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Hand/Peripheral Nerve

The Reason Matters: Deep Wrist Injury Patterns Differ with Intentionality (Accident versus Suicide Attempt)

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Background: Despite the clinical importance of suicidal deep wrist injuries (DWIs), we currently do not know whether their injury patterns differ from accidental injuries.
Methods: This retrospective study included all patients admitted to the Clinic of Plastic Surgery for acute treatment of a DWI from 2008 to 2016, except for isolated injuries to the palmaris longus (PL) and amputations. Intentionality of the injury was determined using documentation of psychiatric evaluations; cases that could not be categorized regarding intentionality were excluded.
Results: About 20% of DWIs stemmed from suicide attempts, which involved the nondominant hand in 94.5%. Suicidal DWIs were more likely to involve the median nerve, radial artery, PL, and flexor carpi radialis (FCR), especially on the nondominant hand, but were less likely to involve the ulnar artery and nerve on the dominant hand. The effect of the protective structures PL/flexor carpi ulnaris on the median nerve/ulnar artery could be confirmed for suicidal DWIs, but intactness of the FCR was associated with increased radial artery injuries. Longitudinal cut orientation in suicidal DWIs was associated with more radial artery injuries, but fewer injuries to tendons and nerves. Frequencies of various other injury constellations are tabulated to aid in clinical assessment.
Conclusions: Suicidal and accidental DWIs differed in various aspects of injury pattern. Suicidal injuries were mostly localized to the nondominant radial side, and accidental injuries to the ulnar side. Also, the so-called protective structure FCR had the opposite effect in suicidal injuries. Thus, findings regarding injury patterns in accidental DWIs cannot be generalized to suicidal injuries. *(Plast Reconstr Surg Glob Open 2019;7:e2139; doi: 10.1097/GOX.0000000000002139; Published online 3 May 2019.)*

INTRODUCTION

Close to 800,000 people die of suicide every year, translating to 1.4% of deaths worldwide. For every completed suicide, there are 20 suicide attempts,[1] frequently by wrist cutting.[2] In surviving patients, the consequent effects on deep structures like arteries, nerves, and tendons can drastically impair hand function[3] and thus the capacity to work and carry out hobbies increase the risk of further suicide attempts. To stop this vicious cycle, reliable epidemiological data on suicidal deep wrist injuries (DWIs) are needed to optimize surgical management. Previous studies, however, have focused on epidemiology,[4–6] psychology,[7] and functional outcome[3,8,9] of suicidal DWIs or on accidental DWIs alone,[10–14] but did not compare suicidal and accidental DWIs. Therefore, we currently do not know whether findings from samples with (predominantly) accidental DWIs can be generalized to suicidal DWIs. Moreover, most previous studies categorized injuries by right/left hand (instead of dominant/nondominant), exposing them to handedness as a confounding factor, as most suicidal DWIs are performed by the dominant hand on the nondominant hand. Also, previous studies did not differentiate between injuries self-inflicted with different intentions, for example, between suicide attempt and emotion regulation. However, patients aiming at emotion

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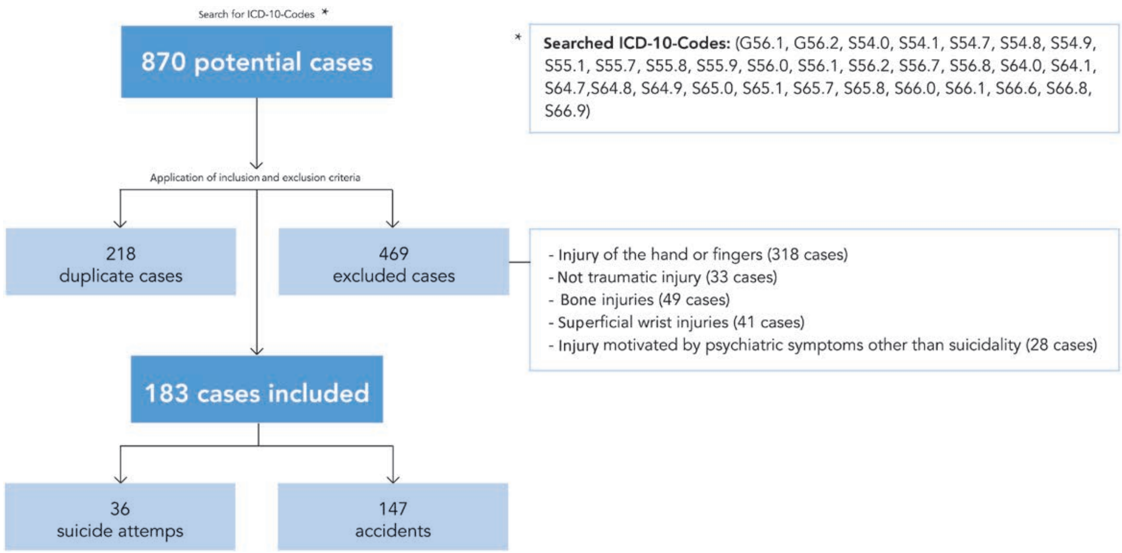

Fig. 1. Study design. The study population consisted of all patients admitted to the Clinic of Plastic Surgery, University Hospital of Schleswig-Holstein, Lübeck Campus, Germany, for acute treatment of a DWI from 2008 to 2016. T.K. and N.M. searched for the relevant International Classification of Diseases, 10th Revision (ICD-10) codes in the patient database of the Clinic of Plastic Surgery and collected data of the included cases from digital and analog archives of the Clinic of Plastic Surgery. Simultaneously but independently, A.L.W. compiled a list of all psychiatric consultations in the Clinic of Plastic Surgery in the study period, regardless of somatic diagnoses, and acquired the relevant data of these cases in the analog archive of the Department for Psychiatry and Psychotherapy. Both data sets were pseudonymized and patient identifying data were saved in a separate reference list. An independent trustee (A.L.W.), not involved in patient care, searched 2 reference lists for matches. Using the pseudonyms of successful matches, psychiatric data were then added to the surgical data set. The resulting data set was anonymized by deletion of both reference lists.

regulation will likely differ from patients aiming at death in cutting pattern, depth, and criteria for termination of cutting (fading of emotion versus subjective injury of vital structures), resulting in different injury patterns.

Consequently, the main objective of this study was to compare injury patterns of accidental versus suicidal DWIs with as little bias as possible.

SUBJECTS AND METHODS

Sample

This retrospective study included all patients admitted to the Clinic of Plastic Surgery, University Hospital of Schleswig-Holstein, Lübeck Campus, for acute treatment of a DWI from 2008 to 2016. During hospitalization, patients gave fully informed written consent to have their administrative and clinical data used for research purposes.

The inclusion criterion was a DWI, defined as damage of least one deeper anatomical structure at the palmar wrist (distal wrist crease to 10 cm proximally). Excluded were isolated injury to the palmaris longus (PL) tendon, amputations, and the impossibility of categorization of intentionality (eg, boxing through a glass pane with the intention to defend oneself from an optical hallucination of the devil). Cases with DWI on one hand and superficial injury on the other were classified as one-sided injuries.

After determination of the study protocol, approval by the ethics committee, and start of data acquisition, one of the authors (A.L.W.) suffered an accidental DWI. As there were no psychiatric data on her (being an accident victim) and as she did not handle surgical data before anonymization, we regarded the risk of bias to be low and elected to include A.L.W.'s case in the study.

Procedure

Before data acquisition, the study protocol was approved by the Ethics Committee of the University of

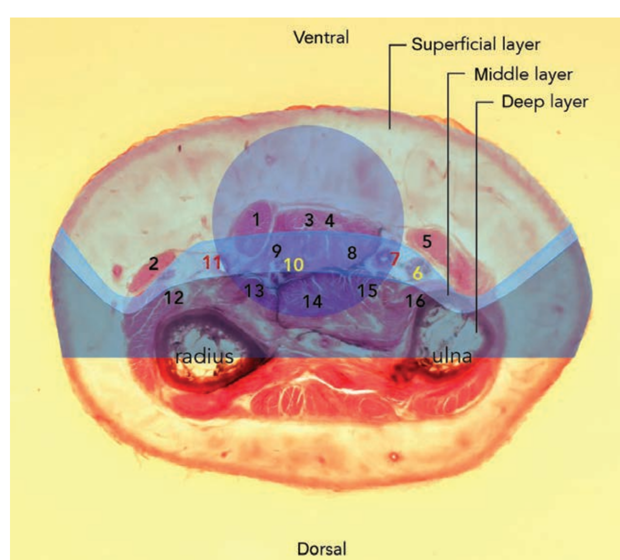

Fig. 2. Cross section of the wrist. 1 = PL, 2 = FCR, 3–4 = 3-/4-FDS, 5 = FCU, 6 = ulnar nerve, 7 = ulnar artery, 8–9 = 5-/2-FDS, 10 = median nerve, 11 = radial artery, 12 = FPL, 13–16 = deep flexor tendon 2–5.

Lübeck (reference number 13-054) and registered at *ClinicalTrials.gov* (ID: NCT03038581; see Fig. 1).

Operationalization

Injuries were coded dichotomously, for example, partial injuries were coded like total injuries. Injuries of individual structures were aggregated into radial triad [median nerve, PL, flexor carpi radialis (FCR) tendon] and ulnar triad [ulnar nerve, ulnar artery, flexor carpi ulnaris (FCU)] according to the study by Noaman[11] and Weinzweig et al.[12] and into superficial [PL, FCR, third flexor digitorum superficialis (FDS) tendon, FDS4, FCU; Fig. 2], middle (ulnar nerve, ulnar artery, FDS5, FDS2, median nerve, radial artery), and deep layer [flexor pollicis longus (FPL) tendon, second flexor digitorum profundus, FP3, FP4, FP5] according to the study by Lee et al.[4] Triads were deemed injured only when all individual structures in the triad were injured.

Numerical time point descriptions were categorized as follows: morning: 6:00 AM to 10:00 AM; noon: 10:00 AM to 2:00 PM; afternoon: 2:00 PM to 6:00 PM; evening: 6:00 PM to 10:00 PM; night: 10:00 PM to 6:00 AM.

The injuring object was categorized according to the type of injury typically caused, yielding the following categories: cutting tools (eg, knives, scissors, scalpels), shards (of glass, porcelain, Perspex, CDs, etc.), tearing machinery or tools (eg, circular saw, bread slicer), and thermal injuries (scalding with hot water, burns, etc.).

Statistical Analysis

All statistical analyses were carried out using SPSS version 23.0.0.1 for Windows (SPSS Inc., Chicago, Illinois, USA) except for post hoc power analysis, which was carried out using G*Power.[15] Results were deemed significant when the type I error probability fell <0.05. Differences between complementary conditional frequencies (P (A|B) and (P (A|-B) were considered significant if (1) the *P* value of the χ^2 omnibus test fell <0.05 and (2) the sum of the corrected residuals exceeded |1.96|.[16] Cramér's V was used as a measure of effect size in χ^2 tests. Power for χ^2 tests was calculated post hoc at 0.964, 0.985, and 0.994 for 4, 2, and 1 *df*, respectively, with the noncentrality parameter set to $\lambda = 20$. To identify potential predictors of outcome, we used stepwise regression, specifically the backward method to minimize suppressor effects (in logistic regression using the Wald statistic as criterion for elimination).

RESULTS

Demographic and Clinical Characteristics

Demographic and clinical characteristics of the sample are given in Tables 1 and 2, respectively. DWIs (19.7%) stemmed from suicide attempts, mostly in the context of a major depressive episode (66.6%, see supplementary materials 2), substance-related disorder (21.2%), and/or a reaction to stress (15.2%). Rates of alcohol intoxication at the time of the injury are given in Table 2. In addition,

Table 1. Demographic Characteristic of the Sample

		Cause of Injury		
	All	Accident	Suicide Attempt	Test Statistic
n	183	147	36	
Age (y), mean (SD)	41.7 (19.7)	38.0 (18.3)	56.9 (18.4)	F (1, 181) = 30.94, P < 0.001, η^2 = 0.38
Sex (%)				
Male	77.6	80.9	63.9	χ^2 (1) = 4.84, P = 0.028
Female	22.4	19.0	36.1	
Handedness (%)				
Right handed	88.7	87.3	94.1	NS
Left handed	11.3	12.7	5.9	
Ethnicity (%)				
White	93.2	92.2	97.1	NS
Asian	6.8	7.8	2.9	
Profession (%)				
Armed forces occupations	1.0	1.3	0.0	NS
Managers	3.0	2.3	4.0	
Professionals	10.9	6.6	24.0	
Technicians and associate professionals	4.0	5.3	0.0	
Clerical support workers	13.9	11.8	20.0	
Service and sales workers	13.9	15.8	8.0	
Skilled agricultural, forestry, and fishery workers	5.0	5.3	4.0	
Craft and related trades workers	36.6	36.8	36.0	
Plant and machine operators, and assemblers	4.0	5.3	0.0	
Elementary occupations	7.9	9.2	4.0	
Employment status (%)				
Self-employed	46.4	67.2	16.7	χ^2 (3) = 24.0, $P \leq 0.001$, corrected residuals = 4.9 and −4.9
Unemployment benefits or invalidity pension	14.9	10.9	31.0	χ^2 (3) = 24.0, $P \leq 0.001$, corrected residuals = −2.7 and 2.7
Old-age pension	20.8	20.2	48.3	χ^2 (3) = 24.0, $P \leq 0.001$, corrected residuals = −3.1 and 3.1
Other	1.6	1.7	3.4	NS

Test statistic refers to the comparison between patients after accidents and patients after suicide attempts.
NS, not significant.

Table 2. Clinical Characteristics of the Sample

	Weekday of the Injury (%)		Time of Day of the Injury (%)					Alcohol Intoxication at the Time of the Injury (%)	Injuring Object (%)				Injured Hand (%)			Orientation of Cut (%)			No. Injured Structures [Mean (SD)]
	Monday to Friday	Saturday, Sunday	Morning	Noon	After-noon	Evening	Night		Cutting Tool	Shards	Tearing Machin-ery or Tool	Other	Only Dominant	Only Non dominant	Both	Axial	Trans verse	Both	
Cause of injury																			
All	62.8	37.2	15.1	35.8	26.4	9.4	13.2	46.1	27.9	57.0	11.6	3.5	42.9	50.0	7.1		NA		4.3 (±3.8)
Accident	59.9	40.1	13.2	36.8	28.9	10.5	10.5	57.4	13.4	69.0	13.4	4.2	53.0	46.3	0.7		NA		4.2 (±3.5)
Suicide attempt	75.0	25.0	20.0	33.3	20.0	6.7	20.0	23.5	96.7	0.0	3.3	0.0	5.6	63.9	30.6	18.2	69.7	12.1	4.7 (±4.7)
Test statistic	χ^2 (1) = 85.68*		NS					χ^2 (1) = 10.44*	χ^2 (1) = 73.88*				χ^2 (1) = 17.89*	χ^2 (1) = 65.22*	χ^2 (1) = 8.33, P = 0.004	χ^2 (2) = 19.82*			NS

Test statistic refers to the comparison of patients after accidents with patients after suicide attempts.

*$P \leq 0.001$.

NA, not assessed; NS, not significant.

3 patients in the suicide attempt subsample had intoxicated themselves with prescription drugs and 1 with illegal drugs.

Injury Patterns

On average, 4.3 (±3.8) anatomical structures (including PL) were injured per case (see also Table 2). The majority of DWIs involved ≥1 tendon [78.7%, one-sided χ^2 (1, 181) = 60.25, $P < 0.001$; see also Table 3 and Fig. 3], nerve [62.8%, one-sided χ^2 (1, 181) = 12.07, $P = 0.001$], and artery [60.7%, one-sided χ^2 (1, 181) = 8.31, $P = 0.004$]. The middle layer of the anatomical structure was injured more often than the superficial or deep layer [McNemar's χ^2 (1, 181) = 15.28, $P < 0.001$ and McNemar's χ^2 (1, 181) = 90.47, $P < 0.001$]. The superficial layer was injured more often than the deep layer [McNemar's χ^2 (1, 181) = 55.36, $P < 0.001$].

Regarding protective structures, patients with intact FCR were less likely to have damage to the radial artery than those with damage to the FCR [χ^2 (1, 181) = 7.70, $P = 0.006$] (see Table 5 for frequencies and supplementary material 3 for test statistics), patients with intact PL were less likely to have damage to the median nerve [χ^2 (1, 181) = 21.80, $P < 0.001$], and patients with intact FCU were less likely to have damage to the ulnar artery [χ^2 (1, 181) = 37.91, $P < 0.001$]. In addition, patients with intact FCU were less likely to have damage to the ulnar nerve than patients with injured FCU [χ^2 (1, 181) = 24.08, $P < 0.001$].

Differences in Injury Patterns Associated with Intentionality

Bilateral injuries occurred almost exclusively in the context of a suicide attempt (91.7%), and isolated injuries of the dominant hand mostly in accidents (97.3%). Left-handed accident victims were more likely to injure their dominant than their nondominant hand [76.5%, χ^2 (1, 15) = 4.77, $P = 0.029$].

Regarding the frequency of damage to arteries, nerves, and tendons, there were no differences between intentionality groups (all $P \geq 0.31$). However, patients who had attempted suicide were more likely to have injured the radial artery than accident victims (44.4% versus 25.2%, see Table 3 for test statistics). The frequency of injuries to the ulnar artery was lower in patients after suicide attempts than in accident victims (22.2% versus 38.1%), but this comparison did not reach significance. Also, patients who had attempted suicide were more likely to have an injury to >1 artery than accident victims (11.1% versus 2.7%). Double arterial injuries due to suicide attempts mostly involved both hands, whereas all double arterial injuries due to accidents involved only 1 hand. Taking handedness into account, patients after suicide attempts were less likely to have damage to the ulnar artery on the dominant hand (5.9% versus 25.4%), but more likely to have damage to the radial artery on the nondominant hand (44.1% versus 12.7%).

Regarding nerve injuries, patients after suicide attempts were more likely than accident victims to have damage to the median nerve (50.0% versus 29.9%), as likely to have damage to the superficial branch of the radial nerve (13.9% versus 12.2%) and less likely to have damage to the

Table 3. Injury Patterns

	Any Hand						Dominant Hand						Nondominant Hand					
	Total	Accident	Suicide Attempt	Comparison Accident Versus Suicide Attempt			Total	Accident	Suicide Attempt	Comparison Accident Versus Suicide Attempt			Total	Accident	Suicide Attempt	Comparison Accident Versus Suicide Attempt		
	183	147	36				168	134	34				168	134	34			
n	%	%	%	χ^2	*P*	V	%	%	%	χ^2	*P*	V	%	%	%	χ^2	*P*	V
Radial triad	9.8	5.4	27.8	16.3	≤0.001°	0.30	4.8	3.0	11.8				6.0	3.0	17.6	10.41	0.005°	0.25
Ulnar triad	14.8	17.0	5.6				8.9	11.2	0.0	4.18	0.043°	0.16	6.0	6.0	5.9			
Superficial layer	67.2	66.7	69.4				35.7	38.8	23.5				36.3	29.9	61.8	11.94	0.001	0.27
Middle layer	85.2	84.4	88.9				41.7	47.8	17.6	10.12	0.001	0.25	46.4	37.3	82.4	22.23	≤ 0.001	0.36
Deep layer	29.0	31.3	19.4				16.7	19.4	5.9				12.5	11.9	14.7			
Radial artery	29.0	25.2	44.4	5.2	0.022	0.17	10.1	11.9	2.9				19.0	12.7	44.1	17.38	≤ 0.001	0.32
Ulnar artery	35.0	38.1	22.2				21.4	25.4	5.9	6.12	0.013	0.19	14.9	12.7	23.5			
Any artery	60.7	60.5	61.1				29.2	34.3	8.8	8.54	0.003	0.23	31.5	23.9	61.8	18.02	≤ 0.001	0.33
>1 Artery	4.4	2.7	11.1	4.9	0.049°	0.16	1.2	1.5	0.0				1.2	0.7	2.9			
Superficial branch of radial nerve	12.6	12.2	13.9				4.8	5.2	2.9				8.3	7.5	11.8			
Median nerve	33.9	29.9	50.0	5.2	0.023	0.17	17.9	18.7	14.7				16.1	9.7	41.2	19.92	≤ 0.001	0.34
Ulnar nerve	28.4	34.0	5.4	11.5	0.001	0.25	16.7	20.9	0.0	8.53	0.004	0.23	11.3	12.7	5.9			
Any nerve	62.8	64.4	55.6				32.1	35.8	17.6	4.11	0.043	0.16	31.5	27.6	47.1	4.75	0.029	0.17
>1 Nerve	13.7	11.6	22.2				7.1	9.0	0.0				4.2	2.2	11.8	6.16	0.032°	0.19
PL	20.8	16.3	38.9	8.9	0.003	0.22	10.7	8.2	20.6				13.1	9.0	29.4	9.97	0.004°	0.24
FCR	33.9	27.9	58.3	12.0	0.001	0.26	12.5	11.9	14.7				23.2	16.4	50.0	17.16	≤ 0.001	0.32
FCU	29.5	29.3	30.6				17.9	19.4	11.8				15.5	11.9	29.4	6.33	0.012	0.19
FPL	13.1	12.2	16.7				7.7	8.2	5.9				4.8	3.0	11.8			
FS2	19.1	21.1	11.1				10.1	11.9	2.9				9.5	9.0	11.8			
FS3	23.0	23.8	19.4				13.7	14.9	8.8				10.1	9.0	14.7			
FS4	27.3	29.9	16.7				17.9	20.9	5.9	4.17	0.041	0.16	10.1	10.4	8.8			
FS5	21.9	25.2	8.3				12.5	15.7	0.0	6.09	0.008°	0.19	10.7	11.2	8.8			
Any superficial flexor tendon	37.2	39.5	27.8				23.2	26.1	11.8				16.1	14.9	20.6			
FD2	9.8	10.2	8.3				5.4	6.0	2.9				4.2	3.0	8.8			
FD3	11.5	12.2	8.3				7.1	8.2	2.9				5.4	4.5	8.8			
FD4	16.9	18.4	11.1				9.5	10.4	5.9				8.9	9.0	8.8			
FD5	14.2	15.6	8.3				7.1	9.0	0.0				8.3	8.2	8.8			
Any profound flexor tendon	25.1	27.2	16.7				14.3	16.4	5.9				11.9	11.2	14.7			
Any extensor tendon	17.5	16.3	22.2				8.3	8.2	8.8				10.7	9.7	14.7			
Any tendon	78.7	79.6	75.0				41.7	44.0	32.4				42.9	38.1	61.8	6.22	0.013	0.19

χ^2 values and corresponding values of *P* and Craméгs V (denominated with "V") are given for the comparison between accident victims versus patients after suicide attempts (*P* value of Fisher's exact test given when necessary, indicated by °) when reaching the significance level of $\alpha \le 0.05$. Lighter/darker gray background = frequency lower/higher in patients after suicide attempt than in patients after accidents.

APB, abductor polocis brevis; APL, abductor policis longus; ECRB, extensor carpi radialis brevis; ECRL, extensor carpi radialis longus; ECU, extensor carpi ulnaris; ED2–5: extensor digitorum 2–5; EDM: extensor digiti minimi; EI2, extensor indicis 2; EPB, extensor policis brevis; EPL, extensor policis longus; FS2–5, flexor digitorum profundus 2–5.

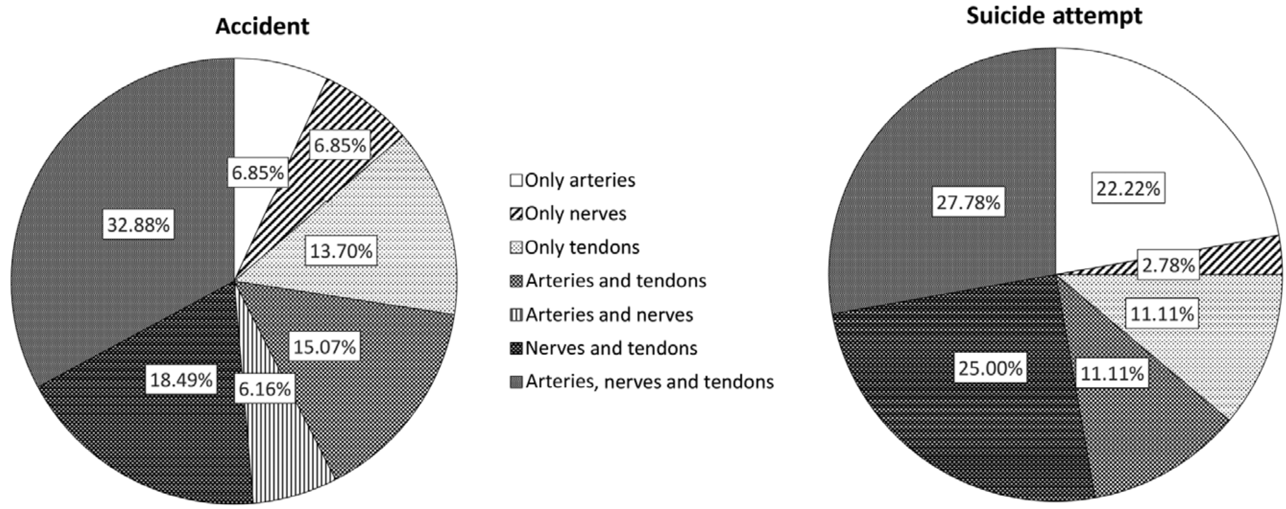

Fig. 3. Frequencies of types of structures injured, separated by intentionality of the injury (N = 183).

ulnar nerve (5.4% versus 34.0%). Taking handedness into account, patients after suicide attempts were less likely to have damage to the ulnar nerve on the dominant hand (0.0% versus 20.9%), but more likely to have damage to the median nerve on the nondominant hand (41.2% versus 9.7%). Regarding isolated injuries after suicide attempts, the afflicted structure was mostly an artery (80%), more specifically the radial artery of the dominant hand (70%). In accidents resulting in an isolated injury, the type of the damaged structure was evenly distributed among arteries (32.3%), nerves (35.5%), and tendons (32.3%).

Regarding protective structures, results from accidental DWIs were similar to the whole sample (Table 4). Analogously, in suicidal DWIs with intact PL, damage to the median nerve was less frequent [27.3% versus 85.7%, χ^2 (1, 34) = 11.69, P = 0.001], and in suicidal DWIs with intact FCU, ulnar artery injury was less frequent [8.0% versus 54.5%, χ^2 (1, 34) = 9.58, exact P = 0.005] as was ulnar nerve injury (0.0% versus 18.2%), although the latter comparison did not reach significance. However, in suicidal DWIs with intact FCR, radial artery injury was *more* frequent than in suicidal DWIs with injury to the FCR [66.7% versus 28.6%, χ^2 (1, 34) = 5.14, P = 0.023].

Relative Influence of Predictors of Injury Patterns

To compare the relative influence of the aforementioned variables on the frequency of injuries to specific important structures, we used backward binary logistic regression. Regarding the radial artery, patients with intact protective structure (FCR) were 0.4 times as likely to have injury to the radial artery (for test statistics, see Table 5) and patients after suicide attempt were 3.4 times as likely. Regarding the median nerve, patients with intact protective structure (PL) were 0.2 times as likely to have an injury to the median nerve and patients after suicide attempt were 2.4 times as likely (This coefficient did not reach significance.). Regarding the ulnar artery, patients with intact protective structure (FCU) were 0.1 times as likely to have an injury to the ulnar artery and patients after suicide attempts were 0.4 times as likely (This coefficient did not reach significance.). Regarding the ulnar nerve, patients with intact protective structure (FCU) were 0.2 times as likely to have an injury to the ulnar nerve and patients after suicide attempts were 0.1 times as likely.

Differences in Injury Patterns Associated with Cut Orientation

The majority of suicide attempts (81.8%) presented with transversely oriented cuts (ie, perpendicular to the axis of the forearm, see Table 2) and 30.3% with longitudinally oriented cuts. The subgroup with only longitudinal cuts (ie, without transverse cuts) consisted exclusively of isolated injuries. There were no injuries of tendons and less injuries of nerves [16.7% versus 70.4%, χ^2 (1, 32) = 5.93, exact P = 0.025] but more injuries to the radial artery [83.3% versus 37.0%, χ^2(1, 32) = 4.24, P = 0.039, exact P = 0.070] than in the subgroup with transverse suicidal DWIs.

DISCUSSION

One in five DWIs in our study originated in a suicide attempt, in accordance with previous studies.[4,10,12,17,18] Suicide attempts (94.5%) involved the nondominant hand, whereas in accidents, handedness had no effect on injured side, similar to previous findings.[8,13] The preponderance of injuries to the nondominant hand in suicide attempts might be due to habitual usage of the dominant hand when using a tool such as a knife, leaving the unoccupied nondominant hand as potential target for cutting.

Suicidal DWIs were 3.4 times as likely to involve the radial artery and more likely to involve the radial triad (median nerve, PL, and FCR), but accidental injuries were more likely to involve the ulnar triad (ulnar nerve, ulnar artery, and FCU) and FS4/5 on the dominant hand. This pronounced ulnar-radial distribution of injuries according to intentionality is in accordance with some previous studies[3,8] and might be a result of hand position at the time of injury: In an accident, reflective

Table 4. Conditional Frequencies of Injuries to Important Anatomical Structures

		all causes of injury (N = 183)						accidents (n = 147)						suicide attempts (n = 36)					
		radial artery	FPL	median nerve	DFT	ulnar artery	ulnar nerve	radial artery	FPL	median nerve	DFT	ulnar artery	ulnar nerve	radial artery	FPL	median nerve	DFT	ulnar artery	ulnar nerve
		[%]						[%]						[%]					
all injury patterns		29,0	13,1	33,9	25,1	35,0	28,4	25,2	12,2	29,9	27,2	38,1	34,0	44,4	16,7	50,0	16,7	22,2	5,6
patients **with** injury of	FCR	41,9	24,2	50,0	32,3	25,8	11,3	48,8	22,0	39,0	34,1	24,4	12,2	28,6	28,6	71,4	28,6	28,6	9,5
	radial artery	-	15,1	26,4	15,1	11,3	7,5	-	18,9	24,3	16,2	10,8	5,4	-	6,3	31,3	12,5	12,5	12,5
	PL	28,9	15,8	65,8	31,6	31,6	10,5	33,3	16,7	54,2	37,5	33,3	12,5	21,4	14,3	85,7	21,4	28,6	7,1
	median nerve	22,6	29,0	-	41,9	35,5	27,4	20,5	29,5	-	45,5	38,6	34,1	27,8	27,8	-	33,3	27,8	11,1
	ulnar artery	9,4	14,2	34,4	45,3	-	67,2	7,1	12,5	30,4	46,4	-	73,2	25,0	25,0	62,5	37,5	-	25,0
	ulnar nerve	7,7	13,5	32,7	48,1	82,7	-	4,0	12,0	30,0	46,0	82,0	-	100,0	50,0	100,0	100,0	100,0	-
	FCU	11,1	20,4	37,0	38,9	68,5	53,7	7,0	14,0	27,9	37,2	72,1	62,8	27,3	45,5	72,7	45,5	54,5	18,2
patients **without** injury of	FCR	22,3	7,4	25,6	21,5	39,7	37,2	16,0	8,5	26,4	24,5	43,4	42,5	66,7	0,0	20,0	0,0	13,3	0,0
	radial artery	-	12,3	36,9	29,2	44,6	36,9	-	10,0	31,8	30,9	47,3	43,6	-	25,0	65,0	20,0	30,0	0,0
	PL	29,0	12,4	25,5	23,4	35,9	33,1	23,6	11,4	25,2	25,2	39,0	38,2	59,1	18,2	27,3	13,6	18,2	4,5
	median nerve	32,2	5,0	-	16,5	34,7	28,9	27,2	4,9	-	19,4	37,9	34,0	61,1	5,6	-	0,0	16,7	0,0
	ulnar artery	39,5	12,6	33,6	14,3	-	7,6	36,3	12,1	29,7	15,4	-	9,9	50,0	14,3	46,4	10,7	-	0,0
	ulnar nerve	37,4	13,0	34,4	16,0	16,0	-	36,1	12,4	29,9	17,5	15,5	-	41,2	14,7	47,1	11,8	17,6	-
	FCU	36,4	10,1	32,6	19,4	20,9	17,8	32,7	11,5	30,8	23,1	24,0	22,1	52,0	4,0	40,0	4,0	8,0	0,0

Depicted are frequencies of injury to certain anatomical structures (in columns) under certain conditions (injury versus intactness of other anatomical structures, in rows). Conditional frequencies that significantly differed from their complementary conditional frequency are shown on a lighter/darker gray background signifying a lower/higher frequency.
DFT, deep flexor tendons; NA, not applicable; FPL, flexor policis longus.

pronation results in the ulnar wrist side protruding farthest outward and thus suffering most of the impact with the injuring object. In suicide attempts, most patients assumedly have enough anatomical knowledge to supinate their hand to injure an artery. This results in the radial side of the wrist pointing upwards and thus being most easily accessible.

Other studies, however, found a more even distribution of injuries, for example, Kabak et al.,[13] which might be due to sample differences, as two thirds of the injuries in Kabak et al. stemmed from punching through a window, when either inebriated or infuriated. Such cases would have been excluded from our study due to the impossibility of categorization of intentionality.

Regarding protective structures, intactness of PL and FCU was associated with intactness of the median nerve and ulnar artery/nerve, respectively, in both whole-sample and subgroup analyses, confirming previous findings. Regarding the FCR, its intactness was associated with fewer radial artery injuries in accident victims. Surprisingly, intactness of the FCR in suicidal DWIs was associated with a 2-fold *increase* in radial artery injuries but a decrease in median nerve injuries, maybe due to the cutting pattern.

Regarding orientation, longitudinal cuts were associated with more radial artery injuries, confirming its common appraisal as the more dangerous variant of suicidal DWI.[19] However, longitudinal cuts involved less damage to tendons and nerves, and may therefore be associated with better functional outcome in survivors.

To the best of our knowledge, the present study has the biggest hitherto published sample size in the field and is one of the first to analyze injury patterns separately according to intentionality of the injury. We excluded self-inflicted injuries without suicidal intent, supposing that patients aiming at emotion regulation will differ from patients aiming at death in cutting pattern, depth, and criteria for termination of cutting (fading of emotion versus subjective injury of vital structures). Also, analysis of dominant versus nondominant sides (instead of right versus left) allowed us to avoid handedness as a confounding factor. However, an important limitation of our study is the retrospective design, leading to missing data. We refrained from correcting for multiple comparisons to prevent accumulation of type II error, thereby exposing our study to the risk of type I errors. Also, as stepwise multiple regression poses the dangers of over- and underfitting the model to the data, our predictor model is only exploratory and needs confirmation or falsification from other populations.

CONCLUSIONS

Suicidal and accidental deep wrist injuries (DWIs) differed in various aspects of injury pattern in our study. Suicidal injuries were mostly localized to the nondominant radial side, and accidental injuries to the ulnar side. Also, in suicide attempts, intactness of the so-called protective structure FCR was associated with more radial artery injuries. Thus, findings regarding injury patterns in accidental DWIs cannot be generalized as suicidal injuries, and future research should analyze these patient populations separately. Also, it remains to be investigated whether differences in injury patterns translate to systematic differences in functional outcome between accidental and suicidal DWIs.

Table 5. Coefficients of Binary Logistic Regressions

	Model Test Statistics			Predictors											
				Intact Protective Structure			Suicidal Intention			Injury to the Dominant Hand			Unilateral Injury		
Criteria	χ^2	R^2	Hosmer-Lemeshow χ^2	*b*	Wald	OR (95% CI)	*b*	Wald	OR (95% CI)	*b*	Wald	OR (95% CI)	*b*	Wald	OR (95% CI)
Radial artery injury	15.15*	0.09/0.12*	13.20*	−0.82	4.86*	0.44 (0.21–0.91)	1.208	6.89*	3.35 (1.36–8.25)		Excluded		1.99	5.01*	7.32 (1.28–41.84)
Median nerve injury	33.10*	0.18/0.25*	0.89	−1.84	18.49*	0.16 (0.07–0.37)	0.86	3.61	2.37 (0.97–5.78)	0.95	6.19*	2.58 (1.22–4.44)		Excluded	
Ulnar artery injury	43.08*	0.22/0.31*	0.89	−2.08	28.26*	0.13 (0.06–0.27)	−0.89	3.06	0.41 (0.15–1.11)	0.77	4.24*	2.17 (1.04–4.53)		Excluded	
Ulnar nerve injury	36.89*	0.20/0.28*	0.92	−1.84	21.29*	0.16 (0.07–0.35)	−2.41	9.56*	0.09 (0.02–0.41)		Excluded			Excluded	

R^2s were estimated according to Cox and Snell/Nagelkerkes. In the model predicting injury of the radial artery, the protective structure is the FCR; in the case of the median nerve, the PL; and in the case of the ulnar artery and ulnar nerve, the FCU.

*Significant at the 0.05 error level.

b, unstandardized regression coefficient; excluded, excluded in backstep regression; OR, odds ratio.

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REFERENCES

1. World Health Organisation. *Practice manual for establishing and maintaining surveillance systems for suicide attempts and self-harm*. Available at http://apps.who.int/iris/bitstream/10665/208895/1/9789241549578_eng.pdf. Accessed February 20, 2018.
2. Asnis GM, Friedman TA, Sanderson WC, et al. Suicidal behaviors in adult psychiatric outpatients, I: description and prevalence. *Am J Psychiatry*. 1993;150:108–112.
3. Gu JH, Jeong, S-H. Self–wrist cutting injury: a traumatologic and psychological analysis. *Plast Reconstr Surg*. 2012;129:763e–764e.
4. Lee CH, Cha SM, Shin HD. Injury patterns and the role of tendons in protecting neurovascular structures in wrist injuries. *Injury* 2016;47:1264–1269.
5. Fujioka M, Murakami C, Masuda K, et al. Evaluation of superficial and deep self-inflicted wrist and forearm lacerations. *J Hand Surg Am*. 2012;37:1054–1058.
6. Shin JY, Roh SG, Lee NH, et al. Risk factors related to recurrent suicide attempts in patients with self-inflicted wrist injuries. *J Plast Reconstr Aesthet Surg*. 2016;69:722–723.
7. Carroll R, Thomas KH, Bramley K, et al. Self-cutting and risk of subsequent suicide. *J Affect Disord*. 2016;192:8–10.
8. Ersen B, Kahveci R, Saki MC, et al. Analysis of 41 suicide attempts by wrist cutting: a retrospective analysis. *Eur J Trauma Emerg Surg*. 2017;43:129–135.
9. Yazdanshenas H, Naeeni AF, Ashouri A, et al. Treatment and post-surgery functional outcome of spaghetti wrist. *J Hand Microsurg*. 2016;8:127–133.
10. Jaquet JB, van der Jagt I, Kuypers PD, et al. Spaghetti wrist trauma: functional recovery, return to work, and psychological effects. *Plast Reconstr Surg*. 2005;115:1609–1617.
11. Noaman HH. Management and functional outcomes of combined injuries of flexor tendons, nerves, and vessels at the wrist. *Microsurgery* 2007;27:536–543.
12. Weinzweig N, Chin G, Mead M, et al. "Spaghetti wrist": management and results. *Plast Reconstr Surg*. 1998;102:96–102.
13. Kabak S, Halici M, Baktir A, et al. Results of treatment of the extensive volar wrist lacerations: 'the spaghetti wrist'. *Eur J Emerg Med*. 2002;9:71–76.
14. Rogers GD, Henshall AL, Sach RP, et al. Simultaneous laceration of the median and ulnar nerves with flexor tendons at the wrist. *J Hand Surg Am*. 1990;15:990–995.
15. Faul F, Erdfelder E, Lang AG, et al. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*. 2007;39:175–191.
16. Sharpe D. Your chi-square test is statistically significant: now what? *Pract Assess Res Eval*. 2015;20:1–10.
17. Puckett CL, Meyer VH. Results of treatment of extensive volar wrist lacerations: the spaghetti wrist. *Plast Reconstr Surg*. 1985;75:714–721.
18. Widgerow AD. Full-house/spaghetti wrist injuries. Analysis of results. *S Afr J Surg*. 1990;28:6–10.
19. Sigrist T, Dirnhofer R. [Suicide by cutting the radial artery of the wrist. Report of 2 cases]. *Z Rechtsmed*. 1983;91:159–164.