Application of hydrosurgery for burn wound debridement: An 8-year cohort analysis

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Abstract

Introduction: During the last decade, the Versajet™ hydrosurgery system has become popular as a tool for tangential excision in burn surgery. Although hydrosurgery is thought to be a more precise and controlled manner for burn debridement prior to skin grafting, burn specialists decide individually whether hydrosurgery should be applied in a specific patient or not. The aim of this study was to gain insight in which patients hydrosurgery is used in specialized burn care in the Netherlands.

Methods: A retrospective study was conducted in all patients admitted to a Dutch burn centre between 2009 and 2016. All patients with burns that required surgical debridement were included. Data were collected using the national Dutch Burn Repository R3.

Results: Data of 2113 eligible patients were assessed. These patients were treated with hydrosurgical debridement (23.9%), conventional debridement (47.7%) or a combination of these techniques (28.3%). Independent predictors for the use of hydrosurgery were a younger age, scalds, a larger percentage of total body surface area (TBSA) burned, head and neck burns and arm burns. Differences in surgical management and clinical outcome were found between the three groups.

Conclusion: The use of hydrosurgery for burn wound debridement prior to skin grafting is substantial. Independent predictors for the use of hydrosurgery were mainly burn related and consisted of a younger age, scalds, a larger TBSA burned, and burns on irregularly contoured body areas. Randomized studies addressing scar quality are needed to open new perspectives on the potential benefits of hydrosurgical burn wound debridement.

Keywords: Burns, Tangential excision, Conventional debridement, Hydrosurgical debridement, Versajet hydrosurgery

1. Introduction

In the last decade, hydrosurgery has become available in burn surgery as an alternative technique for tangential excision alongside the golden standard of conventional tangential excision by guarded knives. The hydrosurgical device used in the treatment of burns is usually known as the Versajet™. The Versajet™ hydrosurgery system (Smith and Nephew, St. Petersburg, FL, USA) was developed in 1997 for soft tissue debridement in various types of wounds. The Versajet™ hydrosurgery system works by producing a high-pressure jet of water across an aperture in an angled hand piece. Through the Venturi principle, the jet creates a suction force that draws tissues into the path of the fluid where they are ablated and sucked into the device together with the irrigation fluid[1,2]. Power settings can be adjusted to control the cutting and aspiration effects, depending on the depth of debridement the surgeon wants to achieve[3]. Although hydrosurgery was introduced for burn wound debridement in Dutch burn care in 2006, it only became widely used in 2008[4].

A report of the National Institute for Health Care and Excellence (NICE) presented an overview of the studies concerning the safety of hydrosurgery[2]. The majority of these studies showed good clinical results with minimal adverse outcomes in both adults and children with acute and chronic wounds[4-11]. Studies on burn wounds showed that the Versajet system may be faster and more precise in obtaining the desirable excision plane. Nevertheless, the Versajet has typically not been favoured in deeper burns due to belief its penetration is less efficient in thick eschar, as it 'bounces' off the hard tissue and causes irregular grooves[2,7].

Burn specialists widely use hydrosurgery as an alternative for conventional debridement prior to skin grafting, however, only two randomized controlled trials comparing hydrosurgical and conventional debridement in patients with burns have been published[7,12]. These studies reported a significant reduction in excision time and better preservation of viable tissue after hydrosurgical debridement. Nevertheless, no significant differences were found on postoperative pain, contracture rates, healing time, graft take, post-operative infection, bacterial burden and scar quality at 6 months post burn. Whether these results influenced the current application of the Versajet™ system is unexplored. To our knowledge, no algorithm is available for burn specialists guiding them whether or not to use hydrosurgery. Due to an absent algorithm and a paucity of studies, the clinical application of hydrosurgery in burn care remains unknown.

The aim of this study was to gain insight in which patients hydrosurgery is used in specialized burn care in the Netherlands and whether the actual application of hydrosurgical application matches the currently available literature. Furthermore, surgical outcomes of different debridement techniques are examined.

2. Methods

2.1 Study design and population

In this cohort study, all patients with a burn-related admission in one of the burn centres in the Netherlands (Maasstad Hospital in Rotterdam, Martini Hospital in Groningen, and Red Cross Hospital in Beverwijk) between January 2009 and 31 December 2016 were included.

2.2 Data collection

Data were obtained from the national burn registry of the three burn centres in the Netherlands (Dutch Burn Repository R3) which started collecting data from 2009 onwards. The database is filled by dedicated burn care professionals, and quality monitoring by a coordinator and improvement is formally organized. Data on patient characteristics, burn, treatment, and outcome were documented (Table 1 and 4).

2.3 Data analysis

Eligible patients were divided into three groups: hydrosurgical debridement, hydrosurgical in combination with conventional debridement and a conventional debridement group (Fig. 1). The proportions of patient and injury related characteristics were compared between the three groups. Patients were divided into an early surgery group (<7 days post-burn) and a delayed surgery group (>7 days post-burn) to evaluate the effect of timing of surgery on the use of hydrosurgery. A subgroup analysis of patients with only one body part burned was performed to identify the prevalence of the use of hydrosurgery per affected body site.

2.4 Statistical analysis

Data were analysed using IBM SPSS Statistics for Windows version 23.0 (IBM Corp., NY, USA). Outcomes were reported as percentages for categorical variables. Continuous variables were summarized as either means with corresponding standard deviations (SD) or medians with interquartile ranges (IQR) depending on normality of distribution. Univariable logistic regression analysis was performed to identify parameters that were associated with the use of hydrosurgery. Parameters that were associated in univariable analysis ($p < 0.10$) were checked for multicollinearity (Spearman's r (rs) > 0.75) and subsequently entered into a multivariable logistics regressions analysis (forward stepwise LR). Differences in patient, and injury related characteristics, differences in surgical treatment and outcome between the three groups were compared using the chi-squared (categorical data) or Kruskal-Wallis (continuous data) test. Differences in surgical treatment and outcome between the groups treated with hydrosurgiery alone and the group treated with conventional techniques alone were compared using the chi-squared (categorical data) or Mann-Whitney (continuous data) test. Two-tailed p values below 0.05 were considered statistically significant for all statistical tests.

3. Results

3.1 Inclusions

A total of 6031 patients had been admitted in the three Dutch Burn centres between January 2009 and December 2016. In total 63.0% of the patients was excluded because they did not have surgical debridement of their wounds and 1.9% was excluded because of lack of information on the used technique during surgery (Fig. 1). The final study population consisted of 2113 patients (59.5% males) with a median age of 41 years (IQR 36) and median TBSA of 5% (IQR 10). Patient and injury characteristics per group are shown in Table 1.

3.2 Prevalence of the use of hydrosurgery and predictors

In 52.3% (n = 1105) of the included patients hydrosurgery was used for debridement of their burn wounds. In 23.9% (n = 506) of these patients hydrosurgery was used exclusively for debridement of their burn wounds and in 28.3% (n = 599) hydrosurgery was used in combination with conventional debridement. The mean prevalence in the period 2010-2016 was 25.3% (Fig. 2). The lowest prevalence of patients who received exclusive hydrosurgical debridement was in 2009: 12.2%. Burn severity did not change between 2009 and 2016 (ANOVA, $p = 0.16$).

The median age in the groups in which hydrosurgery was used was lower (29 (IQR 42) years and 28.3 years (IQR 35) vs. 44 years (IQR 35), $p<0.001$; Table 1). Elderly patients (>65 years) had lower odds of being treated with hydrosurgical debridement compared to all other age categories (univariable analysis; Table 2). There was a trend toward differences in gender ($p<0.10$; Table 1). Males had a higher likelihood of being treated with hydrosurgical debridement, whether or not in combination with conventional debridement techniques (resp. OR 1.23 95%CI 1.03-1.46, OR 1.23 95%CI (1.03-1.59); Table 2). Scalds were more frequently debrided with hydrosurgery alone (Table 2; OR 2.23 95%CI 1.76-2.83), while contact burns and burns with other causes (e.g. electricity, chemical) were more frequently debrided with conventional excision alone (Table 2, univariable analyses both p<0.01). Median percentage TBSA burned was higher (11.0% (IQR 17.8; Table 1) and time to surgery was longer (29.1 days (IQR 10); Table 1) in the combination group compared to the hydrosurgical (5.0% (IQR 8), 15.0 days (IQR, 8)) and conventional group (2.0% (IQR 5.5), 13.0 days (IQR, 9))). Hydrosurgery was more often used in patients with a higher percentage TBSA burned, although the odds for exclusive hydrosurgical debridement decreased in patients with a TBSA >20% (OR 4.42 95%CI 2.56-.62; Table 2). In addition, patients with a delayed timing of surgery had higher odds of being treated with hydrosurgery alone (OR 1.80 (1.20-2.54); Table 2).

Significant independent predictors of the use of hydrosurgery were a younger age, scalds, a larger TBSA burned, head/neck burns and arm burns (multivariable analyses; Table 2).

3.3 Prevalence of hydrosurgery for burn wound debridement per affected body region

In patients who were only burned in one body region hydrosurgery was most frequently exclusively used for debridement of the neck (58.3%), followed by the scalp (31.6%) and genitals (31.6%) (Table 3).

3.4 Surgical treatment and clinical outcome

The TBSA excised was higher in both groups in which hydrosurgery was used (p<0.001; Table 4). Patients in the group exclusively treated with hydrosurgery were less often treated with dermal substitutes. Also, they underwent less surgical procedures and had a lower mean volume of blood transfusion.

In the groups of patients in which hydrosurgery was used, whether or not in combination with conventional techniques median length of stay were higher. In the group of patients in which hydrosurgery was used exclusively, wound infection rates were lower compared to the other groups.

4. Discussion

This multi-centre study appears to be the first evaluation of the application of hydrosurgery for tangential excision in burns in a large cohort over multiple years.

The aim of this study was to gain insight in which patients hydrosurgery is used and whether the actual field of hydrosurgical application matches the current available literature. Our data show that the use of hydrosurgery is substantial, as it has been used, also in combination with conventional debridement techniques, in more than fifty percent of the patients requiring tangential excision since 2010. Hydrosurgical excision is described to be specifically useful for the debridement of superficial and deep dermal burns since full thickness burns are not as easily debrided hydrosurgically[2,7]. Therefore, conventional techniques have to be used next to hydrosurgery for sufficient debridement of burns wound with mixed depths [1,13].

Our study identified a younger age, scalds, a higher percentage TBSA burned, head/neck burns and arm burns (including hands) as independent predictors for the use of hydrosurgery. Our finding that scalds are predictors for the use of hydrosurgery might be a reflection of its use in superficial burns, as scalding is known to result in more superficial burns[14]. Next to that, our results showed that burns with other causes (e.g. electricity, chemical) had lower chances of being treated hydrosurgically, whereas these causes are known to result in deeper burns[14,15]. The exclusive use of hydrosurgery decreased in patients with extensive burns (TBSA>20%), which might be explained by the fact that patients with extensive burns have a higher chance of burn wounds with mixed depths.

In our study population, patients in the age category 0-4 years were more often treated with hydrosurgery. In these young children, scalds are the most common type of burn injury[16]. A younger age and scalds remained as independent predictors for the use of hydrosurgery in the multivariable analysis. Therefore, the high prevalence of scald injuries is not the only explanation for the more frequent use of hydrosurgery in young children. Conventional tangential knife excision is described to have a tendency to remove more viable tissue than is actually necessary for adequate debridement [6,12,17]. Our results that toddlers and infants had the highest chance of being treated with hydrosurgical excision may reflect the wish for a more precise debridement in the paediatric burns population to maximize preservation of viable dermis. Next to improvement of scar quality and scar contraction, this could potentially lead to a decrease in hypertrophic scarring, which is in fact a significant problem in children[18,19]. Another potential benefit of hydrosurgical debridement is that the small Versajet hand piece allows irregularly contoured and relatively inaccessible areas to be easily reached[1,7]. This is in line with our results that hydrosurgery was more often used for debridement of irregular contoured locations as the head and arms, and less in large flat body parts as the trunk. Because surgery characteristics are not linked to specific body locations in the R3 database we performed a subanalysis in patients with only one body part burned. This analysis also showed that the scalp, neck and genital area were more often treated with hydrosurgery alone.

Although we expected that hydrosurgery would be more often used in patients with smaller burns, we found that patients with a percentage TBSA beneath one percent were more often treated with conventional excision techniques only and that the median percentage TBSA excised was higher in the groups in which hydrosurgery was used . This might be explained by the higher costs of the Versajet™ compared with the costs of conventional excision techniques. The current cost of the disposable Versajet™ II headpiece is €141,86 ($167.55) whilst the costs of a re-usable guard and handle of the Weck knife are respectively €0,91 ($1.08) and €20,91 ($24.70). The cost of one sterilized, single use Weck blade is €1,08 ($1.28). In our experience, burn specialist prefer to use a Weck knife in smaller burns to reduce treatment costs.

In current study, the mean volume of blood transfusion was lower in the group that was exclusively treated with hydrosurgery than in patients treated with conventional excision, even though the median TBSA excised was higher in the hydrosurgical treated group. Next to a possible more subtle debridement using the Versajet™ system, this might be the results of delayed debridement undertaken in the hydrosurgery group. To our knowledge, no other study compared the amount of blood loss in hydrosurgical and conventional treated burn patients. However, in wounds with delayed healing, maximum blood loss was found to be less in the hydrosurgical debridement group compared to the conventional debridement group in one clinical trial[9]. Our results also show that the prevalence of wound infection was significant lower in the group exclusively debrided with hydrosurgery compared to the conventional only debridement group. A few studies on chronic wounds have reported that hydrosurgery may decrease bacterial burden after debridement and therefore post-operative infection, but this was not confirmed by randomized trials in burn patients[7,10-12,20]. The differences in surgical management and clinical outcome might be explained by the possibility that the wounds that were treated with hydrosurgery alone were more likely to be superficial. This is supported by the lower use of dermal substitutes in this group. Unfortunately we were not able to adjust our results for burn depth.

Some shortcomings of our study have to be mentioned. As it is a retrospective study, data were not collected for the specific purpose of this study and was lacking in details on wound and surgery characteristics. As a result, we were not able to perform a multivariable analysis on the clinical outcomes and more prospective research is necessary to support the outcomes of our study. Nevertheless, the Dutch Burn Repository R3 database is closely linked to medical registers in three dedicated burn centres and study groups were large. Therefore, this database gives a unique picture of the use of hydrosurgery in burn care with comprehensive and generalizable data. The Dutch Burn Repository R3 registers burn depth estimated at admission and percentage TBSA excised during surgery. We were not able to conclusively conclude that hydrosurgery was the preferred debridement tool for deep dermal burns instead of full thickness burns during surgery, nor correct our outcomes for burn depth. Another shortcoming is the lack of long-term results. Although scar quality is considered to be one of the most important outcomes of burn surgery today, no clinical study compared the effect of hydrosurgical debridement on scarring in the long term. Hyland et al. performed a randomized trial in the paediatric burn population comparing hydrosurgery with conventional debridement. They did not observe significant differences in scarring at 3 or 6 months after injury measured with the Vancouver scar scale (VSS)[12]. Nevertheless, the follow-up duration of 6 months may not be adequate for scar quality assessment and the VSS was formally not designed to assess burn scar severity, has a moderate reliability, and does not include the opinion of the patient[21-23]. Only one study showed a superior result after hydrosurgery was used for burn wound debridement[4]. Unfortunately, data of this retrospective study were not published. Hence, it remains unclear if hydrosurgical debridement results in better functional and cosmetic scar outcomes.

In conclusion, this study provides evidence that the use of the Versajet™ hydrosurgery system for burn wound debridement prior to skin grafting is substantial. In the three Dutch burn centres, it is often used in combination with sharp conventional tangential debridement with knives. Individual predictors for its use are a younger age, scalds, higher TBSA burned, and burns on convex locations.

Our study group currently performs a randomized trial to compare scar quality after hydrosurgical and conventional tangential excision, to optimize burn outcomes in the future and to provide new perspectives on the benefits of hydrosurgical debridement in burn surgery (Netherlands trial registry: NTR 6232)[24].

Conflict of interest statement

We declare that there is no conflict of interest including any financial, personal or other relationship.

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Figure Legends

Figure 1. Patient inclusion flowchart

Figure 2. Prevalence of the use of hydrosurgery and conventional techniques in patients requiring excision and grafting of their burns in the three Dutch burn centres: 2009-2016

Table 1. Patient and injury characteristics

Values are presented as median (IQR) and percentage

[¥]n = 1 missing, [¶]n = 19 missing. †more than one location per patient is possible

IQR = interquartile range, TBSA = Total Body Surface Area

*Between the three different groups

Table 2. Predictors for the use of hydrosurgery for burn wound debridement.

[¥]whether or not in combination with conventional techniques

ref = reference group, y = years, TBSA = Total Body Surface Area

*p < 0.01, **p<0.05, [a] reference group = all others, [b] more than one body location per patients possible, [c] the following variables were included in the multivariable odds: age, gender, scalds, fire/flame burns, contact, other, %TBSA burned, head and neck burns, trunk, arms, genitals and >7 days to surgery, [d] the following variables were included in the multivariable odds: Age, gender, scalds, contact, other, %TBSA burned, head and neck, trunk, arms legs an >7days to surgery.

Table 3. Details on body region debrided with hydrosurgery[a]

[a] The burn centre registration allowed the registration of multiple burn locations per patient and does not differentiate between conservative, conventional and hydrosurgically treated body locations. Therefore, a subgroup analysis of patients with only one body part burned was performed to identify the prevalence of the use of hydrosurgery per body region.

[b] More than one subcategory per body region is possible.

Table 4. Surgical treatment and clinical outcome

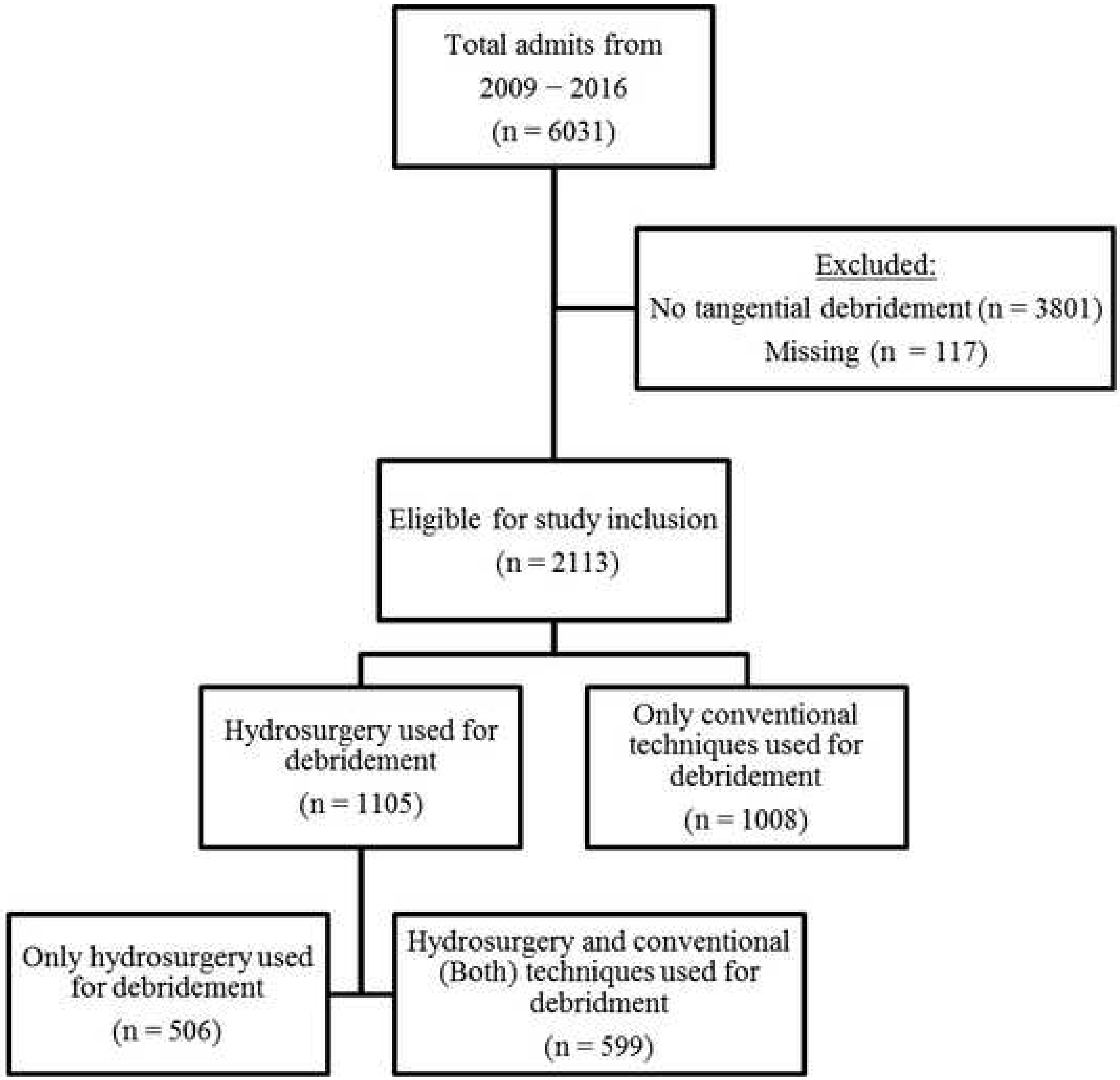
Values are presented as median (IQR) and percentage

† Presentation of range and SD to improve interpretability

SSG = split skin graft, MEEK = Meek micrografting, IQR = Inter Quartile range, SD = Standard Deviation

[a]188 missing, [b]More than one surgical technique per patient possible, [c]23 missing, [d]307 missing

Figure 1



Total admits from
2009 – 2016
(n = 6031)
Excluded:
No tangential debridement (n = 3801)
Missing (n = 117)
Eligible for study inclusion
(n = 2113)
Hydrosurgery used for
debridement
(n = 1105)
Only conventional
techniques used for
debridement
(n = 1008)
Only hydrosurgery used
for debridement
(n = 506)
Hydrosurgery and conventional
(Both) techniques used for
debridment
(n = 599)

Figure 2

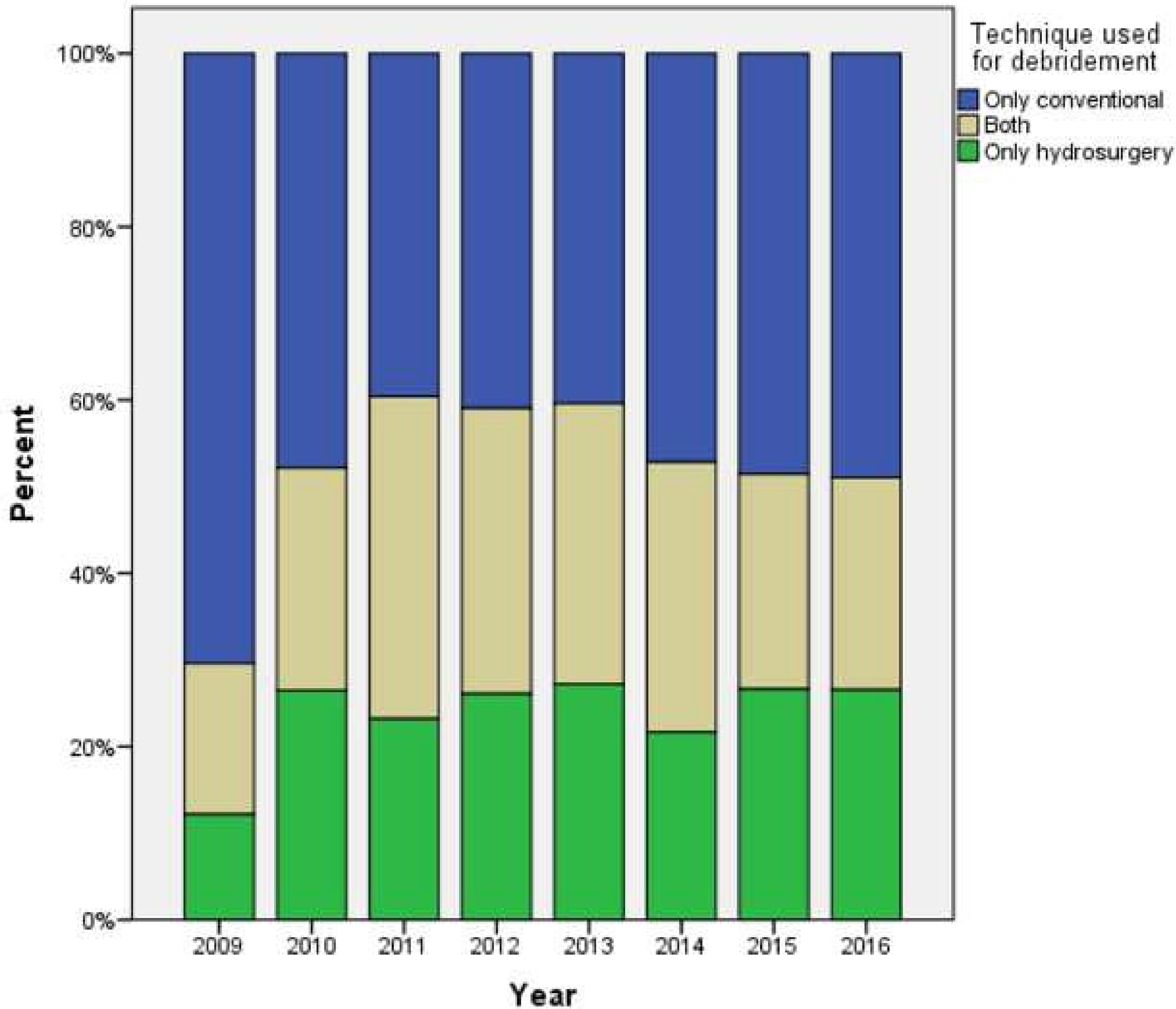

Technique used for debridement
Only conventional
Both
Only hydrosurgery
Percent
100%
80%
60%
40%
20%
0%
2009
2010
2011
2012
2013
2014
2015
2016
Year

Table 1. Patient and injury characteristics

	Hydrosurgery used for debridement		Only conventional techniques used for debridement	
	Only hydrosurgery (n = 506)	Both techniques (n = 599)	(n = 1008)	p value*
Total, %	23.9	28.3	47.7	
Median age at injury (IQR)¥	29 (42)	43 (35)	44 (35)	<0.001
Age in categories, %				
0-4y	21.9	7.8	6.7	<0.000
5-17y	13.4	9.8	9.3	0.011
18-65y	54.5	66.6	64.1	<0.001
>65y	10.1	16.4	20.0	<0.001
Gender, %				0.059
Female	37.2	39.0	43.1	
Male	62.8	61.0	56.9	
Aetiologie, % ¶				
Scald	37.9	21.6	18.8	<0.001
Flame	43.1	44.6	64.0	<0.001
Grease	11.0	9.0	7.9	0.207
Contact	4.8	13.6	3.7	<0.001
Other	3.2	11.1	5.5	<0.001
Median % TBSA burned (IQR)	5.0 (8)	11.0 (17.8)	2.0 (5.5)	<0.001
TBSA burned in categories, %				
<1	6.5	3.8	23.2	<0.001
1-2	12.1	4.7	21.1	<0.001
2-5	25.7	17.0	21.4	<0.001
5-10	28.1	20.5	18.3	0.001
10-20	20.2	25.2	9.9	0.001
>20	7.5	28.7	6.1	<0.001
Body location, %†				
Head and neck	42.5	52.4	22.0	<0.001
Trunk	43.9	62.9	35.8	<0.001
Arms	69.4	78.5	53.5	<0.001
Genitals	9.3	21.7	8.2	<0.001
Legs	47.2	57.4	55	<0.001
Median time to surgery in days (IQR)	15.0 (8)	29.1 (10)	13.0 (9)	<0.001
Time to excision, %				<0.001
≤ 7 days	9.3	29.9	15.6	
> 7 days	90.7	70.1	84.4	

Values are presented as median (IQR) and percentage

¥n = 1 missing, ¶n = 19 missing , †more than one location per patient is possible

IQR = interquartile range, TBSA = Total Body Surface Area

*Between the three different groups

Table 2. Predictors for the use of hydrosurgery for burn wound debridement.

	Hydrosurgery used for debridement[¥] vs. Only conventional techniques used for debridement		**Only hydrosurgery used for debridement vs. Only conventional techniques used for debridement**	
	Univariable analysis OR (95% CI)	Multivariable analysis OR (95% CI)[c]	Univariable analysis OR (95% CI)	Multivariable analysis OR (95% CI)[d]
Age in categories				
0-4y	3.27 (2.29-4.67)*	2.50 (1.67-3.74)*	6.53 (4.24-10.06)*	4.00 (2.48-6.43)*
5-17y	1.87 (1.33-2.64)*	2.31(1.58-3.39)*	2.85 (1.84-4.42)*	3.29 (2.05-5.29)*
18-65y	1.45 (1.14-1.84)*	1.49 (1.13-1.87)*	1.69 (1.20-2.37)*	1.75 (1.22-2.51)*
>65y	ref.	ref.	ref.	ref.
Gender				
Male	1.23 (1.03-1.46)*		1.23 (1.03-1.59)**	
Aetiology[a]				
Scald	1.38 (1.13-1.69)*	1.45 (1.13-1.87)**	2.23 (1.76-2.83)*	1.80 (1.33-3.21)*
Fire/Flame	1.45 (1.25-1.77)*		0.94 (0.76-1.17)	
Grease	1.04 (0.77-1.40)		1.24 (0.87-1.77)	
Contact	0.28 (0.19-0.39)*		0.32 (0.20-0.50)*	
Other	0.42 (0.30-0.58)*		0.31 (0.19-0.50)*	0.54 (0.32-0.92)*
% TBSA burned				
<1	ref.	ref.	ref.	ref.
1-2	1.75 (1.20-2.57)*	1.77 (1.20-2.62)*	2.04 (1.29-3.24)*	1.98 (1.23-3.21)*
2-5	4.49 (3.18-6.34)*	4.33 (3.03-6.20)*	4.27 (2.79-6.52)*	3.88 (2.48-6.08)*
5-10	6.02 (4.25-8.51)*	4.86 (3.31-7.12)*	5.47 (3.58-8.37)*	3.81 (2.36-6.16)*
10-20	10.57 (7.29-15.34)*	8.55 (5.59-13.08)*	7.23 (4.58-11.42)*	5.44 (3.20-9.23)*
>20	14.39 (9.57-21.63)*	11.21 (6.95-18.09)*	4.42 (2.56-7.62)*	3.50 (1.84-6.64)*
Body location [a,b]				
Head and neck	3.25 (2.69-3.93)*	1.66 (1.31-2.09)*	2.60 (2.08-3.30)*	1.85 (1.38-2.48)*
Trunk	2.12 (1.78-2.53)*	0.71 (0.56-0.91)*	1.40 (1.13-1.74)*	0.57 (0.43-0.77)*
Arms	2.52 (2.10-3.02)*	1.64 (1.32-2.04)*	1.97 (1.57-2.47)*	1.81 (1.34-2.37)*
Genitals	2.13 (1.61-2.80)*		1.41(0.78-1.66)	
Legs	0.92 (0.77-1.09)		0.74 (0.59-0.91)*	
Time to surgery				
> 7 days	0.72 (0.57-0.90)*	1.68 (1.15-2.44)*	1.80 (1.20-2.54)*	

[¥]whether or not in combination with conventional techniques

ref = reference group, y = years, TBSA = Total Body Surface Area

*p < 0.01, **p<0.05, [a] reference group = all others, [b] more than one body location per patients possible, [c] the following variables were included in the multivariable odds: age, gender, scalds, fire/flame burns, contact, other, %TBSA burned, head and neck burns, trunk, arms, genitals and >7 days to surgery, [d] the following variables were included in the multivariable odds: Age, gender, scalds, contact, other, %TBSA burned, head and neck, trunk, arms legs an >7days to surgery.

Table 3. Details on body region debrided with hydrosurgery[a]

Body region[b]	**Only hydrosurgical debridement**	**Total**	**%**
Head and neck	14	43	32.6
Scalp	6	19	31.6
Face	9	33	27.3
Neck	7	12	58.3
Trunk	14	99	14.1
Ventral	12	83	15.7
Dorsal	4	26	15.4
Upper extremity	103	369	26.0
Arm	55	213	25.8
Hand	70	252	27.8
Genitals	11	40	27.5
Genital area	6	19	31.6
Buttocks	6	27	22.2
Lower extremity	135	675	20.0
Legs	96	486	19.8
Feet	63	279	22.6

[a] The burn centre registration allowed the registration of multiple burn locations per patient and does not differentiate between conservative, conventional and hydrosurgically treated body locations. Therefore, a subgroup analysis of patients with only one body part burned was performed to identify the prevalence of the use of hydrosurgery per body region.

[b] More than one subcategory per body region is possible.

Table 4. Surgical treatment and clinical outcome

	Hydrosurgical H	Both B	Conventional C	p-value Overall	p-value H vs C
n (%)	506 (23.9)	599 (28.3)	1008 (47.7)		
Surgical management					
Median TBSA Excised (IQR) [a]	2.0 (3.0)	5.0 (11.0)	1.0 (2.5)	<0.001	<0.001
Grafting technique (%) [b]					
SSG	95.5	96.0	93.2	0.031	0.077
MEEK	1.6	19.4	3.1	<0.001	0.083
Homograft	1.8	11.5	3.3	<0.001	0.095
Dermal substitute	0.2	2.2	1.5	0.018	0.021
Mean number of surgical procedures (range, SD)[c†]	1.2 (1-12, 0.8)	2.8 (1-22, 3.1)	1.4 (1-11,1.1)	<0.001	0.019
Mean volume of blood transfusion in ml (range, SD)[d†]	57.2 (0-4400, 361)	821.2 (0-32625, 2480)	156.0 (0-1485, 870)	<0.001	0.036
Clinical outcome					
Re-admission (%)	22.9	26.0	20.3	0.030	0.245
Median length of stay (IQR)	17.0 (16.0)	27.0 (27)	8.0 (20.0)	<0.001	<0.001
Wound infection (%)	1.6	6.7	3.8	<0.001	0.019
Reconstructions (%)	4.7	18.0	5.3	<0.001	0.667

Values are presented as median (IQR) and percentage
[†] Presentation of range and SD to improve interpretability
SSG = split skin graft, MEEK = Meek micrografting, IQR = Inter Quartile range, SD = Standard Deviation

a. 188 missing
b. More than one surgical technique per patient possible
c. 23 missing
d. 307 missing