

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

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35 **Abstract**

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

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

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

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

56 **Keywords:** Burns, Tangential excision, Conventional debridement, Hydrosurgical
57 debridement, Versajet hydrosurgery

58 1. Introduction

59 In the last decade, hydrosurgery has become available in burn surgery as an alternative
60 technique for tangential excision alongside the golden standard of conventional tangential
61 excision by guarded knives. The hydrosurgical device used in the treatment of burns is usually
62 known as the Versajet™. The Versajet™ hydrosurgery system (Smith and Nephew, St.
63 Petersburg, FL, USA) was developed in 1997 for soft tissue debridement in various types of
64 wounds. The Versajet™ hydrosurgery system works by producing a high-pressure jet of water
65 across an aperture in an angled hand piece. Through the Venturi principle, the jet creates a
66 suction force that draws tissues into the path of the fluid where they are ablated and sucked
67 into the device together with the irrigation fluid^{1,2}. Power settings can be adjusted to control
68 the cutting and aspiration effects, depending on the depth of debridement the surgeon wants to
69 achieve³. Although hydrosurgery was introduced for burn wound debridement in Dutch burn
70 care in 2006, it only became widely used in 2008⁴.

71 A report of the National Institute for Health Care and Excellence (NICE) presented an
72 overview of the studies concerning the safety of hydrosurgery². The majority of these studies
73 showed good clinical results with minimal adverse outcomes in both adults and children with
74 acute and chronic wounds⁴⁻¹¹. Studies on burn wounds showed that the Versajet system may
75 be faster and more precise in obtaining the desirable excision plane. Nevertheless, the
76 Versajet has typically not been favoured in deeper burns due to belief its penetration is less
77 efficient in thick eschar, as it 'bounces' off the hard tissue and causes irregular grooves^{2,7}.

78 Burn specialists widely use hydrosurgery as an alternative for conventional debridement prior
79 to skin grafting, however, only two randomized controlled trials comparing hydrosurgical and
80 conventional debridement in patients with burns have been published^{7,12}. These studies
81 reported a significant reduction in excision time and better preservation of viable tissue after
82 hydrosurgical debridement. Nevertheless, no significant differences were found on

83 postoperative pain, contracture rates, healing time, graft take, post-operative infection,
84 bacterial burden and scar quality at 6 months post burn. Whether these results influenced the
85 current application of the Versajet™ system is unexplored. To our knowledge, no algorithm is
86 available for burn specialists guiding them whether or not to use hydrosurgery. Due to an
87 absent algorithm and a paucity of studies, the clinical application of hydrosurgery in burn care
88 remains unknown.

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

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104 **2. Methods**

105 **2.1 Study design and population**

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

109

110 **2.2 Data collection**

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

116

117 **2.3 Data analysis**

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

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126 **2.4 Statistical analysis**

127 Data were analysed using IBM SPSS Statistics for Windows version 23.0 (IBM Corp., NY,

128 USA). Outcomes were reported as percentages for categorical variables. Continuous variables

129 were summarized as either means with corresponding standard deviations (SD) or medians
130 with interquartile ranges (IQR) depending on normality of distribution. Univariable logistic
131 regression analysis was performed to identify parameters that were associated with the use of
132 hydrosurgery. Parameters that were associated in univariable analysis ($p < 0.10$) were checked
133 for multicollinearity (Spearman's r (r_s) > 0.75) and subsequently entered into a multivariable
134 logistics regressions analysis (forward stepwise LR). Differences in patient, and injury related
135 characteristics, differences in surgical treatment and outcome between the three groups were
136 compared using the chi-squared (categorical data) or Kruskal-Wallis (continuous data) test.
137 Differences in surgical treatment and outcome between the groups treated with hydrosurgery
138 alone and the group treated with conventional techniques alone were compared using the chi-
139 squared (categorical data) or Mann-Whitney (continuous data) test. Two-tailed p values below
140 0.05 were considered statistically significant for all statistical tests.

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143 3. Results

144 3.1 Inclusions

145 A total of 6031 patients had been admitted in the three Dutch Burn centres between January
146 2009 and December 2016. In total 63.0% of the patients was excluded because they did not
147 have surgical debridement of their wounds and 1.9% was excluded because of lack of
148 information on the used technique during surgery (Fig. 1). The final study population
149 consisted of 2113 patients (59.5% males) with a median age of 41 years (IQR 36) and median
150 TBSA of 5% (IQR 10). Patient and injury characteristics per group are shown in Table 1.

151

152 3.2 Prevalence of the use of hydrosurgery and predictors

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

160 The median age in the groups in which hydrosurgery was used was lower (29 (IQR 42) years
161 and 28.3 years (IQR 35) vs. 44 years (IQR 35), p<0.001; Table 1). Elderly patients (>65
162 years) had lower odds of being treated with hydrosurgical debridement compared to all other
163 age categories (univariable analysis; Table 2). There was a trend toward differences in gender
164 (p<0.10; Table 1). Males had a higher likelihood of being treated with hydrosurgical
165 debridement, whether or not in combination with conventional debridement techniques (resp.
166 OR 1.23 95%CI 1.03-1.46, OR 1.23 95%CI (1.03-1.59); Table 2). Scalds were more
167 frequently debrided with hydrosurgery alone (Table 2; OR 2.23 95%CI 1.76-2.83), while

168 contact burns and burns with other causes (e.g. electricity, chemical) were more frequently
169 debrided with conventional excision alone (Table 2, univariable analyses both $p < 0.01$).
170 Median percentage TBSA burned was higher (11.0% (IQR 17.8; Table 1) and time to surgery
171 was longer (29.1 days (IQR 10); Table 1) in the combination group compared to the
172 hydrosurgical (5.0% (IQR 8), 15.0 days (IQR, 8)) and conventional group (2.0% (IQR 5.5),
173 13.0 days (IQR, 9)). Hydrosurgery was more often used in patients with a higher percentage
174 TBSA burned, although the odds for exclusive hydrosurgical debridement decreased in
175 patients with a TBSA $> 20\%$ (OR 4.42 95% CI 2.56-.62; Table 2). In addition, patients with a
176 delayed timing of surgery had higher odds of being treated with hydrosurgery alone (OR 1.80
177 (1.20-2.54); Table 2).
178 Significant independent predictors of the use of hydrosurgery were a younger age, scalds, a
179 larger TBSA burned, head/neck burns and arm burns (multivariable analyses; Table 2).

180

181 **3.3 Prevalence of hydrosurgery for burn wound debridement per affected body region**

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

185

186 **3.4 Surgical treatment and clinical outcome**

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

191 In the groups of patients in which hydrosurgery was used, whether or not in combination with
192 conventional techniques median length of stay were higher. In the group of patients in which

193 hydrosurgery was used exclusively, wound infection rates were lower compared to the other
194 groups.

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197 4. Discussion

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

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

208 Our study identified a younger age, scalds, a higher percentage TBSA burned, head/neck
209 burns and arm burns (including hands) as independent predictors for the use of hydrosurgery.
210 Our finding that scalds are predictors for the use of hydrosurgery might be a reflection of its
211 use in superficial burns, as scalding is known to result in more superficial burns¹⁴. Next to
212 that, our results showed that burns with other causes (e.g. electricity, chemical) had lower
213 chances of being treated hydrosurgically, whereas these causes are known to result in deeper
214 burns^{14,15}. The exclusive use of hydrosurgery decreased in patients with extensive burns
215 (TBSA>20%), which might be explained by the fact that patients with extensive burns have a
216 higher chance of burn wounds with mixed depths.

217 In our study population, patients in the age category 0-4 years were more often treated with
218 hydrosurgery. In these young children, scalds are the most common type of burn injury¹⁶. A
219 younger age and scalds remained as independent predictors for the use of hydrosurgery in the
220 multivariable analysis. Therefore, the high prevalence of scald injuries is not the only
221 explanation for the more frequent use of hydrosurgery in young children. Conventional

222 tangential knife excision is described to have a tendency to remove more viable tissue than is
223 actually necessary for adequate debridement^{6,12,17}. Our results that toddlers and infants had
224 the highest chance of being treated with hydrosurgical excision may reflect the wish for a
225 more precise debridement in the paediatric burns population to maximize preservation of
226 viable dermis. Next to improvement of scar quality and scar contraction, this could potentially
227 lead to a decrease in hypertrophic scarring, which is in fact a significant problem in
228 children^{18,19}. Another potential benefit of hydrosurgical debridement is that the small Versajet
229 hand piece allows irregularly contoured and relatively inaccessible areas to be easily
230 reached^{1,7}. This is in line with our results that hydrosurgery was more often used for
231 debridement of irregular contoured locations as the head and arms, and less in large flat body
232 parts as the trunk. Because surgery characteristics are not linked to specific body locations in
233 the R3 database we performed a subanalysis in patients with only one body part burned. This
234 analysis also showed that the scalp, neck and genital area were more often treated with
235 hydrosurgery alone.

236 Although we expected that hydrosurgery would be more often used in patients with smaller
237 burns, we found that patients with a percentage TBSA beneath one percent were more often
238 treated with conventional excision techniques only and that the median percentage TBSA
239 excised was higher in the groups in which hydrosurgery was used . This might be explained
240 by the higher costs of the VersajetTM compared with the costs of conventional excision
241 techniques. The current cost of the disposable VersajetTM II headpiece is €141,86 (\$167.55)
242 whilst the costs of a re-usable guard and handle of the Weck knife are respectively €0,91
243 (\$1.08) and €20,91 (\$24.70). The cost of one sterilized, single use Weck blade is €1,08
244 (\$1.28). In our experience, burn specialist prefer to use a Weck knife in smaller burns to
245 reduce treatment costs.

246 In current study, the mean volume of blood transfusion was lower in the group that was
247 exclusively treated with hydrosurgery than in patients treated with conventional excision,
248 even though the median TBSA excised was higher in the hydrosurgical treated group. Next to
249 a possible more subtle debridement using the Versajet™ system, this might be the results of
250 delayed debridement undertaken in the hydrosurgery group. To our knowledge, no other study
251 compared the amount of blood loss in hydrosurgical and conventional treated burn patients.
252 However, in wounds with delayed healing, maximum blood loss was found to be less in the
253 hydrosurgical debridement group compared to the conventional debridement group in one
254 clinical trial⁹. Our results also show that the prevalence of wound infection was significant
255 lower in the group exclusively debrided with hydrosurgery compared to the conventional only
256 debridement group. A few studies on chronic wounds have reported that hydrosurgery may
257 decrease bacterial burden after debridement and therefore post-operative infection, but this
258 was not confirmed by randomized trials in burn patients^{7,10-12,20}. The differences in surgical
259 management and clinical outcome might be explained by the possibility that the wounds that
260 were treated with hydrosurgery alone were more likely to be superficial. This is supported by
261 the lower use of dermal substitutes in this group. Unfortunately we were not able to adjust our
262 results for burn depth.

263 Some shortcomings of our study have to be mentioned. As it is a retrospective study, data
264 were not collected for the specific purpose of this study and was lacking in details on wound
265 and surgery characteristics. As a result, we were not able to perform a multivariable analysis
266 on the clinical outcomes and more prospective research is necessary to support the outcomes
267 of our study. Nevertheless, the Dutch Burn Repository R3 database is closely linked to
268 medical registers in three dedicated burn centres and study groups were large. Therefore, this
269 database gives a unique picture of the use of hydrosurgery in burn care with comprehensive
270 and generalizable data. The Dutch Burn Repository R3 registers burn depth estimated at

271 admission and percentage TBSA excised during surgery. We were not able to conclusively
272 conclude that hydrosurgery was the preferred debridement tool for deep dermal burns instead
273 of full thickness burns during surgery, nor correct our outcomes for burn depth. Another
274 shortcoming is the lack of long-term results. Although scar quality is considered to be one of
275 the most important outcomes of burn surgery today, no clinical study compared the effect of
276 hydrosurgical debridement on scarring in the long term. Hyland et al. performed a randomized
277 trial in the paediatric burn population comparing hydrosurgery with conventional
278 debridement. They did not observe significant differences in scarring at 3 or 6 months after
279 injury measured with the Vancouver scar scale (VSS)¹². Nevertheless, the follow-up duration
280 of 6 months may not be adequate for scar quality assessment and the VSS was formally not
281 designed to assess burn scar severity, has a moderate reliability, and does not include the
282 opinion of the patient²¹⁻²³. Only one study showed a superior result after hydrosurgery was
283 used for burn wound debridement⁴. Unfortunately, data of this retrospective study were not
284 published. Hence, it remains unclear if hydrosurgical debridement results in better functional
285 and cosmetic scar outcomes.

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

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

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297 Conflict of interest statement

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

300

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304

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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

^aThe 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

^a188 missing, ^bMore than one surgical technique per patient possible, ^c23 missing, ^d307 missing

Figure 1

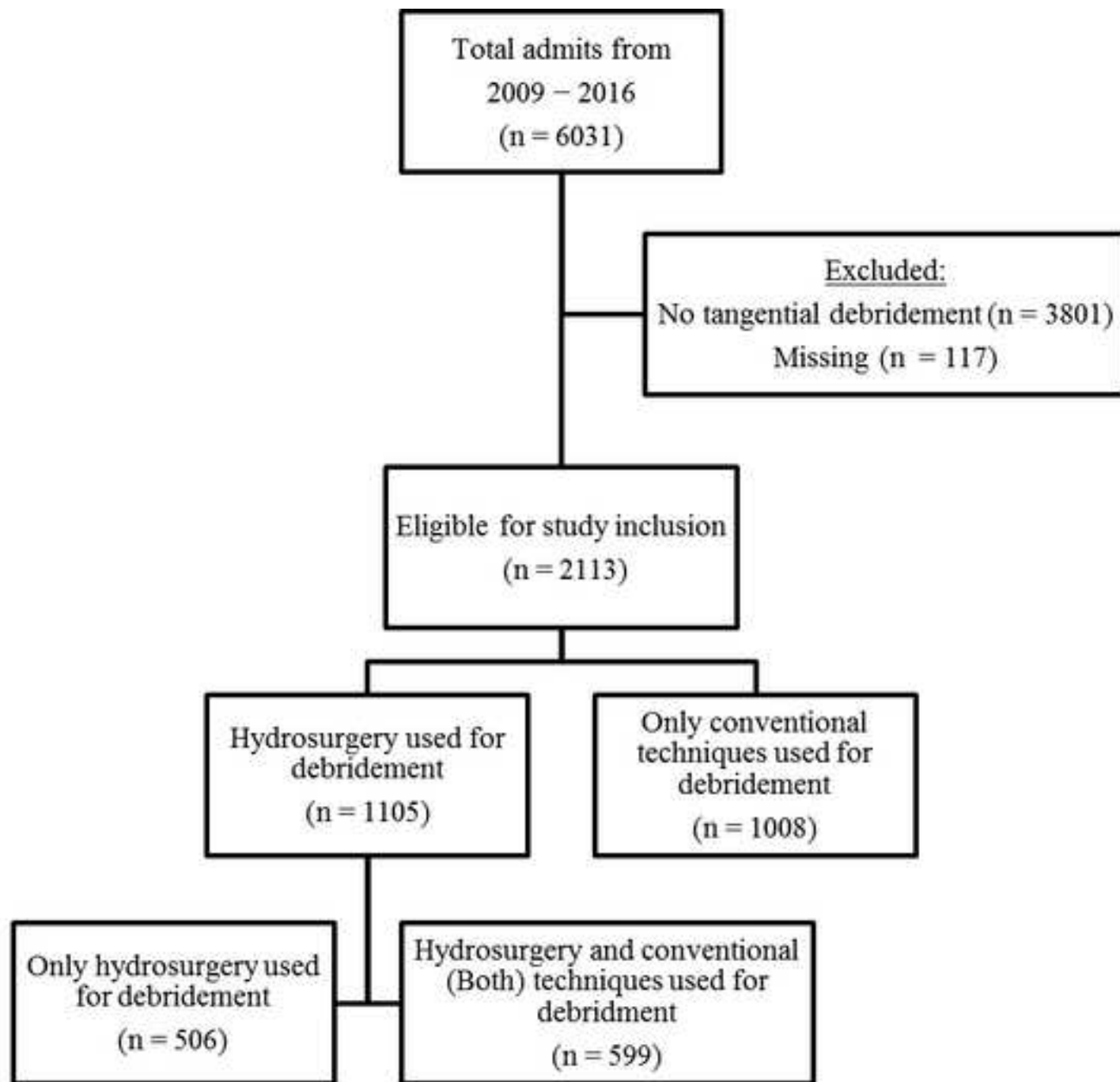


Figure 2

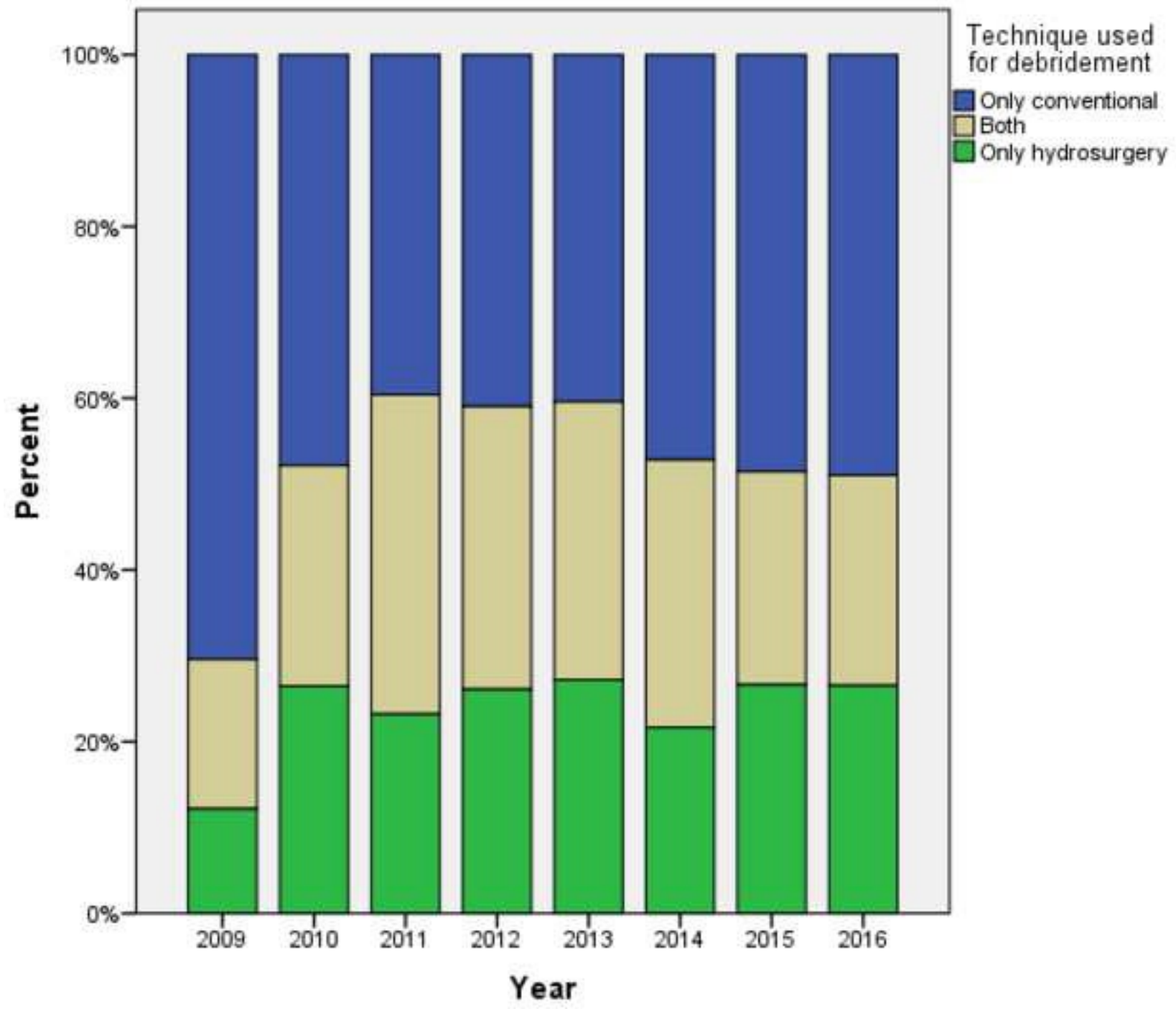


Table 1. Patient and injury characteristics

	Hydrosurgery used for debridement		Only conventional techniques used for debridement	p value*
	Only hydrosurgery	Both techniques		
	(n = 506)	(n = 599)	(n = 1008)	
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	
Aetiology, %[¶]				
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	Multivariable analysis	Univariable analysis	Multivariable analysis
	OR (95% CI)	OR (95% CI) ^c	OR (95% CI)	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

^aThe 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

	Hydro-surgical H	Both B	Conventional C	p-value Overall	p-value H vs C
n (%)	506 (23.9)	599 (28.3)	1008 (47.7)		
<i>Surgical management</i>					
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
<i>Clinical outcome</i>					
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