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Treatment and outcome of AO/OTA type C distal radius fractures: 12 199 fractures from the Swedish Fracture Register

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The aim of this study was to examine the epidemiology, treatment, and patient-reported outcome of AO/OTA type C distal radius fractures (DRF) using data from a large national fracture register. We used prospectively collected data from the Swedish Fracture Register covering all AO/OTA type C DRFs registered between April 2012 and December 2018. Data on fracture type, epidemiology, trauma-mechanism, and treatment had been recorded by the treating physician. Patients had been sent an outcome questionnaire including EQ-VAS, EQ-5D, and the SMFA at the time of injury and 12 months after. A total of 12 199 cases with AO/OTA type C fracture were identified. AO/OTA type C1 fracture was most common, with 5400 cases, followed by AO type C2 with 4304 and AO/OTA type C3 with 2495. Cast treatment and surgical treatment with volar locking plate fixation were the most common treatments. Patient-reported outcome measures worsened significantly one year after the fracture, and 56% reported moderate problems with pain and discomfort one year after the fracture. Patients treated with a volar plate reported a significantly larger deterioration in EQ-5D outcome compared to patients treated with a cast. No treatment method was found to be superior. A good outcome after a type C fracture is possible, but many patients do not recover completely. Our findings indicate a relatively better self-reported outcome for patients treated with a cast, but as treatment was not randomized the clinical relevance is unclear.

Keywords: Distal radius fracture, Epidemiology, Swedish fracture register, AO/OTA type C, patient-reported outcome measures.

INTRODUCTION

The distal radius fracture (DRF) is the most common fracture among adults, having been shown to represent 18% of the fractures in an orthopedic trauma unit[1]. The incidence in Sweden has been estimated to be 25-28 fractures per 10 000 inhabitants annually; however, as life expectancy is increasing for both men and women, the total number of fractures can be expected to increase[2]. Non-displaced and displaced but reducible fractures are commonly treated non-operatively. Displaced and unstable fractures, which cannot be reduced, are usually considered for operative treatment[3]. In recent years, previously more common fixation methods have been replaced by volar locking plates, which were introduced in 2002[4,5]. Some publications report improved outcome regarding patient-reported outcome and grip strength when using volar locking plates rather than the older techniques[6,7].

The best way to stabilize an intraarticular DRF remains unclear. A volar locking plate is arguably the most common method today, but other methods such as combined plating, fragment-specific fixation, and a dorsal spanning plate are options in more complex fracture patterns[2,8]. Malunion and gap formation with intraarticular step-off are considered predictors for the development of posttraumatic arthritis (PA)[9]. Consequently, anatomical restoration is beneficial to minimize the risk of PA[10]. However, the link between radiographic PA and clinical symptoms from the wrist remains unclear[10]. AO/OTA type A, B, and C DRFs often differ regarding patient demographics, trauma mechanism, and functional demands of the patient. Overall, studies focusing on AO/OTA type C DRFs are sparse.

The Swedish Fracture Register (SFR) is a nation-wide register with prospective data collection on orthopedic fractures, injury, patient characteristics, patient-

reported outcome measures (PROMs) and treatment[11]. The aim of this study was to investigate epidemiology, treatment, PROMs and injury characteristics in patients with AO/OTA type C DRFs, utilizing data from the SFR.

MATERIALS AND METHODS

All DRFs of AO/OTA type C enrolled in the SFR between April 1st 2012 and December 31st 2018 in patients > 18 years were included in the study. The attending orthopedic surgeon files a web-based registration at the affiliated departments. Only fractures occurring in Sweden are registered. By 2015, 50% of the departments in Sweden treating fractures had joined the register. By the end of 2017 the coverage was over 80% of the Swedish population. As of 2021, all Swedish orthopedic units treating DRFs are affiliated to the register.

Trauma mechanism is classified as simple fall, unspecified fall, traffic accident, fall from a height, and other causes. Unspecified falls may include simple falls and falls from a height as they are not further classified at registration. The trauma mechanism is divided into low-energy or high-energy. There is no strict guideline in the SFR for choosing between high and low energy during registration; it is for the registering doctor to categorize this. Open fractures are classified according to Gustilo-Anderson[12]. Fractures classification is done according to the Muller AO/OTA system[13]. In general, high levels of validity and accuracy as well as moderate classification accuracy regarding DRFs have been demonstrated in the SFR[14]. During the online classification process, a manual with images of the different fracture groups in the AO/OTA classification is used together with accompanying written explanations (Figure 1).

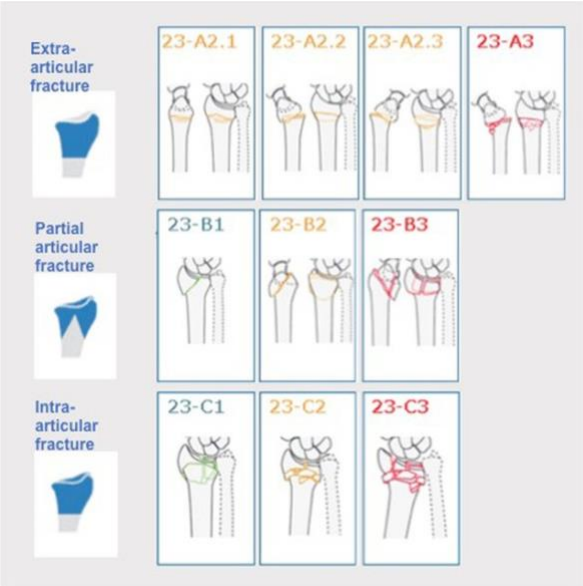

Figure 1 — Schematic illustration of the AO/OTA classification system as seen in the SRF for distal radius fractures.

The location of the injury is classified as the patient´s residence (including institutional housing), in a public place, in a street/road, or at an unspecified place. DRF treatment is specified as operative or non-operative. Operative treatment is further specified as volar plate, dorsal plate, external fixator, K-wires and other methods which includes combined treatments such as dorsal spanning plate, K-wires plus external fixator, external fixator plus a volar plate and so on. The operating surgeons experience level is specified as hand surgeon, orthopedic trauma surgeon (>50% trauma in daily practice), resident assisted by an orthopedic surgeon, resident in orthopedic surgery, and other orthopedic subspecialties.

PROMs include the the EQ-VAS, EQ-5D, the Arm Hand Function Index, and the Bother Index of the Short Musculoskeletal Function Assessment (SMFA), using validated Swedish translations[15,16]. The questionnaires are distributed to the patient at the time of the fracture. The patient reports their health status as they recall it being during the week before the fracture. The one-year follow-up questionnaires are only sent to patients who complete the initial questionnaires. The EQ-5D is a common questionnaire measuring health-related quality of life (QoL) for a range of conditions and treatments[17]. The respondent's health is reported on five dimensions (mobility, usual activities, self-care, pain/discomfort, anxiety/depression), with each dimension measured using one question. The SFR initially used the version with three levels (EQ-5D-3L), but in February 2019 the version with five levels (EQ-5D-5L) was introduced. Consequently, some of the one-year follow-ups to fractures from 2018 were performed using the EQ-5D-5L instead of the EQ-5D-3L. Methods have been described to adapt EQ 5D 3L to EQ 5D 5L, but due to the limited number of cases this was not undertaken[18]. To make a general assessment of the respondent's health, a visual analog scale (EQ-VAS) is included. Scores on the EQ-VAS range from 0 to 100, with 100 indicating optimal outcome/health status. The EQ-5D can be summarized into a single index (EQ-5D Index) using a formula attaching specific weights to each dimension´s severity level, anchored at 1 (optimal health) and 0 (worst outcome). The SMFA measures the functional status of patients with musculoskeletal disorders and injuries. The Swedish version has been shown to be reliable and sensitive to change over time[16].

Table I. — Baseline data per subtype AO/OTA type C1, C2 and C3.

	C1	C2	C3
Number of cases	5400	4304	2495
Mean age (years)	62.0 (SD 17.0)	62.8 (SD 16.0)	60.8 (16.6)
Sex female/male (%)	74.9/25.1	77.2/22.8	67.1/32.9
Low-energy trauma/high-energy trauma/not known (%)	87.4/5.5/3.3	84.8/8.2/2.9	75.9/16.2/4.0
Simple fall	3550	2871	1380
Fall from a height	525	435	430
Unspecified fall	582	399	229
Traffic accident	371	330	288
Other causes	277	199	128
Cause unknown	95	70	40

It consists of two parts: a bother index with 12 items and a dysfunction index with 34 items. There are four groups of dysfunction items: daily activities, mobility, arm hand function index, and emotional status. A conversion formula is used to create a score from 0 to 100, with a higher score indicating inferior function. Mortality is included in the register and is updated by a link to the Swedish Tax Agency on a daily basis; in this study, it is presented as one-year mortality.

Scale variables are featured as mean and standard deviation (SD). Nominal values are presented as proportions of the fractures. Change over time was computed using Wilcoxon signed-rank test because of a non-normal distribution (Shapiro-Wilks test, data not shown). The EQ-5D Index ranges from 0 to 1 and 1.0 represents the optimal outcome. EQ-VAS has a range from 0 to 100, where 100 is an optimal outcome/health status. The Arm Hand Function index and Bother Index ranges from 0 to 100, a higher scores signifies inferior outcome. A one-way ANOVA was undertaken to assess for differences between treatment methods. Statistical significance was further assessed using Bonferroni-corrected post-hoc tests. A chi-square test was used to assess differences regarding the frequency of open fractures between men and women. A P-value<0.05 was considered statistically significant.

RESULTS

From April 1st 2012 to December 31st 2018, 50035 DRFs were registered, 12 199 of which were AO/OTA type C. The C1 subtype constituted 44.3% (5400/12199) of these, followed by C2 (35.3%) and C3 (20.5%). The incidence of high-energy trauma was three times as high for the C3 fractures as for the C1 fractures (16.2% vs. 5.5%). The proportion of men was highest for the C3 subtype, which also had a lower mean age than the C1 and C2 subtypes. The most common cause of injury was simple falls, while falls from a height and traffic accidents were relatively more common for the C3 fractures compared to the C1 and C2 fractures (Table I). The frequency of open fractures was 2.5% (n=304/12199), and there was no significant gender difference (women: 2.5%, n=222/9041; men: 2.6%, n=82/3158). Among the open fractures, the frequency of high-energy trauma was 22.2%. For the type C3 fractures, the frequency of open fractures was 5.8% compared to 0.6% for the C1 fractures. Women with an open fracture had a mean age of 72 (SD 15.5). Men with an open fracture had a mean age of 53 (SD 18.7). Most type C DRFs occurred in the patient's residence or accommodation (30.7%, n=3746/12199) (Table II). The primary treatment was non-surgical in 49.4% of cases (n=6037/12199), and a volar plate was the dominant surgical fixation method (35.5%, n=4325/12199). External fixator and K-wires were the second and third most common fixation methods. Twelve of the 12199 cases were stabilized by a dorsal spanning plate (Table III). In the cases where the surgeon's experience level was specified, an orthopedic trauma surgeon as operating surgeon was more than twice as common and a hand surgeon as operating surgeon was more than four times as common for C3 compared to C1 fractures. Moderate issues with usual

Table II. — Place of injury.

Location	Number (%)
Patients residence	3746 (30.7)
In the street/road	1445 (11.8)
Public place	1203 (9.9)
Unspecified location	4590 (37.6)
Location missing	1215 (10.0)

Table III. — Type of treatment; number (%).

Treatment method	Patients
Cast	6042 (49.5%)
Volar locking plate	4325 (35.5%)
K-wire	208 (1.7%)
Double plates	157 (1.3%)
External fixation	78 (0.6%)
Bridge plate	12 (0.1%)
Other treatments	348 (2.9%)
Treatment information missing	1029 (8.4%)
Other treatments include combinations of treatments such as bridge plate, K-wires + external fixator, volar plate + K-wires, external fixator + volar plate.	

and February (11.0%, 12.1%, and 10.2% respectively); the lowest incidence was seen in September and October (6.2% and 6.6%) with a slight increase during the summer months (Figure 2). The one-year mortality was 2.0% (n=238/12199). The number of responders to the EQ-VAS was 6624/12199 (54.2%) at the time of injury and 5072/12199 (41.6%) one year after the injury, for the Arm Hand Function Index of the SMFA it was 6362/12199 (52.2%) at the time of injury and 4680/12199 (38.3%) one year after the injury. For the Bother Index of the SMFA it was 6048/12199 (49.6%) at the time of injury and 4402/12199 (36.1%) one year after the injury.

Table IV. — Distribution of problems with respect to EQ-5D 3L dimensions before the fracture and one year after; number (%).

	Pre-fracture EQ-5D 3L			EQ-5D 3L one year after the fracture		
Factor	**No problems**	**Moderate problems**	**Severe problems**	**No problems**	**Moderate problems**	**Severe problems**
Mobility	5552 (87.4)	793 (12.5)	11 (0.2)	3318 (84.0)	613 (15.5)	17 (0.4)
Self-care	5799 (91.0)	481 (7.5)	96 (1.5)	3727 (93.0)	233 (5.8)	48 (1.2)
Usual activity	5434 (85.5)	608 (9.6)	315 (5.0)	3213 (80.0)	689 (17.2)	112 (2.8)
Pain/discomfort	4133 (65.0)	2023 (31.8)	205 (3.2)	1618 (40.4)	2252 (56.2)	134 (3.3)
Anxiety/depression	5179 (81.3)	1080 (17.0)	112 (1.8)	3192 (79.6)	752 (18.8)	64 (1.6)

Table V. — Patient-reported outcome measures; mean (95% confidence intervals).

	Pre-injury	1 year after injury	p-value
EQ-5D Index	0.85 (0.845, 0.857)	0.80 (0.798, 0.811)	<0.001
EQ-VAS	86.3 (85.8, 86.7)	78.9 (78.2, 79.6)	<0.001
Arm Hand Function Index SMFA	5.6 (5.2, 5.9)	11.8 (11.3, 12.3)	<0.001
Bother Index SMFA	8.3 (8.0, 8.7)	14.5 (14.0, 15.0)	<0.001

activities and pain/discomfort were substantially more commonplace one year after the fracture (17.2% and 56.2%, respectively) compared to before the fracture (9.6% and 31.8%) (Table IV). The PROMs (EQ-5D, EQ-VAS, Arm Hand Function Index and the Bother Index of the SMFA) all worsened significantly one year after the injury compared to before the fracture (P<0.001) (Table V). Patients operated with a volar plate reported a larger deterioration of EQ-5D scores (0.028) compared to patients treated with a cast (P=0.016). For the Arm Hand Function Index, patients treated with external-fixator reported a greater deterioration compared to those treated with a cast or a volar plate (10.8, P=0.06 and 9.9, P=0.018 respectively). For the EQ VAS, patients treated with double plating reported inferior outcome (9.9) compared to patients treated with a cast (P=0.045). The months with the highest frequency of type C DRFs were December, January,

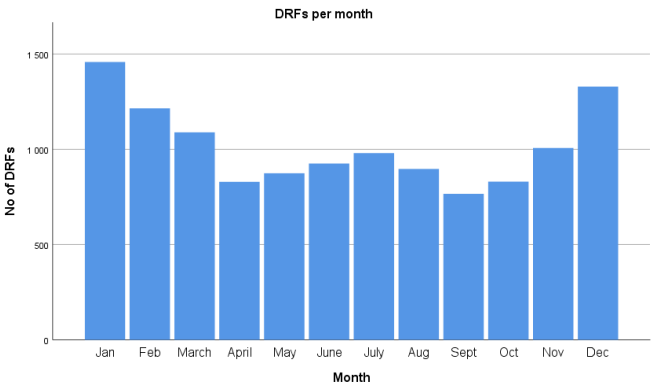

Fig. 2 — Distribution of number of DRFs per month.

DISCUSSION

This study constitutes the largest cohort study focused on AO/OTA type C DRFs to our knowledge. The majority of the type C DRFs occurred in women

because of a fall in the patient´s residence. The overall proportion occurring in women (74%) was somewhat lower than previously reported by Rundgren et al., but somewhat higher than reported by Stirling et al.[19,20]. Those studies also included type A and B fractures, therefore the cohorts are not altogether comparable. The incidence of high-energy trauma as well as the proportion of men was substantially higher for type C3 fractures than type C1 fractures, likely because type C3 represents the most comminuted DRFs and men are more commonly injured in high-energy trauma[21].

In contrast, a previous study demonstrated a moderate accuracy for the DRF-classification in the SFR (14). The DRFs in this study represent classifications made by the treating orthopedic surgeons in real-life conditions, some of whom have limited experience. Almost 40% of the DRFs were treated operatively in our study. A substantially higher percentage than the proportion noted in a national study from Sweden, where 20% of the DRFs were treated surgically[2]. This finding is likely related to the fact that all fractures in this study were intraarticular. Unacceptable joint incongruency and instability of the fracture after reduction may favor a decision for surgery. The development of posttraumatic arthritis (PA) has been linked to joint incongruency[22]. However, the link between PA and clinical symptoms from the wrist is still unclear[10].The volar plate was dominant among the surgical treatments of type C fractures, which is in line with previous studies[2].

The frequency of open fractures was 2.5% of all cases, with a slightly higher frequency of open fractures for men compared to women. In contrast, a previous study by Rundgren et al. found an incidence of open fractures of 1.2%, but this included fractures of type A, B, and C[19]. Elderly women are known to have a higher incidence of open fractures in comparison to men[23]. On the other hand, the age distribution among men is bimodal, with younger and older men showing a higher incidence, while women have a unimodal distribution in which the increased incidence occurs in the 6th decade, after the menopause[23]. The higher incidence of open fractures for men in the present study is likely related to the study group, which contained only type C fractures and a relatively high frequency of high-energy trauma. The most common injury location was the patient's residence, this is similar to previous findings[19].

Patient satisfaction can be expressed as a combination of socio-cultural and subjective feelings in addition to cognitive, psychological and behavioral influences[24]. It is of importance to understand what a metric captures in a patient following a DRF. Moderate issues with pain/discomfort and usual activities, as expressed in the EQ-5D, were substantially more common after the fracture compared to before, indicating that a considerable number of patients experience trouble one year after a type C DRF. Long-term follow-up for this cohort is not available, but a study with intermediate-term outcome on patients with major disability one year after a DRF found that the majority still had major disability up to 12 years after the fracture[25]. Comparing treatments, our findings indicate a relatively better self-reported outcome for patients treated with a cast. However, the clinical relevance of this is unclear.

Type C DRFs constitute a diverse group of fractures. Fractures with a small dislocation are often selected for conservative treatment, whereas more complex and displaced fractures are selected for operative treatment; this can lead to selection bias affecting the PROMs for each method. As treatment was not randomized, but rather based on local tradition, we cannot draw conclusions as to which treatment is the best choice for a type C DRF. Our finding that the volar plate played a dominating role among the surgical options is consistent with previous findings[26]. Interestingly, there was only a very sparse use of methods some-times considered well-suited to fixate unstable multi-fragmented intraarticular type C DRFs, such as fragment-specific fixation and combined plating (volar plus dorsal plates). The dorsal bridge plate is also a valid option in select cases of unstable type C DRFs, but our data indicate it is rarely used in Sweden.

All PROMs worsened significantly one year after the injury compared to before. EQ-5D Index scores one year after the fracture were similar to the findings from a previous study on patients who had been treated with a volar locking plate or cast, with no significant difference between the methods[27]. The EQ-5D has an acceptable/good responsiveness in DRF-patients[15]. In addition, the threshold for minimal important change (MIC) was not reached, thus the clinical relevance of this finding is unclear[28,29]. In addition, MIC-values for the EQ 5D have not been established for DRFs. More disease-specific PROMs such as the quick DASH and the PRWE might be better able to detect an impairment of wrist function compared to SMFA and EQ-5D, which are not designed for upper extremity disorder assessment[30,31]. The SMFA and EQ-5D on the other hand represent the general well-being of the patient, which must be considered an important outcome measure. The one-year mortality was 2.0%, which is somewhat lower than the findings of Rundgren[19]. This is likely due to a different age distribution in the cohorts.

Fracture incidence increased considerably during the winter months, probably due to unfavorable conditions with icy slippery streets in Sweden. With the exception of December, January, and February, the distribution of DRFs was fairly even over the year with a small increase during the summer months. This finding is in line with previous findings from the UK[20]. The small increase noted during the summer months may be related to an increased frequency of outdoor activities during warm weather and vacations. Choice of treatment was based on personal preferences and local traditions. National guidelines for the treatment of DRFs in Sweden have recently been launched[32]. A previous study has shown a substantial variation in the operative management of DRFs between different Swedish regions[33]. As it covered more than 80% of the Swedish population at the end of 2017, the SFR provides a good illustration of DRF treatment in Sweden[19].

The large number of patients with prospectively registered data represents a strength of this study. Bias related to different treatment traditions, epidemiological and socio-demographic differences may be reduced due to data being collected on a national level. Data regarding fracture type, treatment and patient characteristics are registered in a systematic, pre-specified way. To our knowledge, the size and detail regarding AO/OTA type C DRFs in this study is unique.

There are some limitations to this study. No specific trauma-score, like the Injury Severity Score, was used to assess high-energy or low-energy trauma[34]. At the same time, the lack of a clear definition means that high-energy cases in our data indicate what the average orthopedic surgeon in Sweden interprets to be a high-energy trauma. The AO/OTA classification system was used to classify the fractures. The system has demonstrated a high validity and accuracy of data[35]. The AO/OTA system is probably the most reliable classification system for DRFs. Some data indicate that the reliability between observers for fracture-type only is fair and that the value of classification of subgroups (C1, C2 etc.) therefore is limited[36]. The lack of national coverage is another limitation, but the coverage improved substantially during the study period. Register studies are limited by the response rate for the PROMs. This is to some extent mitigated by a large number of fractures registered. Regarding non-responders, a previous study found that non-responders and initial responders reported similar function regarding the PROMs in the SFR[37]. Given this, we estimate to have an acceptable response rate in our study. A recent study indicates that the SFR is an accurate and complete source of information, compared to the national patient register which often overestimates the number of fractures[38]. At inclusion the patients filled out the questionnaires for their status pre-injury using a recall technique as of the week before the injury, which may have introduced recall bias. The lack of radiographic outcome in the SFR is also a limitation, although the correlation between short-term radiographic outcome and PROMs remains unclear[39].

CONCLUSION

Our findings indicate that choice of treatment has a limited correlation to PROMs one year after an AO/OTA type C DRF. In general, PROMs worsened significantly one year after a type C DRF in comparison to before. More than 50% of patients experienced moderate problems with discomfort and pain. Open fractures were equally common among men and women. Further studies are warranted to clarify optimal treatment for this subgroup of DRFs and which interventions are reimbursable. Future studies can be done as register-based randomized controlled trials if a fracture register is available.

Conflict of Interest Statement: the authors declare that they have no conflict of interest.

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REFERENCES

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006;37(8):691-697.
2. Mellstrand-Navarro C, Pettersson HJ, Tornqvist H, Ponzer S. The operative treatment of fractures of the distal radius is increasing: results from a nationwide Swedish study. The bone & joint journal. 2014;96-b(7):963-969.
3. Handoll HH, Madhok R. Surgical interventions for treating distal radial fractures in adults. The Cochrane database of systematic reviews. 2003(3):Cd003209.
4. Orbay JL, Fernandez DL. Volar fixation for dorsally displaced fractures of the distal radius: a preliminary report. J Hand Surg Am. 2002;27(2):205-215.
5. van Schaik DE, Goorens CK, Wernaers P, Hendrickx B, Scheerlinck T, Goubau JF. Evaluation of current treatment techniques for distal radius fractures amongst Belgian orthopaedic surgeons. Acta Orthop Belg. 2015;81(2):321-326.
6. Mellstrand Navarro C, Ahrengart L, Tornqvist H, Ponzer S. Volar Locking Plate or External Fixation With Optional Addition of K-Wires for Dorsally Displaced Distal Radius Fractures: A Randomized Controlled Study. J Orthop Trauma. 2016;30(4):217-224.

7. Saving J, Enocson A, Ponzer S, Mellstrand Navarro C. External Fixation Versus Volar Locking Plate for Unstable Dorsally Displaced Distal Radius Fractures-A 3-year Follow-Up of a Randomized Controlled Study. J Hand Surg Am. 2018.
8. Landgren M, Abramo A, Geijer M, Kopylov P, Tagil M. Fragment-Specific Fixation Versus Volar Locking Plates in Primarily Nonreducible or Secondarily Redisplaced Distal Radius Fractures: A Randomized Controlled Study. J Hand Surg Am. 2017;42(3):156-165.e1.
9. Lutz M, Arora R, Krappinger D, Wambacher M, Rieger M, Pechlaner S. Arthritis predicting factors in distal intraarticular radius fractures. Arch Orthop Trauma Surg. 2011;131(8):1121-1126.
10. Lundqvist E, Fischer P, Wretenberg P, Krauss W, Sagerfors M. Posttraumatic Arthritis After Combined Plating of Distal Radius Fractures AO Type C: A 7-Year Follow-up of 97 Cases. Hand (New York, NY). 2021:15589447211028991.
11. Bergh C, Möller M, Ekelund J, Brisby H. 30-day and 1-year mortality after skeletal fractures: a register study of 295,713 fractures at different locations. Acta Orthop. 2021:1-7.
12. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am. 1976;58(4):453-458.
13. Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA, et al. Fracture and dislocation classification compendium - 2007: Orthopaedic Trauma Association classification, database and outcomes committee. J Orthop Trauma. 2007;21(10 Suppl):S1-133.
14. Bergvall M, Bergdahl C, Ekholm C, Wennergren D. Validity of classification of distal radial fractures in the Swedish fracture register. BMC Musculoskelet Disord. 2021;22(1):587.
15. Rundgren J, Enocson A, Mellstrand Navarro C, Bergström G. Responsiveness of EQ-5D in Patients With a Distal Radius Fracture. Hand (New York, NY). 2018;13(5):572-580.
16. Ponzer S, Skoog A, Bergström G. The Short Musculoskeletal Function Assessment Questionnaire (SMFA): cross-cultural adaptation, validity, reliability and responsiveness of the Swedish SMFA (SMFA-Swe). Acta Orthop Scand. 2003;74(6):756-763.
17. Devlin NJ, Brooks R. EQ-5D and the EuroQol Group: Past, Present and Future. Appl Health Econ Health Policy. 2017;15(2):127-137.
18. van Hout BA, Shaw JW. Mapping EQ-5D-3L to EQ-5D-5L. Value Health. 2021;24(9):1285-1293.
19. Rundgren J, Bojan A, Mellstrand Navarro C, Enocson A. Epidemiology, classification, treatment and mortality of distal radius fractures in adults: an observational study of 23,394 fractures from the national Swedish fracture register. BMC Musculoskelet Disord. 2020;21(1):88.
20. Stirling ERB, Johnson NA, Dias JJ. Epidemiology of distal radius fractures in a geographically defined adult population. J Hand Surg Eur Vol. 2018;43(9):974-982.
21. Ali M, Eiriksdottir A, Murtadha M, Akesson A, Atroshi I. Incidence of distal radius fracture in a general population in southern Sweden in 2016 compared with 2001. Osteoporos Int. 2020.
22. Knirk JL, Jupiter JB. Intra-articular fractures of the distal end of the radius in young adults. J Bone Joint Surg Am. 1986;68(5):647-659.
23. Court-Brown CM, Biant LC, Clement ND, Bugler KE, Duckworth AD, McQueen MM. Open fractures in the elderly. The importance of skin ageing. Injury. 2015;46(2):189-194.
24. Brokelman RB, Haverkamp D, van Loon C, Hol A, van Kampen A, Veth R. The validation of the visual analogue scale for patient satisfaction after total hip arthroplasty. Eur Orthop Traumatol. 2012;3(2):101-105.
25. Landgren M, Teurneau V, Abramo A, Geijer M, Tagil M. Intermediate-Term Outcome After Distal Radius Fracture in Patients With Poor Outcome at 1 Year: A Register Study With a 2- to 12-Year Follow-Up. J Hand Surg Am. 2019;44(1):39-45.
26. Gouk CJC, Bindra RR, Tarrant DJ, Thomas MJE. Volar locking plate fixation versus external fixation of distal radius fractures: a meta-analysis. J Hand Surg Eur Vol. 2018;43(9):954-960.
27. Saving J, Severin Wahlgren S, Olsson K, et al. Nonoperative Treatment Compared with Volar Locking Plate Fixation for Dorsally Displaced Distal Radial Fractures in the Elderly: A Randomized Controlled Trial. J Bone Joint Surg Am. 2019;101(11):961-969.
28. Marks M, Grobet C, Audigé L. Validity, responsiveness and minimal important change of the EQ-5D-5L in patients after rotator cuff repair, shoulder arthroplasty or thumb carpometacarpal arthroplasty. Qual Life Res. 2021;30(10):2973-2982.
29. Marti C, Hensler S, Herren DB, Niedermann K, Marks M. Measurement properties of the EuroQoL EQ-5D-5L to assess quality of life in patients undergoing carpal tunnel release. J Hand Surg Eur Vol. 2016;41(9):957-962.
30. Beaton DE, Wright JG, Katz JN. Development of the QuickDASH: comparison of three item-reduction approaches. J Bone Joint Surg Am. 2005;87(5):1038-1046.
31. Mellstrand Navarro C, Ponzer S, Tornkvist H, Ahrengart L, Bergstrom G. Measuring outcome after wrist injury: translation and validation of the Swedish version of the patient-rated wrist evaluation (PRWE-Swe). BMC Musculoskelet Disord. 2011;12:171.
32. www.https://nationelltklinisktkunskapsstod.se/ accessed Nov 1st 2022
33. Saving J, Ponzer S, Enocson A, Mellstrand Navarro C. Distal radius fractures-Regional variation in treatment regimens. PLoS One. 2018;13(11):e0207702.
34. Husum H, Strada G. Injury Severity Score versus New Injury Severity Score for penetrating injuries. Prehosp Disaster Med. 2002;17(1):27-32.
35. Juto H, Möller M, Wennergren D, Edin K, Apelqvist I, Morberg P. Substantial accuracy of fracture classification in the Swedish Fracture Register: Evaluation of AO/OTA-classification in 152 ankle fractures. Injury. 2016;47(11):2579-2583.
36. Waever D, Madsen ML, Rolfing JHD, et al. Distal radius fractures are difficult to classify. Injury. 2018;49 Suppl 1:S29-s32.
37. Juto H, Gärtner Nilsson M, Möller M, Wennergren D, Morberg P. Evaluating non-responders of a survey in the Swedish fracture register: no indication of different functional result. BMC Musculoskelet Disord. 2017;18(1):278.
38. Bergdahl C, Nilsson F, Wennergren D, Ekholm C, Möller M. Completeness in the Swedish Fracture Register and the Swedish National Patient Register: An Assessment of Humeral Fracture Registrations. Clin Epidemiol. 2021;13:325-333.
39. Sagerfors M, Bjorling P, Niklasson J, Pettersson K. Combined Volar T-Plate and Dorsal Pi-Plate for Distal Radius Fractures: A Consecutive Series of 80 AO type C2 and C3 Cases. Journal of wrist surgery. 2019;8(3):180-185.