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USING OF NEGATIVE WOUND PRESSURE THERAPY (NPWT): A CASE SERIES OF WOUND DISRUPTION AS A COMPLICATION OF A CAESAREAN SECTION

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ABSTRACT

Introduction: Wound disruption following caesarean sections is a common issue that can increase maternal mortality and morbidity. Several factorshave been identified, including maternal, procedural, and antibiotic factors. The re-suturing method, primer, and secondary suture often fail,causing recurrent and delayed healing.
Case Illustration: CASE 1: A 26-year-old woman, 7 days post-caesarean section, presented with a wet wound and yellowish serous fluid. Three weeks later, wound dehiscence occurred despite re-debridement and re-suturing. Subsequent installation of VAC resulted in granulation tissue and re-epithelialization. CASE 2: A 32-year-old woman, 14 days post-caesarean section, complained of weakness and pus in the surgical wound. Upon examination, a red-yellowish fluid was found, indicating wound dehiscence. Re-debridement and VAC installation led to the formation of granulation tissue and re-epithelialization.
Discussion: VAC is the new wound care technique that suctions or collects excess exudate thatabsorbent gauze cannot accommodate. In comparison, absorbent gauze is limited in its capacity to absorb the fluid that produced in wounds. An innovation where the use of VAC, which has anegative pressure function, can stimulate granulation tissue to form and can bind the edges of the wound so that it can close naturally.
Conclusion: In instances of wound disruption following surgery, such as in the case of a caesarean section, it may be prudent to contemplate re-debridement followed by re-suturing. VAC presents itself as a viable alternative for managing wound dehiscence until the formation of granulation tissue.

Highlights:

1. Surgical site infection during caesarean section can cause complications, thereby increasing maternal mortality and morbidity, especially in groups at risk.
2. VAC therapy can stimulate granulation tissue formation so that primary wound junctions occur.
3. VAC shows its ability to close wounds entirely within 3-4 weeks

INTRODUCTION

Surgical Site Infection (SSI) is an infection at the surgical site that occurs burdens for patients. Patients who experience SSI are estimated to have three times more readmissions with significantly higher costs within 30 days after surgery. Surgical wound infections can be classified based on the depth of the tissue involved, starting from the outer and subcutaneous to deeper tissue, including fascia and muscle layers. The infection can spread to organs and body cavities.[1] Studies show that the most common pathogen causing SSI is *Staphylococcus aureus,* which occurs in 15%-20% of cases.[2]

A survey conducted in the UK revealed that Surgical Site Infection (SSI) ranked as the third most common cause of Healthcare-Associated Infections (HAIs).[3] According to data from the Centers for Disease Control and Prevention (CDC) in 2015, there were 110,800 cases of SSI reported in inpatient surgical procedures, contributing a percentage of 20 percent of all HAIs cases. Even though there have been developments in improving operating room ventilation, controlling infections, providing prophylactic antibiotics, as well as developing sterilization methods and surgical techniques, SSI still contributes to the cause of morbidity and mortality in patients with a mortality risk of up to 75%.

Infection is a risk factor for disturbances in wound healing. Continuous inflammation due to prolonged cleaning of microbes can cause chronic wounds and failure to heal.[4] Wounds will experience delayed re-epithelialization, leading to the formation of hypertrophic scars due to the accumulation of abnormal extracellular matrix.[5]

Based on a survey in the UK, patients with SSI will experience prolonged hospitalization of up to 9.7 days, which causes an additional cost burden than non-infected patients, with additional costs reaching £5,249. Cost burdens include expenditures on diagnostics, inpatient care, staffing, and pharmaceuticals, encompassing heightened antibiotic usage, increased utilization of wound dressings, and additional therapeutic interventions.[3]

Surgical Site Infection (SSI) is a complication that can occur after a caesarean section, which is associated with high maternal morbidity and mortality rates in subsequent pregnancies.[6] Numerous risk factors contribute to the occurrence of SSI post-caesarean section, encompassing individual, pregnancy-related, intrapartum, and procedural considerations. Personal factors include maternal age, obesity, maternal comorbid diseases, history of miscarriage, and history of previous caesarean section. Pregnancy and intrapartum factors include hypertensive disease, gestational diabetes mellitus, multiple pregnancies, premature rupture of membranes, and chorioamnionitis. Procedural factors indicate an increased risk of delivery without prophylactic antibiotics, emergency delivery, the need for blood transfusions during surgery, prolonged labor duration, and operating environments with poor sanitation.[2] An infection in a post-caesarean wound can lead to various complications, one of which is wound dehiscence.

Many preventive measures are available to mitigate Surgical Site Infection (SSI) and associated complications following caesarean sections, spanning perioperative, intraoperative, and postoperative phases. The closure technique employed for the wound significantly influences the incidence of wound dehiscence. Conventionally, wound closure typically involves suturing, utilizing staples, or a combination of both. However, such techniques still carry the risk of wound dehiscence.

Vacuum Assisted Closure (VAC) therapy is widely utilized for managing various types of wounds, including those in the abdomen, fractures, sternum, and as prophylaxis for closed incisions.[7] Studies have consistently shown that VAC therapy significantly reduces the incidence of Surgical Site Infection (SSI), wound dehiscence, seroma formation, and skin necrosis by facilitating primary wound

closure. Its effectiveness extends to managing wound dehiscence following caesarean sections, thereby lowering the risk of SSIs and subsequent wound dehiscence.

CASE ILLUSTRATION

Case 1

A 26-year-old housewife, G1 P1A0, with a gestational age of 38-39 weeks, underwent complete prenatal care with no uterine abnormalities detected. The patient opted for a caesarean section due to indications of prolonged labor on March 3rd, 2023. She had a height of 155 cm and a body weight of 75 kg, resulting in a BMI of 31, classified as Obesity level I. Prior to surgery, the patient received prophylactic antibiotic cefazolin 2g (first-class cephalosporin). No intraoperative abnormalities were noted. The baby was born immediately crying with an Apgar score of 9, weighing 3100 g, and clear amniotic fluid. The patient and baby were discharged two days after the caesarean section.

Figure 1. Post Caesarian Section (A) First week, (B)Third week, (C)Third days after the first re-debridement, (D) Second re-debridement and VAC installed, (E)Second weeks after VAC installed, (F) Third weeks after VAC installed, (G)First weeks after VAC removed

As a follow-up to the surgery, a week later, the patient returned for wound inspection with the main complaint of a burning sensation in the wound accompanied by yellowish fluid discharge from the surgical wound. The patient reported no fever, weakness, or nausea. Vital signs of the patient were as follows: blood pressure 120/80 mmHg, heart rate 80 bpm, respiratory rate 22 times/minute, and body temperature 37.1°C. Based on a complete blood test, the patient's hemoglobin level was 12 g/dL, leukocytes were 10,200 µ/L, and platelet count was 345,000. The patient was observed in the hospital for wound management.

Based on the observations in the first-week post-surgery, the patient's wound exhibited a wet dressing accompanied by yellowish serous fluid with a positive *Staphylococcus aureus* culture. The patient received a course of co-amoxiclav injections, 3 x 1g for seven days. The wound fluid was cleaned using absorbable gauze every two days while maintaining wound moisture. In the second week after wound care (three weeks after caesarean section), dehiscence was discovered with open wound edges and stretched stitches, leading to re-debridement and re-suturing. Dehiscence recurred after re-debridement and re-suturing of the wound on the third day, with a positive *Staphylococcus aureus* culture. Re-debridement was performed first. On the third day after the initial re-debridement, the wound was re-debrided, and a decision was made to install a VAC. In the second week after VAC installation, the wound turned reddish, indicating the beginning of revascularization. By the third week after VAC installation, granulation tissue started forming in the

wound. In the first week after VAC removal, the wound appeared closed.

Case 2

The 32-year-old woman is a teacher, G2P2A0, with a gestational age of 39-40 weeks. The patient's prenatal history is complete, and there were no visible abnormalities during the pregnancy. A caesarean section was performed on March 3rd, 2023, due to indications of premature rupture of membranes for more than 24 hours. The patient's height is 162 cm, with a body weight of 63 kg, resulting in a BMI of 24 (standard classification). A preoperative prophylactic antibiotic, 2g cefazolin injection (first-class cephalosporin), was administered. During the operation, greenish amniotic fluid was observed. The baby cried immediately after birth, with an Apgar score of 8-9. Three days post-caesarean section, the patient was discharged home.

Figure 2. Post Caesarian Section (A) First day, (B) Third day, (C) Re-debridement, (D) VAC installation, (E) First week after VAC installation, (F) Second week after VAC installation, (G) Third week after VAC installation, (H) First treatment after VAC removal, (I) First week after VAC removal

Two weeks after the caesarean section, the patient came for wound control with the main complaints of weakness and the presence of yellowish fluid coming out of the wound in small quantities. There is no fever or pain in the wound. The patient's vital signs are blood pressure 127/60 mmHg, heart rate 75 bpm, respiratory rate 22 times/minute, and body temperature 36.8°C. A complete blood examination shows a hemoglobin level of 12 g/dL, 9800 µ/L leukocytes, and platelets 298,000. The patient was then hospitalized for observation and wound care. Wound care is carried out every two days. A culture was carried out on the wound specimen. The patient was hospitalized for observation and wound management.

Based on observation results in the second week post-surgery, wound dehiscence with yellowish fluid was noted, and the *Staphylococcus aureus* culture was positive. A regimen of co-amoxiclav injection, 3×1 g for seven days, was administered alongside wound treatment. On the second day post-wound treatment, increased exudate production and widening of wound dehiscence prompted the decision to install a Negative Pressure Wound Therapy (NPWT) system, specifically the Negative Pressure Wound Therapy (NPWT) in the two cases mentioned.

During the first week after NPWT installation, exudate and wound area decreased. In the second week, wound edges appeared to draw closer, with vascularization evident. By the third week, visible granulation

tissue formation was observed. Upon VAC removal, the wound appeared fully closed and healed. Subsequent follow-up in the first-week post-VAC removal showed primary wound closure and no recurrence of wound dehiscence.

The VAC type used was Negative Pressure Wound Therapy (NPWT) in the two cases above. Before installing a VAC, the wound is first cleaned thoroughly with normal saline. The black sterile foam was used to bandage wounds. According to Agarwal et al. (2019), VAC therapy for thoracic or abdominal wounds can be used with lighter black foam (Polyurethane ether) with a 400-600 mm pore size. This foam provides an even distribution of negative pressure throughout the wound bed.[8] A fenestrated evacuation tube is mounted on the foam and connected to a vacuum pump. Then, the foam and pipe are covered with adhesive to keep the wound water and airtight. The pressure used was 120 mmHg in continuous mode, and the foam was replaced, and the wound was evaluated weekly.

DISCUSSION

Surgical Site Infection (SSI) is an infection that occurs within 30 days after surgery. SSI can be classified based on the depth of tissue involved into superficial incision SSI, deep incision SSI, and cavity/organ SSI. The risk factors for SSI are not only related to the wound but are also influenced by perioperative-related and individual factors. In Case 1, the patient's obesity, classified by their BMI, poses a specific risk factor for SSI following caesarean section. The indication for a caesarean section in case 2 wasdue to premature rupture of the membranes. A history of previous infection, which is visiblein the greenish amniotic fluid, is a risk factors responsible for surgical wound infection in the mother's caesarean wound. With the high number of caesarean deliveries and increasing inthe last ten years[9], delivery rooms have thepotential to have low sterility, thereby creating a risk of SSI after caesarean delivery in mothers.

The presence of SSI often leads to wound dehiscence, defined as total or partial separation of wound edges due to incomplete wound healing, primarily in the early stages of wound healing.[10] Wound dehiscence itself, if not handled properly, can cause various complications, one of which is persistent infection, which induces a prolonged inflammatory process, causing delayed wound healing. This excessive inflammatory process can stimulate fibrotic tissue, which can cause the accumulation of abnormal extracellular matrix, which leads to hypertrophic scars.[5]

Conventionally, the management of wound closure after a caesarean section generally uses the method of skin closure using sutures and staple closure.[6] However, the re-stitching method in case 1 did not show good results even after re-debridement three times, which resulted in the patient experiencing wound dehiscence again. Likewise, in case 2, after wound treatment, there was still a widening of the wound dehiscence and increased exudate production. Based on the series of wound treatments that were carried out, it turned out that the wound could not improve, so it was decided to undergo therapy using VAC.

Vacuum Assisted Closure (VAC) offers an alternative approach to wound management, utilizing negative pressure to prepare the wound site for natural healing or less invasive reconstructive treatment options.[11] It is a therapeutic technique within the negative pressure wound therapy (NPWT) system, applying subatmospheric pressure to reduce inflammation and stimulate granulation tissue formation.[12] NPWT efficiently removes necrotic tissue and wound secretions, stimulates granulation tissue production, reduces bacterial infection, and accelerates wound healing.[13]

The VAC system consists of a semi-occlusive adhesive cover, polyurethane foam sponge, fluid collection system, and suction pump. Its working mechanism encompasses four main mechanisms: macrodeformation,

fluid drainage, stabilization of the wound environment, and microdeformation.[14] These mechanisms are supported by clinical evidence demonstrating faster wound healing and reduced complications compared to conventional wound closure methods. They emphasize how VAC contributes to wound contraction, reduction of edema, and the promotion of angiogenesis and granulation tissue formation, all crucial for effective wound healing.

Subatmospheric pressure induces macrodeformation by promoting wound contraction, while polyurethane foam aids in pressure distribution and effective exudate absorption, ultimately reducing the wound's surface area.[14] Edema in wounds can suppress extracellular matrix cells, reducing cell proliferation essential for wound healing. With VAC, suction minimizes edema by removing extracellular fluid, increasing intravascular fluid velocity, and reducing intravascular hydrostatic pressure, thereby lowering intravascular fluid efflux and edema.[8] Reducing exudate in wounds also benefits tissue perfusion and can limit the depth of dead cells.[14,15]

The semi-occlusive polyurethane drape stabilizes the wound environment by acting as a semipermeable membrane, which maintains warmth and moisture while limiting microbial colonization and preventing further infections. This stability reduces the frequency of dressing changes, unlike traditional gauze dressings. Moreover, by minimizing the risk of recurrent Surgical Site Infection (SSI), wounds can heal without delays, thus preventing the formation of hypertrophic scars.[5]

Microdeformation, induced by the negative pressure generated by VAC at the interface between the wound and the foam, triggers shear stress, promoting cell deformation and enhancing wound tissue perfusion. This microdeformation process also stimulates angiogenesis, cell proliferation, and granulation tissue formation. Angiogenesis is facilitated by tissue hypoxia, leading to the release of nitric oxide (NO) and the expression of Vascular Endothelial Growth Factor (VEGF).[8] Experimental studies in animal models have consistently shown accelerated wound healing, with a significant increase in granulation tissue formation compared to gauze dressings.[16]

Cases 1 and 2 achieved complete wound healing in just 3-4 weeks, faster than the typical wound healing phase. The stimulation of granulation tissue formation facilitates the natural closure of the wound.

Furthermore, the use of VAC enhances patient and nursing staff comfort compared to traditional dressings, reducing the frequency of dressing changes, fluid leakage, and wound odor.[14,17] Despite potentially higher initial costs, the overall treatment cost using VAC is comparable to modern dressings. The long-term benefits of VAC therapy include accelerated healing, reduced complications, and minimized hospitalization time, making it a cost-effective option for wound management.

In addition, the use of Vacuum Assisted Closure (VAC) minimizes the risk of Surgical Site Infections (SSI) and reduces the likelihood of patient re-hospitalization.[15] VAC effectively cleans surgical wounds by continuously removing fluids such as blood, pus, and remnants of dead tissue using negative pressure. This reduction in bacteria and organic matter significantly decreases the risk of infection. Moreover, the negative pressure from VAC promotes the development of crucial granulation tissue, essential for proficient wound healing. Additionally, VAC contributes to reducing tissue swelling or edema surrounding the wound, thereby enhancing blood circulation to the wound site. Improved blood flow facilitates better oxygenation and nutrient delivery to damaged tissues, fostering accelerated healing. Furthermore, VAC's semi-occlusive design creates a warm, moist, and shielded environment for the wound, protecting it from external contaminants. These conducive conditions promote optimal wound healing, diminish infection risks, and

expedite the healing process.

The implementation of Negative Pressure Wound Therapy (NPWT) has shown promising results in reducing complications, expediting wound healing, enhancing patient comfort, and improving overall outcomes for post-operative wounds, including those from caesarean sections, while also reducing long-term costs.

This study underscores the importance of employing appropriate methods to treat wound infections, particularly post-caesarean section wound infections. It also explores patients' prenatal to delivery history to establish correlations between risk factors and surgical wound infections. A notable finding of this research is the effectiveness of Vacuum Assisted Closure (VAC) therapy in inhibiting secondary infections, especially among patients with high-risk factors. This highlights the potential of VAC therapy as a preventive measure against secondary infections.

The research monitors wound care in cases ranging from infection through dressing methods to VAC therapy, revealing improving wound healing outcomes. Further evaluation indicates no complications in these cases, with negative *Staphylococcus aureus* bacterial cultures. Consequently, Agarwal et al. (2019)[8] recommend wide adoption of VAC therapy, particularly in treating Surgical Site Infections (SSI). They argue that VAC therapy is a simple and more effective method compared to conventional dressings, reducing wound volume, depth, treatment duration, and costs[8]. However, the study's limitation lies in its small sample size, resulting in descriptive data prone to bias. Additionally, the absence of a control group prevents the assessment of method effectiveness and identification of risk factors in treating infected wounds post-caesarean section.

CONCLUSION

Wound dehiscence due to wound infection after caesarean section still often occurs in mothers, especially in at-risk groups. Inappropriate treatment can trigger persistent infections. These infections have a clinical impact on the wound-healing process. Persistent infections also create a heavier cost burden due to prolonged hospitalization. Therefore, in treating wound dehiscence after caesarean section, VAC can be considered as a definitive therapy to form primary wound junctions.

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CONFLICT OF INTEREST

The authors declare no conflict of interest about research or writing until the publication of this paper.

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AUTHOR CONTRIBUTION

YJ has contributed to the planning and conceptualizing of the manuscript, ERM and DRK have contributed to data collection and analysis, GSW and ESR have contributed to the writing and revision of the manuscript, and HYLW approved this paper for publishing.

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