Traumatic and Chronic Wound Debridement With A Novel Fluidjet Device: The VERSAJET Hydrosurgery System

Introduction
Standard surgical debridement of traumatic wounds is tripartite. First, gross debridement is performed utilising a scalpel and scissors to remove obviously necrotic or devitalised tissue. Second, the wound area is subjected to a pulsed saline lavage of several litres. Third, sharp debridement of any tissue now shown to be devitalised is completed.

This three-step standard approach can be time-consuming. Further, the irrigation phase is often accompanied by saturation of the operative field, splashing of irrigant onto the floor and droplet aerosolisation. These unwanted events can create significant hazards within the operating suite.

A novel fluidjet device has been introduced that is designed to address these concerns with a single instrument. The VERSAJET Hydrosurgery System enables the surgeon to hold, cut and remove damaged tissue and contaminants while simultaneously irrigating the wound. Surgical debridement is accomplished in a single step. Further, the device utilises a relatively small amount of irrigant which is immediately evacuated, minimising saturation of the operative field and reducing the risk of splashing and aerosolisation.

To date, we have treated over twenty-five (25) patients with the VERSAJET Hydrosurgery System. This paper presents our clinical results using this novel instrument.

Methods
The patients included in our study ranged in age from 18 years to 79 years and presented with a myriad of wounds. Specifically, the VERSAJET Hydrosurgery System was used to treat traumatic wounds and burns, to resect necrotic muscle, and to debride decubitus pressure ulcers.

The VERSAJET Hydrosurgery System consists of a reusable power console and a disposable handpiece (Figure 1). The Console is activated by a foot pedal and utilises a fluid supply bag for irrigant and a standard waste receptacle for effluent.

The VERSAJET Hydrosurgery Handpiece is a fluidjet-powered surgical tool available with a 14 mm operating window with a choice of 15° or 45° angle tip, as well as an 8 mm operating window with a 45° angle tip.

The VERSAJET System utilises a high velocity stream of sterile saline created by the Console which jets across the operating window of the Handpiece and into an evacuation collector. This creates a localised vacuum - a Venturi effect - which can hold the tissue within the operating window (Figure 2).

Handpiece orientation relative to the tissue determines the tissue effect. When the operating window is oriented parallel to the tissue, the result is controlled, precise excision with concomitant aspiration (Figure 3A). When the operating window is oriented obliquely to the tissue, wound irrigation and contaminant removal is the primary effect (Figure 3B).

In addition to alteration in Handpiece orientation, we controlled depth and speed of debridement via three mechanisms. First, we adjusted console power settings as necessary. Second, we varied the speed at which we moved the Handpiece across the tissue plane. Finally, we altered the contact pressure applied to the tissue with the Headpiece. In each case, all debridement was performed under direct vision.

Results
In all cases debridement was rapidly performed using this device alone. In no case was more than one (1) litre of irrigant required despite extensive utilisation of the device. These points are illustrated by the case reports that follow.
Case Reports

Rapid Burn Eschar Resection
A 19-year-old woman was alighting from her disabled vehicle on the shoulder of an interstate highway when her vehicle was struck, wedging her between the vehicle and the guardrail. In this position, the dorsum of her foot was held in contact with the catalytic converter thus inflicting a full thickness burn (Figure 4).

During surgical burn excision, the wound was circumscribed with a scalpel, and the VERSAJET System was used to develop the plane between burned skin and viable subcutaneous tissue (Figure 5). Light Handpiece contact pressure rapidly removed eschar; concurrently, injury to the veins of the foot dorsum was avoided, minimising bleeding (Figure 6). A split thickness skin graft was applied with subsequent 100% successful incorporation.

This patient also sustained a crush-type degloving wound of the ipsilateral thigh that extended well down into the soft tissue of the thigh. As the wound was beyond the reach of the Handpiece, traditional sharp debridement and pulsed lavage were required to treat this wound. Compared to wound treatment with the VERSAJET System, this traditional approach was more time-consuming.

Deep Debridement of Foot Gunshot Wound
An 18-year-old male sustained a through-and-through gunshot wound to the foot. The wound was grossly contaminated as the bullet went through the patient’s sneaker. In order to minimise risk of infection, the wound was surgically debrided.

After the removal of grossly visible sneaker cloth remnants, the VERSAJET Handpiece was inserted into the wound (Figure 7). During advancement, the device was rotated 360°. Full rotation was also carried out during device withdrawal. As a result, a thorough, circumferential deep debridement of the wound was achieved.

In this case, traditional local wound exploration would have required enlargement of the wound via dorsal and plantar incision. If this approach had been necessary, there would have been a substantial increase in postoperative morbidity due to pain and risk of infection - consequences which were avoided by the use of the VERSAJET System. The patient made an uneventful recovery and was discharged with a cane on postoperative day 3.

Complete Defatting of Full Thickness Scalp Replant
A 47-year-old male was the unrestrained driver in a high speed motor vehicle crash. His face and frontal scalp were propelled through the windshield by the deceleration which resulted in avulsion of a “skull cap” shaped, 3 cm x 5 cm injury at the vertex. The tissue was physically attached to the remaining scalp by a bridge of obviously devitalised tissue.

In the operating room, the avulsion was completed by dividing the skin bridge. The amputated scalp was then inspected. The viability of the tissue was uncertain but it was felt reasonable to attempt reattachment. The VERSAJET System was used to rapidly and completely defat the scalp tissue, leaving no islands of subcutaneous fat. Using this device, we were able to keep the dermis intact, avoiding “button hole” defects in the skin.

Subsequent inspection of the replanted area showed the tissue to be non-viable and a plastic surgery consult was initiated. The replanted tissue was removed and a scalp advancement flap was performed to achieve wound closure.

Resection of Necrotic Muscle Compartment through Minimal Incision
A 35-year-old morbidly obese woman was the front seat, unrestrained passenger in a high speed motor vehicle crash. She sustained an anterior dislocation of the right knee severing the popliteal artery and vein. Vascular reconstruction of both the artery and vein was completed and an anterior compartment fasciotomy was performed through a 10 cm incision. At the time of surgery, the other compartments were open due to the injury.

The arterial repair was patent but subsequent ultrasound studies showed venous thrombosis. Anticoagulation was initiated and inspection of the anterior compartment revealed the muscle to be non-viable.

Using the VERSAJET System, the entire anterior compartment was simultaneously debrided, lavaged and resected. The length of the VERSAJET Handpiece permitted the surgeon to access the entire compartment without the need to enlarge the initial wound, sparing the patient increased morbidity and prolonged wound healing. Topical negative pressure was used to promote wound healing.
Debridement of Necrotising Soft Tissue Infection

A 55-year-old man “picked” at a pimple on the back of his neck. Three days later, his neck, shoulders and upper chest were profoundly edematous and he was in impending respiratory distress.

In the operating room, generous debridement was performed through parallel incisions extending from back of the neck onto the chest in a collar-like curvilinear fashion. He was subsequently taken back to the operating room for placement of a tracheostomy and further debridement of necrotic tissue (Figure 8).

During the second operative debridement, the VERSAJET System was used. Because this device simultaneously performed the three parts of standard debridement - initial gross debridement, lavage, final sharp debridement - operative time was decreased. This was a critical advantage as the patient was quite unstable at the time of this intervention.

After two additional operative debridements performed with the VERSAJET System, split thickness skin grafts were placed to cover the wounds which could not be primarily closed. The patient made a full recovery.

Debridement of Sacral Decubitus Pressure Ucer

A 79-year-old male - a long time nursing home resident - presented with pneumonia. He was treated in the medical intensive care unit with mechanical ventilation and antibiotics. His recovery was slow and he experienced prolonged, ventilator-dependent respiratory failure. During this time, he developed a large sacral decubitus ulcer and a consult with the surgical service was initiated.

The decubitus pressure ulcer was 12 cm x 15 cm and required operative debridement. First, the wound wascircumscribed with a scalpel and the VERSAJET System was used to detach the necrotic skin and subcutaneous tissue. After this tissue was removed, the surgery proceeded rapidly with efficient debridement of necrotic fat to the required depth using continued, gentle strokes with the VERSAJET Handpiece. Importantly, the device simultaneously lavaged the wound, thus saving the operative time usually required for that component of traditional debridement.

The Learning Curve

We have found that VERSAJET System to be a very intuitive device, allowing operative debridement to progress in the same manner as traditional approaches. Very little formal training is needed since the surgeon is not required to learn any new operative principles. The only requirement is mastery of a new instrument - not a new procedure. This process proceeds rapidly, even for less experienced surgeons and residents.

It is important, however, for the surgeon to develop a “feel” for debridement and lavage energy at low (3 - 5), moderate (5 - 8), and high (9 - 10) power settings. It is also essential that the surgeon develop skill in rapid manipulation of the contact pressure applied to the tissue with the Handpiece. Contact pressure that is too light will produce lavage with little debridement. Contact pressure that is too heavy will cause overly deep debridement and device clogging.

When performing the first case with the VERSAJET System, the Console should initially be set to low power settings (3 - 5). Early use of higher power settings should be avoided so that it will result in unintended, overly aggressive debridement. As the case progresses, however, and the surgeon gains a feel for the level of debridement and lavage energy, the power setting can be increased to moderate power settings (5 - 8). For the next case, the Console can be initially set to moderate power setting (5 - 8). Typically, by the end of that case or during the next, there is rapid progression to comfort with utilisation of high power settings (9 - 10).

Learning Tip: Laboratory Practice

Laboratory practice is an excellent way to master operation of the VERSAJET System. An illustrative model is easily assembled by using chicken pieces from the grocery store. First, a grater is used to shred the chicken tissue. Then particulate matter such as pepper, salt or India ink is applied. The preliminary grating allows placement of the particles into all the “nooks and crannies” to more accurately represent a grossly contaminated traumatic wound.

Discussion

Clinical Benefits

Significant clinical benefits derive from the ability of the VERSAJET System to effect surgical debridement while providing concurrent lavage. In our experience with this new system, wound debridement is efficient and straightforward, reducing operative time.

With the VERSAJET System, tissue excision is precise, avoiding damage to healthy tissue or vasculature. In addition, the design of the VERSAJET Handpiece allows access for debridement without the need to enlarge the wound, reducing postoperative morbidity and promoting wound healing.

The VERSAJET System also requires significantly less irrigant than traditional lavage techniques, confines the irrigant to the wound area, and provides immediate fluid evacuation. With the VERSAJET System, the need to frequently change large saline irrigant bags and multiple suction reservoir waste canisters is substantially reduced. Immediate evacuation of the irrigant also eliminates soaking of the operative field.

In this era of concern about communicable disease, prevention of droplet aerosolisation is a critical goal within the operating room suite. This is especially true when treating trauma patients - a population know to have a higher incidence of viral infection. The design of the VERSAJET Handpiece reduces the risk of aerosolisation thereby offering another important benefit to the surgical staff and patients alike.

Conclusion

The VERSAJET Hydrosurgery System has substantially simplified the debridement of wounds. Using the VERSAJET System, debridement of traumatic wounds, chronic wounds and other soft tissue lesions is accomplished rapidly and precisely, sparing healthy tissue and promoting healing. Additionally, use of the system minimises exposure to droplet aerosolisation in the operating suite.