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VRAM versus alternative flaps for perineal repair following APER in the era of laparoscopic surgery.

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Abstract

Aims

Plastic surgical reconstruction of the perineum is often required following abdominoperineal excision of the rectum (APER). Options for this reconstruction include a vertical rectus abdominis myocutaneous (VRAM) flap, gluteal fasciocutaneous flap and gracilis myocutaneous flap. While the VRAM flap is well established at most centres, less experience exists with the gluteal and gracilis flaps. In the era of laparoscopic colorectal resection plastic surgeons are being forced to use gluteal and gracilis flaps because the VRAM flap must be tunnelled intra-abdominally requiring laparotomy. We therefore aimed to systematically review the evidence comparing VRAM, gluteal and gracilis flaps.

Methods

A comprehensive, structured literature search was conducted using Medline, Google Scholar and Science Direct. Studies included were randomised control trials and observational studies documenting complication rates associated with the VRAM, gluteal or gracilis flap.

Results

11 studies meeting all inclusion and exclusion criteria were identified. When meta-analysed the overall rate of any perineal wound or flap complication amongst VRAM patients (35.8%) was significantly lower than gluteal flap (43.7%) and gracilis flap patients (52.9%) ($p=0.041$).

Conclusions

The VRAM flap is well established for perineal reconstruction and this study suggests it may be superior to the gluteal and gracilis flaps in terms perineal wound and flap complications rates. This should be taken into account when weighing up the risks and benefits of a laparoscopic approach to APER. Large studies making direct comparisons between the flap options should be conducted.

Introduction

Colorectal cancer is the 3rd most common in the UK, and causes approximately 16,000 deaths annually^{1, 2}. Like most tumours, surgical excision represents the only definitive treatment conferring curative potential³; for low rectal tumours this takes the form of an abdominoperineal excision of the rectum (APER)^{4, 5}. Following such a procedure, plastic surgical reconstruction of the perineum is often required⁶. Options for this reconstruction include a vertical rectus abdominis myocutaneous (VRAM) flap, gluteal fasciocutaneous flap and a gracilis myocutaneous flap. While the VRAM flap is well established at most centres, less experience exists with the gluteal and gracilis flaps. In the era of laparoscopic colorectal resection, now thought to account for 40% of all resections⁷, plastic surgeons are being forced to use gluteal and gracilis flaps because the VRAM flap must be tunnelled intra-abdominally, requiring laparotomy. It is therefore pertinent that the evidence surrounding the different reconstructive options is studied carefully to establish whether non-inferiority of the gluteal and gracilis flaps compared to the VRAM flap is realistic, or whether the decreased reliability of these flaps should be considered when weighing up the advantages and disadvantages of a laparoscopic approach.

Methods

A comprehensive, structured literature search was conducted using Medline, Google Scholar and Science Direct, for studies investigating reconstruction of the perineum following abdomino-perineal excision of the rectum. Studies included were randomised control trials, observational studies and cases series published in English, documenting complication rates associated with the VRAM, gluteal or gracilis flap. Studies excluded were individual case reports, studies with inaccessible raw data and studies which pertained exclusively to vaginal

reconstruction or pelvic exenteration. Following amalgamation of the data, complication rates between the different flap options were compared using the chi-square test.

Results

An initial trawl of the literature identified 35 potentially admissible papers. Following review 24 papers were excluded: 5 papers investigated vaginal reconstruction only, 4 only included patients undergoing sacrectomies and pelvic exenterations, 6 papers were review papers/ editorials with no original data, 1 paper was only available in Czech, 2 papers investigated other flaps types (i.e. free latissimus dorsi flap), 4 papers only included patients undergoing omentoplasty or primary closure, 1 paper had inaccessible raw data and 1 paper was an individual case report. This left 11 studies for the final analysis (table 1), five pertaining to the VRAM flap⁸⁻¹², three to the gluteal flap¹³⁻¹⁵ and three to the gracilis flap¹⁶⁻¹⁸. All eleven studies were retrospective in nature. Five papers examined complications rates of a single flap type, five papers compared one type of flap to primary closure/ omentoplasty and one paper compared the VRAM flap to any form of thigh flap.

The individual complications documented in each study and overall complications rates are outlined in table 2. When the data was amalgamated and meta-analysed the overall rate of any perineal wound or flap complication amongst VRAM patients (35.8%) was significantly lower than gluteal flap patients (43.7%) and gracilis flap patients (52.9%) ($p=0.041$) (figure 1). A formal comparison between the flaps for individual types of complication was not made due to the low numbers of each complication. Complications encountered included wound dehiscence, wound infection, pelvic abscess, perineal herniation, haematoma, seroma, fistula and partial or total flap loss. Wound dehiscence and wound infection were the most

commonly reported complications amongst all three flap types. Rates of dehiscence ranged from 2.7% to 37.7% among VRAM patients, 5% to 29.9% in gluteal flap patients and 0% to 4% in gracilis flap patients. Wound infection rates ranged from 9.6% to 10.5% among VRAM patients, 5.6% to 12.5% in gluteal flap patients and 10.0% to 32.0% in gracilis flap patients.

Discussion

We have identified a number of studies that have investigated the efficacy of flap reconstruction of the pelvis and perineum following APER. All studies so far have been retrospective in nature and most of these studies have either reported only on the outcomes of a single group of patients undergoing reconstruction with one flap type, or have compared such patients to a control group consisting of patients undergoing primary perineal closure or omentoplasty; very few studies have performed a direct comparison between the different flap options. Therefore, it is difficult to determine definitively if any one particular flap is superior to the others.

Flap Viability and Perineal Wound Complications

One of the perceived strengths of the VRAM flap is its consistent viability and low rate of perineal wound complications. Several studies have reported low overall rates of such complications (15.8% to 26.8%)⁸⁻¹⁰ (table 1 and 2). For example, Chessin et al conducted a cohort study comparing 19 anorectal cancer patients treated with APER followed by VRAM flap reconstruction with 59 similar patients who underwent primary closure only. The rate of any perineal wound complication was significantly less in the VRAM flap group (15.8%

versus 44.1%; $p=0.03$)⁸. Lefevre et al retrospectively compared 41 anal cancer patients treated with APER followed by VRAM flap reconstruction to 43 similar patients managed with APER and omentoplasty. Perineal wound complications occurred in only 26.8% of the VRAM patients compared to 48.9% of the omentoplasty group ($p=0.0336$)¹⁰. Conversely two studies have reported significantly higher perineal wound or flap complication rates¹¹⁻¹². The first by Nelson et al reported the highest such rate associated with the VRAM flap in the literature, of 51.8% amongst 114 patients undergoing VRAM flap reconstruction following APER or pelvic exenteration¹². The particularly high rate found by this study may reflect the inclusion of pelvic exenteration patients, who represented 59.6% of VRAM flap patients. Pelvic exenteration is associated with a very large pelvic dead space¹⁹ and is known to be associated with a higher rate of perineal wound complications compared to APER when primary closure is used (25-60% vs. 32-84%)¹². Perhaps the same could be assumed with VRAM flap closure. The second study by Butler et al was a retrospective comparison between 35 anorectal cancer patients undergoing APER followed by VRAM flap reconstruction and 76 patients whose perineal wounds were managed with primary closure only. No significant difference was found between the groups in rate of any perineal wound or flap complication and both groups had a high rate of such complications (46% vs. 46%; $p=0.97$)¹¹. This is the only study identified which found that performing a VRAM flap reconstruction conferred no overall complication benefit over less radical closures with omentoplasty or primary closure, suggesting that there is something inherently different about this study; perhaps the lack of significant difference can be explained by the fact that 29% of the VRAM flap patients received intra-operative radiotherapy compared to 0% of the primary closure patients ($p<0.001$)¹¹. This however does not explain the overall high rate of perineal wound or flap complications in VRAM flap patients compared to others studies.

The rates of perineal wound or flap complications following gluteal flap reconstruction have consistently been reported to be moderately high, between 42.5% and 44.4%¹³⁻¹⁵ (table 1 and 2). Arnold et al reported the highest rate of 44.4% in their small study of 18 patients undergoing APER and gluteal flap reconstruction¹⁵. Winterton et al performed a retrospective review of 77 patients undergoing APER followed by gluteal flap reconstruction. Overall perineal wound or flap complication rate was 44.2%¹⁴.

The gracilis flap is perhaps the least well studied of the reconstructive options discussed here. Overall perineal wound or flap complications rates have been reported to lie between 37% and 64.0%¹⁶⁻¹⁸. Like the VRAM flap, the study reporting the highest rate of complications for the gracilis flap included a proportion of patients treated with pelvic exenteration as opposed to APER¹⁶, perhaps explaining the particularly high rate. In this study by Vermaas et al they investigated the surgical outcomes of 25 patients undergoing gracilis flap reconstruction following APER, pelvic exenteration, or other unspecified types of pelvic cancer resection. The overall rate of perineal wound complications was 64.0%¹⁶. However patients undergoing exenteration were also included in the study by Shibata et al which retrospectively compared 16 patients undergoing APER or pelvic exenteration followed by gracilis flap reconstruction to 24 patients undergoing primary closure only. There were significantly fewer major complications in the gracilis group (12% vs. 46%; $p=0.028$) but no significant difference in minor complications (25% vs. 21%; $p>0.05$). Overall complication rate amongst the gracilis flap patients was relatively low at 37.5%¹⁷. This gives less credence to the argument that inclusion of pelvic exenteration patients may increase the complication rate.

Worthy of note is the study mentioned previously by Nelson et al, which is the only study identified that made a direct comparison between different pedicled flap options. This

retrospective study compared 114 VRAM flap patients with a composite group of 19 patients undergoing various types of thigh flap reconstruction following APER or pelvic exenteration. The thigh flap group consisted of 9 gracilis flaps, 8 anterolateral thigh flaps and 4 posterior thigh flaps; exact detail of how each of these flaps were raised is not available. The VRAM flap group had a significantly lower rate of any perineal wound or flap complication (51.8% vs. 84.2%; $p=0.01$) as well as significantly lower rates of several specific wound complications such as pelvic abscess (6.1% vs. 31.6%; $p=0.0005$), perineal wound infection (5.3% vs. 26.3%; $p=0.01$) and major perineal wound dehiscence (5.3% vs. 21.1%; $p=0.04$). No significant difference was seen in terms of partial (5.3% vs. 15.8%; $p=0.12$) or total (0.9% vs. 5.3%; $p=0.27$) flap loss¹² suggesting that VRAM flap viability may not be superior. It should however be noted that the thigh flap group was disproportionately small compared to the VRAM flap group.

While two studies have documented high complication rates amongst VRAM patients (46.0%¹¹ and 51.8%¹²), it still seems possible to argue that the VRAM flap is superior to the gluteal and gracilis flaps, in terms wound complications, since three studies reported low rates amongst VRAM patients (15.8%⁸, 16.4%⁹ and 26.8%¹⁰) whereas no studies pertaining to the other flap types have reported similarly low complication rates (42.5%¹³, 44.2%¹⁴ and 44.4%¹⁵ amongst gluteal flap patients and 37.0%¹⁶, 68.0%¹⁷ and 40.0%¹⁸ amongst gracilis flap patients). The quality of the studies reporting low complication rates amongst VRAM flap patients is at least as high as studies pertaining to other flap types. Additionally in the only study identified that made a direct comparison between different flap options, the VRAM flap was found to be significantly superior to thigh flaps; gracilis flaps represented approximately half of this thigh flap group¹². To make firm conclusions however, direct comparisons would have to be made in larger studies.

Donor Site Morbidity

One of the most important, perceived disadvantages of the VRAM flap is the possibility of increased abdominal herniation in the region of rectus muscle removal.^{10, 19} Despite this, two studies have reported zero cases of abdominal herniation amongst VRAM flap patients,^{8, 9} and three studies have reported non-significantly lower rates of abdominal herniation amongst VRAM flap patients compared to their respective control groups^{8, 10, 11}. For example in the study by Butler et al abdominal incisional hernias were less common in the VRAM flap group as compared to patients undergoing primary closure alone (6.0% vs. 8.0%; p=1.0). Nelson et al found a non-significantly higher rate of abdominal incisional hernias (3.5% vs. 0%; p=1.0) amongst VRAM flap compared to thigh flap patients¹². It should be noted that the length of follow-up is particularly important for a late complication such as abdominal herniation and more donor site morbidity may have been identified if follow-up had been extended.

Donor site morbidity seems to be minimal with the gluteal and gracilis flaps since the gluteus muscle is preserved with gluteal fasciocutaneous flap reconstruction¹⁴ and because in functional terms the gracilis is only a minor leg adductor¹⁶.

Aesthetic Appearance

The European Union of Medical Specialities defines plastic surgery as “surgery intended to restore form and function and to promote well-being²⁰.” Clearly while the most important aim of perineal reconstruction is to close the wound effectively with as few complications as possible, doing so while achieving an aesthetically pleasing result is desirable. This applies to both donor and recipient sites. Arnold et al argue that the VRAM flap produces an egg-

shaped skin flap in the perineum that distorts the natal cleft appearance, where the gluteal flap is particularly useful for restoring normal natal cleft appearance¹⁶. On the other hand the VRAM flap creates no additional donor site scars if an open approach to cancer resection is planned¹¹. Gracilis and gluteal scars are commonly bilateral, as unilateral versions of these flaps are often not bulky enough¹⁰. Winterton et al however argue that gluteal flap scars are particularly inconspicuous¹⁵.

Radiation Exposure

One of the perceived benefits of flap reconstruction of the perineum is that the defect is repaired with non-irradiated tissue⁸. While this can certainly be achieved with the VRAM flap, Smart et al argue that the tissue used to construct a gluteal flap will inevitably have been irradiated to some extent if radiotherapy has been delivered²¹. This presumably also applies to the gracilis flap. This may in part explain the higher complication rates reported with such flaps.

Obliteration of Dead Space

As mentioned previously, flap reconstruction aims to obliterate dead space left within the pelvis following APER⁸. It is generally accepted that VRAM flaps have sufficient bulk to obliterate this dead space^{8,9}. However whether gracilis and gluteal flaps have sufficient bulk is debated. Hainsworth et al argue that while the gluteal fasciocutaneous flap is less bulky initially compared to myocutaneous flaps, the muscle component of such flaps atrophies with time making this difference less substantial¹³. Arnold et al also argue that the smaller bulk of the gluteal flap can be compensated for by taking the flap bilaterally¹⁵. While Chessin argue

that the VRAM is superior to the gracilis flap because of the gracilis flap's inability to fill the pelvic dead space⁸, Shibata et al argue that there is no need to completely fill the dead space as it is the lower pole of the pelvic cavity that is most often affected by complications¹⁷.

Vaginal Reconstruction

It is often necessary to excise portions of the vagina during APER to obtain clear resection margins. In these cases some form of vaginal reconstruction should be performed simultaneously with perineal reconstruction. Lots of experience exists with the VRAM flap for vaginal reconstruction; perhaps not the case for gracilis and gluteal flaps^{8, 12, 13}. Arnold et al concede that while the gluteal flap is a good option for perineal reconstruction, if used for vaginal reconstruction it considerably narrows the vagina and hence the VRAM flap should be used for sexually active females¹⁵. Vermaas believe the cutaneous portion of the gracilis flap can be used to repair the vaginal lining if required¹⁶.

Other Reconstructive Options

In addition to the flaps investigated in the current study, other reconstructive options have been described. The anterolateral thigh (ALT) flap has been used to reconstruct the perineum following APER. Pang et al. reported one surgeon's experience with the ALT flap. 10 patients who underwent ALT flap reconstruction were compared to 9 patients who had VRAM flap repair between 2010 and 2012. No significant difference was found between the groups in terms of infection, haematoma, bleeding and necrosis²². Di Summa et al. describe a method of combining the ALT flap with the underlying vastus lateralis muscle to repair large perineal defects in 6 patients who underwent APR with or without sacrectomy for high grade tumours. 4 patients had uneventful recoveries without complication. One patient developed

partial flap necrosis due to venous congestion secondary to pedicle kinking and one patient had a flap dehiscence felt to be secondary to cancer recurrence²³. These studies are small and further work would be welcomed to investigate other possible alternatives to the VRAM flap in the era of laparoscopic resection.

Laparoscopic Approach to APER

Laparoscopic approaches to colorectal resection are now thought to account for 40% of all resections⁷. VRAM flap reconstruction is not suitable if a laparoscopic APER has been performed because the flap must be tunnelled intra-abdominally¹³. In order to do this a laparotomy would have to be performed, negating the benefits of the original laparoscopic approach. Plastic surgeons must choose an alternative reconstructive option in this case.

Alternatively if it is felt that the patient may have heightened risk of flap failure or perineal wound complications due to the presence of risk factors such as diabetes or smoking, perhaps the less well established reliability of the gluteal and gracilis flaps discussed above, should be considered when deciding whether a laparoscopic approach is appropriate for that particular patient.

Conclusion

Pedicled flap reconstruction is often required following APER. The VRAM flap is well established for perineal reconstruction and Large studies making direct comparisons between the flap options must however be conducted to confirm this superiority or otherwise.

Regardless, gluteal and gracilis flaps will be used more often in the era of laparoscopic resection. These flaps have been successful for substantial numbers of patients and may in

fact be superior to the VRAM flap in terms of aesthetic appearance. While current evidence suggests no increased risk of abdominal herniation with the VRAM flap, studies with long follow-up are required to confirm this.

The VRAM flap is well established for perineal reconstruction and this study suggests it may be superior to the gluteal and gracilis flaps in terms perineal wound and flap complications rates. There are also perceived benefits in terms of reduced radiotherapy exposure, obliteration of pelvic dead space and suitability for simultaneous vaginal reconstruction. The potential superiority of the VRAM flap should be taken into account when weighing up the risks and benefits of a laparoscopic approach to APER. Large studies making direct comparisons between the flap options should be conducted.

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Figure Legends

Table 1: Methodology of studies identified that investigated efficacy of pedicled flap reconstruction of the pelvis and perineum.

Figure 1: Overall perineal wound and flap complication rates.

Table 2: Perineal wound and flap complication rates.

¶ Including cases of cellulitis.

* Parameter not referred to in study text. Impossible to determine whether this is because zero cases occurred or whether the parameter was not under study.

Figure

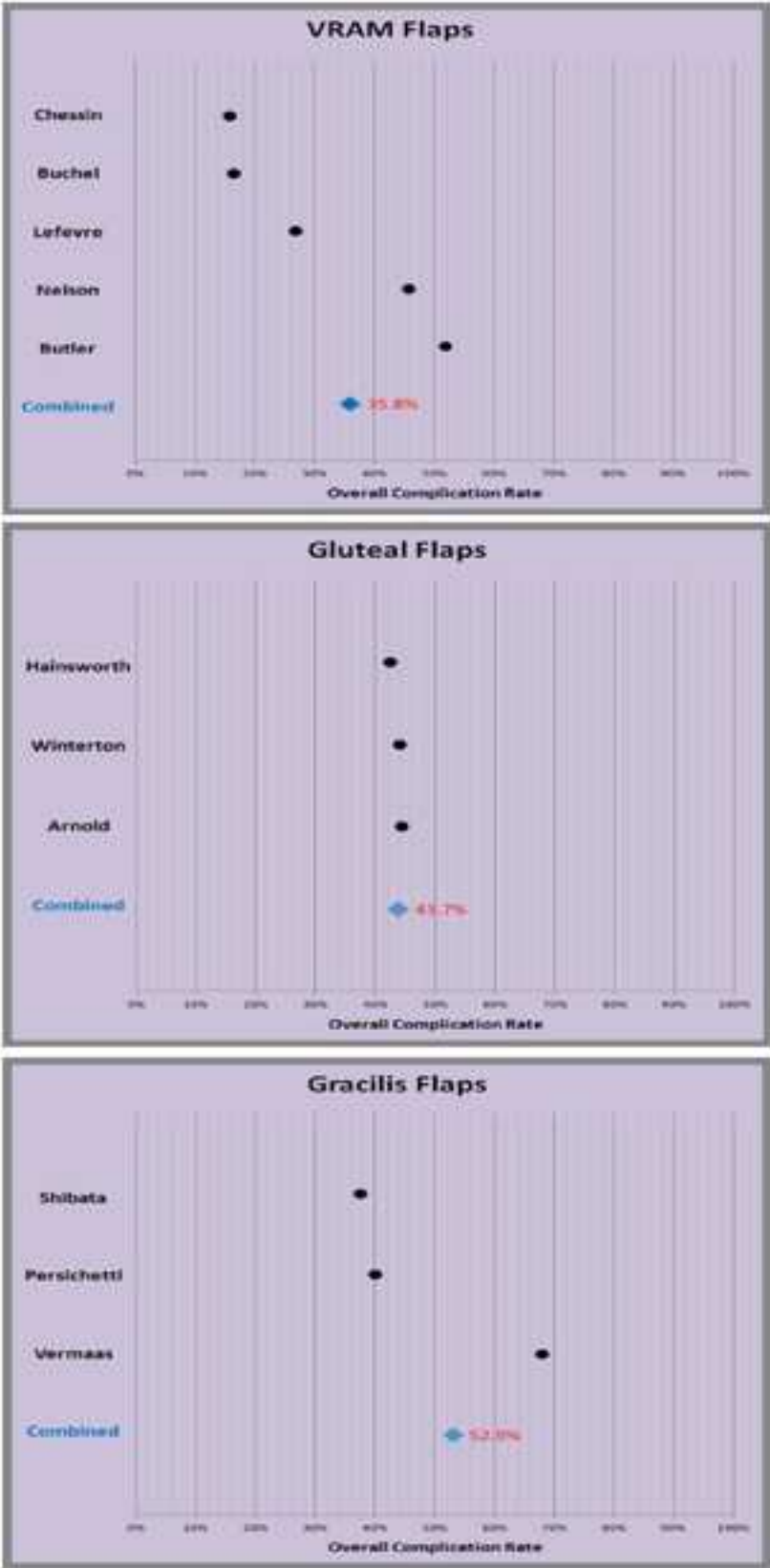


Figure 1: Overall perineal wound and flap complication rates for VRAM, gluteal and gracilis flaps.

Appendix

| Study | | Study Design | Patients/ tumours types included. | Study Group(s) |
|-----------------------|---------------------------|-----------------------------|---|--|
| VRAM Flap Studies | Chessin ⁸ | Retrospective cohort study. | Patients with anorectal cancer undergoing APER. | 19 VRAM flap patients vs. 59 primary closure patients. |
| | Buchel ⁹ | Retrospective case review. | Patients with a variety of pathologies including colorectal and gynaecological malignancies and Crohn's disease, requiring pelvic reconstruction. | 73 VRAM flap patients. |
| | Lefevre ¹⁰ | Retrospective cohort study. | Patients with anal cancer undergoing APER. | 43 VRAM flap patients vs. 52 omentoplasty patients. |
| | Nelson ¹² | Retrospective cohort study. | Patients with a variety of pelvic malignancies (mostly rectal cancer) undergoing APER or pelvic exenteration. | 114 VRAM flap patients vs. 19 thigh flap patients. |
| | Butler ¹¹ | Retrospective cohort study. | Patients with anorectal cancer undergoing APER. | 35 VRAM flap patients vs. 76 primary closure patients. |
| Gluteal Flap Studies | Hainsworth ¹⁴ | Retrospective case review. | Patients with rectal cancer undergoing APER or pelvic exenteration. | 40 Gluteal flap (all bilateral) patients. |
| | Winterton ¹⁵ | Retrospective review. | Patients requiring with anorectal or vulvar cancer requiring pelvic reconstruction. | 77 Gluteal flap (27 unilateral and 50 bilateral) patients. |
| | Arnold ¹⁶ | Consecutive case series. | Patients with anorectal cancer undergoing APER. | 18 Gluteal flap (all bilateral) patients. |
| Gracilis Flap Studies | Shibata ¹⁸ | Retrospective cohort study. | Patients with recurrent rectal cancer undergoing APER or pelvic exenteration. | 16 Gracilis flap (mix of unilateral and bilateral) patients vs. 24 primary closure patients. |
| | Vermaas ¹⁷ | Consecutive case series. | Patients with various pelvic malignancies undergoing APER, pelvic exenteration or other unspecified types of pelvic cancer resection. | 25 Gracilis flap patients. |
| | Persichetti ¹⁹ | Retrospective cohort study. | Patients with rectal cancer undergoing APER. | 10 Gracilis flap patients vs. 25 primary closure patients. |

Table 1: Methodology of studies identified that investigated efficacy of pedicled flap reconstruction of the pelvis and perineum.

| Study | Author | Wound Dehiscence | Wound Infection¶ | Pelvic Abscess | Perineal Herniation | Haematoma | Seroma | Fistula | Partial Flap Loss | Total Flap Loss | Patients with any perineal wound or flap complication. |
|--------------|---------------------------|------------------|------------------|----------------|---------------------|------------|--------------|-------------|-------------------|-----------------|--|
| VRAM Studies | Chessin ⁸ | 1/19 (5.3%) | 2/19 (10.5%) | * | * | * | * | * | * | * | 3/19 (15.8%) |
| | Buchel ⁹ | 2/73 (2.7%) | * | 2/73 (2.7%) | 0/73 (0%) | * | * | * | 7/73 (9.6%) | 1/73 (1.4%) | 12/73 (16.4%) |
| | Lefevre ¹⁰ | * | * | * | 0/41 (0%) | * | * | * | * | * | 11/41 (26.8%) |
| | Nelson ¹² | 43/114 (37.7%) | 11/114 (9.6%) | 7/114 (6.1%) | 1/114 (0.9%) | 0/114 (0%) | 7/114 (6.1%) | * | 6/114 (5.3%) | 1/114 (0.9%) | 59/114 (51.8%) |
| | Butler ¹¹ | 12/35 (34%) | * | 3/35 (9.0%) | 2/35 (6%) | 0/35 (0%) | 0/35 (0%) | * | 0/35 (0%) | 1/35 (3%) | 16/35 (46%) |
| GF Studies | Hainsworth ¹⁴ | 2/40 (5%) | 5/40 (12.5%) | * | 2/40 (5%) | * | * | 1/40 (2.5%) | * | * | 17/40 (42.5%) |
| | Winterton ¹⁵ | 23/77 (29.9%) | 7/77 (9.1%) | 0/77 (0%) | * | * | * | * | 2/77 (2.6%) | 1/77 (1.3%) | 34/77 (44.2%) |
| | Arnold ¹⁶ | 4/18 (22.2%) | 1/18 (5.6%) | 3/18 (16.7%) | * | * | * | * | 0/18 (0%) | 0/18 (0%) | 8/18 (44.4%) |
| GM Studies | Shibata ¹⁸ | * | * | * | * | * | * | * | * | * | 6/16 (37.0%) |
| | Vermaas ¹⁷ | 1/25 (4.0%) | 8/25 (32.0%) | 3/25 (12.0%) | 1/25 (4.0%) | * | * | 4/25 (16%) | 0/25 (0%) | 0/25 (0%) | 17/25 (68.0%) |
| | Persichetti ¹⁹ | 0/10 (0%) | 1/10 (10.0%) | 0/10 (0%) | 0/10 (0%) | * | 1/10 (10.0%) | 0/10 (0%) | 1/10 (10.0%) | 0/10 (0%) | 4/10 (40.0%) |

Table 2: Perineal wound and flap complication rates.

¶ Including cases of cellulitis.

* Parameter not referred to in study text. Impossible to determine whether this is because zero cases occurred or whether the parameter was not under study.