

## Conflicts of interest

Prof. Frederik Berrevoet is an Editorial Board member of International *Journal of Abdominal Wall and Hernia Surgery*. The article was subject to the journal's standard procedures, with peer review handled independently of this Editorial Board member and their research groups.

## References

1. Albanese AR. Liberating incisions in the treatment of large supraumbilical eventrations. Prensa Med Argent 1966;53:2222-7.
2. Ramirez OM, Ruas E, Dellon AL. "Components separation" method for closure of abdominal-wall defects: An anatomic and clinical study. Plast Reconstr Surg 1990;86:519-26.
3. Pereira-Rodriguez JA, Bravo-Salva A, Montcusí-Ventura B, Hernández-Granados P, Rodrigues-Gonçalves V, López-Cano M; EVEREG Registry Members. Early outcomes of component separation techniques: An analysis of the Spanish registry of incisional Hernia (EVEREG). Hernia 2021. doi: 10.1007/s10029-021-02449-x.
4. Shestak KC, Edington HJ, Johnson RR. The separation of anatomic components technique for the reconstruction of massive midline abdominal wall defects: Anatomy, surgical technique, applications, and limitations revisited. Plast Reconstr Surg. 2000;105:731-8; quiz 739.
5. Malik A, Macdonald AD, de Beaux AC, Tulloh BR. The peritoneal flap hernioplasty for repair of large ventral and incisional hernias. Hernia 2014;18:39-45.
6. Petersson P, Montgomery A, Petersson U. Modified peritoneal flap hernioplasty versus retromuscular technique for incisional hernia repair: A retrospective cohort study. Scand J Surg 2020;109:279-88.
7. Maloney SR, Schlosser KA, Prasad T, Kasten KR, Gersin KS, Colavita PD, *et al*. Twelve years of component separation technique in abdominal wall reconstruction. Surgery 2019;166:435-44.
8. Razavi SA, Desai KA, Hart AM, Thompson PW, Losken A. The impact of mesh reinforcement with components separation for abdominal wall reconstruction. Am Surg 2018;84:959-62.
9. de Vries Reilingh TS, van Goor H, Charbon JA, Rosman C, Hesselink EJ, van der Wilt GJ, *et al*. Repair of giant midline abdominal wall hernias: "Components separation technique" versus prosthetic repair: Interim analysis of a randomized controlled trial. World J Surg 2007;31:756-63.
10. Bochicchio GV, Garcia A, Kaufman J, Zhang Q, Horn C, Bochicchio K, *et al*. Evaluating the impact of technique and mesh type in complicated ventral hernia repair: A prospective randomized multicenter controlled trial. J Am Coll Surg 2019;228:377-90.
11. MacDonald S, Johnson PM. Wide variation in surgical techniques to repair incisional hernias: A survey of practice patterns among general surgeons. BMC Surg 2021;21:259.
12. Sneiders D, Yurtkap Y, Kroese LF, Jeekel J, Muysoms FE, Kleinrensink GJ, *et al*. Anatomical study comparing medialization after rives-stoppa, anterior component separation, and posterior component separation. Surgery 2019;165:996-1002.
13. Majumder A, Martin-Del-Campo LA, Miller HJ, Podolsky D, Soltanian H, Novitsky YW. Evaluation of anterior versus posterior component separation for hernia repair in a cadaveric model. Surg Endosc 2020;34:2682-9.
14. Yurtkap Y, van Rooijen MMJ, Roels S, Bosmans JML, Uyttebroek O, Lange JF, *et al*. Implementing preoperative botulinum toxin A and progressive pneumoperitoneum through the use of an algorithm in giant ventral hernia repair. Hernia 2021;25:389-98.
15. Slater NJ, van Goor H, Bleichrodt RP. Large and complex ventral hernia repair using "components separation technique" without mesh results in a high recurrence rate. Am J Surg 2015;209:170-9.
16. Ghazi B, Deigni O, Yezhelyev M, Losken A. Current options in the management of complex abdominal wall defects. Ann Plast Surg 2011;66:488-92.
17. Tong WM, Hope W, Overby DW, Hultman CS. Comparison of outcome after mesh-only repair, laparoscopic component separation, and open component separation. Ann Plast Surg 2011;66:551-6.
18. Eriksson A, Rosenberg J, Bisgaard T. Surgical treatment for giant incisional hernia: A qualitative systematic review. Hernia 2014;18:31-8.
19. Elhage SA, Marturano MN, Prasad T, Colavita PD, Kercher KW, Augenstein VA, *et al*. Impact of perforator sparing on anterior component separation outcomes in open abdominal wall reconstruction. Surg Endosc 2021;35:4624-31.
20. Smolevitz J, Jacobson R, Thaqi M, Millikan S, Millikan KW. Outcomes in complex ventral hernia repair with anterior component separation in class III obesity patients. Am J Surg 2018;215:458-61.
21. Pauli EM, Rosen MJ. Open ventral hernia repair with component separation. Surg Clin North Am 2013;93:1111-33.
22. Deerenberg EB, Timmermans L, Hogerzeil DP, Slieker JC, Eilers PH, Jeekel J, *et al*. A systematic review of the surgical treatment of large incisional hernia. Hernia 2015;19:89-101.
23. Bittner R, Bain K, Bansal VK, Berrevoet F, Bingener-Casey J, Chen D, *et al*. Update of guidelines for laparoscopic treatment of ventral and incisional abdominal wall hernias (international endohernia society (IEHS)): Part B. Surg Endosc 2019;33:3511-49.
24. Klima DA, Brintzenhoff RA, Tsirline VB, Belyansky I, Lincourt AE, Getz S, *et al*. Application of subcutaneous talc in hernia repair and wide subcutaneous dissection dramatically reduces seroma formation and postoperative wound complications. Am Surg 2011;77:888-94.
25. Massey LH, Pathak S, Bhargava A, Smart NJ, Daniels IR. The use of adjuncts to reduce seroma in open incisional hernia repair: A systematic review. Hernia 2018;22:273-83.
26. Lopez-Monclus J, Artes M, Gonzalez J, Blazquez LA, Lucena JL, Robin A, *et al*. Failure of talc seromadesis for the treatment of subcutaneous chronic seromas after incisional hernia surgery. Scand J Surg 2021;110:105-9.
27. Alhussini MA, Awad AT, Kholosy HM. Using quilting sutures in decreasing seroma formation after managing large ventral hernias: A comparative study. Hernia 2019;23:717-22.
28. Gandhi J, Banker A, Chaudhari S, Shinde P. Role of indocyanine green to mitigate wound complications in component separation technique for ventral hernia repair-our early experience. World J Surg 2021;45:3073-9.
29. Berner-Hansen V, Oma E, Willaume M, Jensen KK. Prophylactic negative pressure wound therapy after open ventral hernia repair: A systematic review and meta-analysis. Hernia 2021.

30. Bueno-Lledó J, Franco-Bernal A, Garcia-Voz-Mediano MT, Torregrosa-Gallud A, Bonafé S. Prophylactic single-use negative pressure dressing in closed surgical wounds after incisional hernia repair: A randomized, controlled trial. Ann Surg 2021;273:1081-6.
31. Cornette B, De Bacquer D, Berrevoet F. Component separation technique for giant incisional hernia: A systematic review. Am J Surg 2018;215:719-26.
32. Hodgkinson JD, Leo CA, Maeda Y, Bassett P, Oke SM, Vaizey CJ, *et al*. A meta-analysis comparing open anterior component separation with posterior component separation and transversus abdominis release in the repair of midline ventral hernias. Hernia 2018;22:617-26.
33. Wegdam JA, Thoolen JMM, Nienhuijs SW, de Bouvy N, de Vries Reilingh TS. Systematic review of transversus abdominis release in complex abdominal wall reconstruction. Hernia 2019;23:5-15.
34. Balla A, Alarcón I, Morales-Conde S. Minimally invasive component separation technique for large ventral hernia: Which is the best choice? A systematic literature review. Surg Endosc 2020;34:14-30.