TECHNOLOGY UPDATE:

The ongoing development of a plasma-mediated bipolar radio-frequency ablation device for wound debridement

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The term 'debridement' was first used by French military surgeons in the 18th century and literally means 'unbridling'. It was used to describe a treatment similar to fasciotomy for what would now be described as compartment syndrome[1]. This initial definition did not involve the removal of any tissue from the wound. Historically, there has been an ongoing debate between military surgeons about the best way to treat traumatic wounds, and by the end of the first world war, a consensus was reached that wounds should be explored surgically and that all foreign material and devitalised tissue should be removed from the wound — the term debridement was resurrected to describe this process[1]. **Disclaimer:** *the product featured in this article is not available for commercial distribution within the UK market — those with a clinical interest in coblation technology should contact ArthroCare at: info@arthrocare.com*

INTRODUCTION

Debridement can now be defined as the removal of necrotic, infected or damaged tissue and any contamination from a wound until the surrounding healthy tissue is exposed.

Reasons to debride a wound include[2–6]:

- **Enabling the true dimensions of the ulcer to be perceived**
- **Removing necrotic tissue, senescent cells and foreign bodies**
- **Reducing dead spaces that harbour bacterial growth**
- **Decreasing bacterial load restores bacterial balance**
- **Allowing drainage of exudate and removal of dead tissue — rendering infection less likely**
- **Stimulating the wound-healing cascade to increase the healing rate**
- **Encouraging healing, by restoring a chronic wound to the acute phase**
- **Enabling a deep swab to be taken for culture**
- **Allowing better visual assessment of ulcer area (eg sinus tracts or tunneling).**

Debridement plays a key role in wound bed preparation — one of the cornerstones of chronic wound treatment[7]. While there are various methods for debridement available, traditionally sharp debridement has been the gold standard for the rapid removal of necrotic, infected tissue[8].

New techniques, such as plasma-mediated bipolar radio-frequency ablation (PBRA), have shown promise in early studies[9]. The aim of this study was to evaluate the use of a new PBRA device in the debridement of chronic wounds in the outpatient setting.

Coblation

Coblation- plasma based bipolar radio frequency is based on the creation and application of a high energy field called 'glow discharge plasma'. This plasma ablates tissue through a chemical process not a thermal process as highly energised

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particles in the plasma break down molecules in the target tissue[10].

METHOD

Six patients with chronic leg ulcers of varying aetiology had their wounds debrided with the PBRA device (WoundWand®, ArthroCare Corp). All patients had topical local anaesthetic (EMLA®, AstraZeneca UK Ltd) applied to the wound one hour prior to the procedure taking place.

The PBRA device consists of an active electrode at the distal tip, manufactured from tungsten wire. The active and return electrodes are contained within an alumina ceramic spacer.

The PBRA device also incorporates saline delivery through the spacer of the device to the distal electrodes, in order to act as a medium for the formation of highly focused plasma. There is also a large suction portal at the distal tip of the device to remove excess saline and debrided tissue from the surgical site.

This device is designed to be used exclusively with the Coblator IQ® Controller (ArthroCare Corp), which regulates power output to the device via an attached foot pedal and includes an integrated saline pump for consistent saline delivery. The user interface of the controller allows the user to manually select the ablation set point, saline flow rate, and coagulation set point for the device[8]. All procedures were carried out at the default settings of ablation set point of 7 and saline flow rate of 50mL/min.

Figure 1a shows the PBRA device in action. The power source and portable suction unit are visible in the top-right corner. All wounds were debrided until the operator felt the clinical aims of the procedure had been achieved or the patient could no longer tolerate the procedure. Haemostasis was achieved prior to the end of the procedure. *Figures 1b* and *1c* show the wound before and after, respectively.

Figure 2 shows a series of images of a pressure ulcer on a heel being debrided — the procedure was deemed complete when the wound bed consisted of healthy tissue and haemostasis had been achieved. A scalpel blade was used in all patients to remove dry or macerated skin from around the wound edge. Data regarding patient demographics and wound type were collected, as well as data concerning procedure length, use of equipment, other techniques used and additional comments of operator and patients. Patients were followed up as routine in the outpatient clinic.

RESULTS

A total of seven procedures were carried out. Four men and two women had their wounds debrided using the PBRA device, while one man had his wounds debrided twice. The aetiologies of the wounds included venous ulceration (five patients) and lower limb pressure ulcers in a patient with a spinal cord injury (two patients). Five procedures were completed with the device. Two of the procedures were stopped due to pain, which was variously described as a burning or stinging sensation.

Operators reported that the device was easy to use and had a short and steep learning curve. It debrided and removed infected and necrotic tissue easily to leave healthy appearing wound bed. It was felt that the device decreased procedure time.

However, if the time taken to set up the device is taken into account, there was no net decrease in overall time when compared with traditional sharp debridement. Two patients also required traditional sharp debridement of the wound bed to complete the procedure. No adverse events were reported. All patients' wounds appeared healthier at subsequent routine outpatient clinic follow-up visits.

DISCUSSION

Debridement is established as a vital part of wound bed preparation and, thus, the treatment of chronic wounds. Although several methods have been evaluated and compared for relative efficacy, few have been shown to be superior to sharp surgical debridement[11]. The rationale for using PBRA in wound debridement comes from its ability to selectively ablate tissues as demonstrated by its use in skin resurfacing procedures[9; 12]. *In vivo* studies using porcine models have demonstrated the potential of PBRA as a debridement tool and it is ability to reduce bacterial load in a wound[9,13].

This series demonstrates that in the outpatient setting the PBRA device can achieve the clinical aims for debridement. It shows that the method meets many of the ideals one seeks in a debridement technique, including ease of use, safety,

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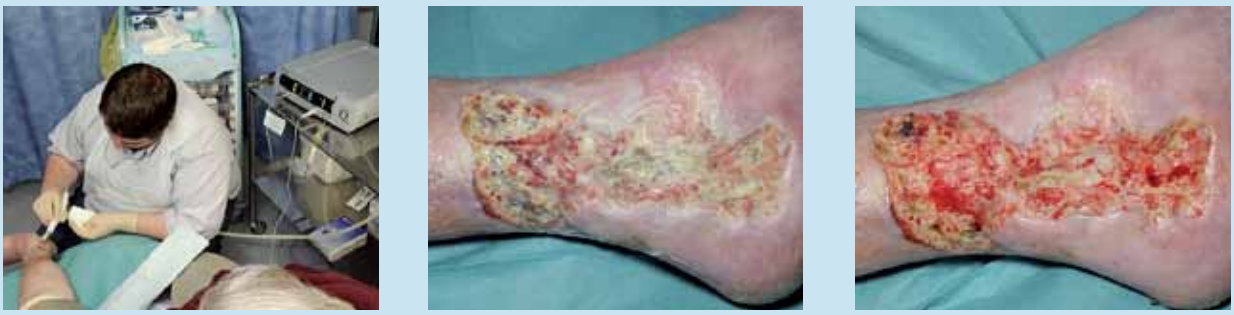

Figure 1a–c: A series of before, during and after images (from left to right) showing the debridement of a medial malleolar ulcer. The image far left shows the PBRA device in action in an outpatient setting.

Figure 2a–c: A series of images showing a pressure ulcer on a heel being debrided using the PBRA device. Note the cauterised bleeding point in the 2c (far right). The PBRA device has a separate cautery function.

Key Points

1. *Debridement plays a key role in wound bed preparation, one of the cornerstones of treatment of chronic wounds.*
2. *In vivo studies using porcine models have demonstrated the potential of PBRA as a debridement tool and it is ability to reduce bacterial load in a wound.*
3. *PBRA is a safe technology, suitable for the outpatient setting in order to achieve adequate wound bed preparation.*
4. *Average depth of penetration of the device is 100 microns, causing minimal damage to surrounding tissue when compared to standard radio frequency and diathermy.*

efficacy, precision and speed.

While the procedure time was felt to be shorter when compared with how long the same procedure would have taken using traditional sharp debridement techniques, it is likely that there is only a minimal net gain in terms of time saving when the time to administer anaesthetics and increased set-up time are taken into account. In a more formal setting, such as an operating theatre, this set-up time would be greatly reduced compared with an outpatient environment. Although the procedure was well tolerated by most of the patients, two patients did ask for the procedure to be stopped because of pain.

All of the sensate patients reported that having their wound debrided with the PBRA device felt different to having it debrided with a scalpel. The commonest description of this sensation was a burning or stinging sensation[9]. Stopping the procedure was found to relieve their symptoms. This was not an issue in the non-sensate patients, ie those with neuropathy or spinal cord injury.

It may well be that the topical local anaesthetic did not penetrate the tissues to an adequate depth for the procedure to be completed. Sub-cutaneous injections of local anaesthetic may be sufficient, however, and for large wounds regional anaesthesia might be more appropriate. However, this would prevent the procedure being carried out in an outpatient setting.

CONCLUSION

Although a small case series was used, this study demonstrates that PBRA is a safe technology that is useable in the outpatient setting to achieve adequate wound bed preparation in appropriately selected patients. Further large-scale studies are required, including a cost-benefit analysis to demonstrate any superiority over established techniques.

AUTHOR DETAILS

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