14 Distal Radius Fractures in the Elderly: Current Controversies

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14.1 Introduction

Distal radius fractures (DRFs) in the elderly population, above 65 years old, represent 18% of all fractures and are thereby the second most frequent fracture in the elderly [1]. These fractures are often the result of low-energy falls from a standing or seated position [2]. They are often comminuted and intra-articular fractures [3].

After hip fracture, DRF is the second most common fracture in the elderly. Peak incidence is in Caucasian women who are over 65 years of age. Osteoporosis is a common risk factor and occurs in 40% of postmenopausal women. Other significant risk factors for DRFs in patients older than 50 years include prior falls, prior fragility fractures, corticosteroid use, and advanced age. Dementia is also a risk factor in patients older than 75 years of age. In older patients, each additional risk factor conveys increased probability of suffering a DRF. DRFs extending into a joint space are twice as common in women with diabetes [4]. The incidence of DRFs is increasing as life expectancy grows, leading to a larger population of patients who are at risk for these injuries [3].

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The purpose of this chapter is to revise the most important current controversies on DRFs in the elderly.

14.2 Conservative Treatment

14.2.1 Objective Outcome Measures Continue to Improve from 6 to 12 Months

In DRFs dislocation and comminution are often used to determine whether nonoperative or operative treatment is indicated. In a prospective case series of minimally displaced DRFs treated with closed reduction (CR) and cast immobilization, Thorninger et al. assessed the complication rate and patient-reported outcome measures. This study analyzed 50 conservatively treated DRF patients for 1 year [1]. Primary outcomes were complications and Quick Disability of Arm, Shoulder, and Hand (qDASH) score. Secondary outcomes were range of motion (ROM), grip strength and pain, and Patient-Rated Wrist/Hand Evaluation (PRWHE). Results showed only minor complications with a return to prior ROM, qDASH score, and pain after 12 months and amelioration in results after 6–12 months. Most DRF patients who were treated nonoperatively with CR and 5-week casting recovered fully after minimally displaced DRFs. Therefore, this approach was considered safe (Fig. 14.1) [1].

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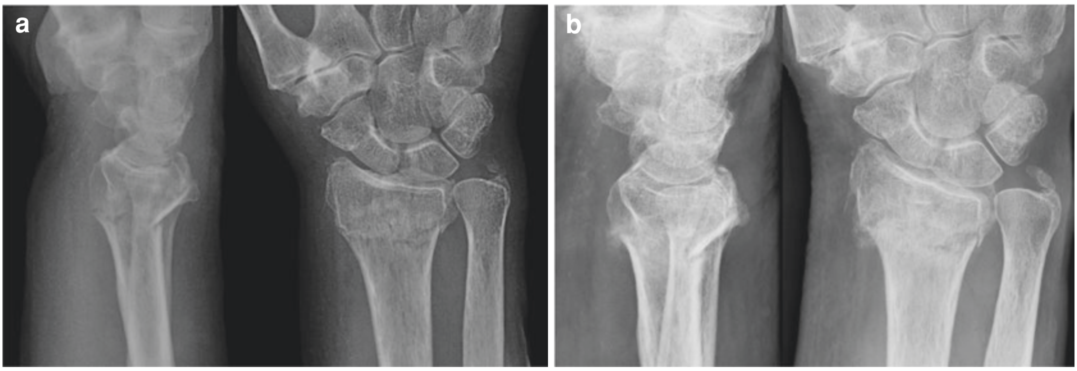

Fig. 14.1 (**a**, **b**) Distal radius fracture (**a**) treated conservatively with a cast for 6 weeks (**b**)

14.3 Surgical Treatment

14.3.1 Preoperative Planning

Yoshii et al. used a three-dimensional preoperative planning for the osteosynthesis of DRF (trial registration: registered as NCT02909647 at ClinicalTrials.gov). They evaluated the reproducibility of three-dimensional preoperative planning for the osteosynthesis of DRFs with three-dimensional reference points [5]. Sixty-three wrists of 63 DRF patients who experienced osteosynthesis with three-dimensional preoperative planning were assessed. After taking preoperative computed tomography (CT) scans of the injured wrists, 3D images of the distal radius were created. Fracture reduction, implant choices, and placement simulation were carried out based on the 3D images. One month after the surgery, postoperative CT images were taken. The reproducibility was assessed with preoperative plan and postoperative 3D images. The images were compared with the three-dimensional coordinates of the radial styloid process, volar and dorsal edges of the sigmoid notch, and the barycentric coordinates of the three reference points. The reproducibility of the preoperative plan was assessed by the distance of the coordinates between the plan and postoperative images for the reference points. The reproducibility of radial inclination and volar tilt on three-dimensional images were assessed by intraclass correlation coefficient (ICC). The distances between the preoperative plan and the postoperative reduction for each reference point were 2.1 mm, 1.9 mm, and 1.9 mm, respectively. The distance between the preoperative plan and postoperative reduction for the barycentric coordinate was 1.3 mm. ICCs were 0.54 and 0.54 for the volar tilt and radial inclination, respectively ($p < 0.01$). The conclusion of this study was that three-dimensional preoperative planning for the osteosynthesis of DRFs was reproducible, with an error of about 2 mm for each reference point and the correlations of reduction shapes were moderate. Therefore, the analysis method and reference points may be helpful to understand the accuracy of reductions for the three-dimensional preoperative planning in the osteosynthesis of DRFs [5].

14.3.2 Percutaneous Pinning Fixation

According to Zhao et al., percutaneous pinning (PP) fixation has been utilized for the treatment of DRFs for decades, especially in the elderly with fragile soft tissue. However, getting and maintaining a sound anatomic reduction prior to PP is difficult if we utilize the manipulative reduction method alone. In their study Zhao et al. utilized the Steinmann pin retractor for CR combined with PP [6]. Forty-nine patients were analyzed in this retrospective cohort study. Sixteen patients were treated with Steinmann pin retractor-assisted CR combined with PP (S-PP), 19 patients were treated with the manipulative reduction combined with PP (M-PP), and 14 patients were treated with the manipulative reduction combined with cast splint (M-C). All these patients received a positive postoperative radiological and clinical assessment. All the patients were followed up for a minimum of 2 years. The radiological parameters in each group improved significantly after surgery (post-treatment). In the S-PP group, the values of radial height (postoperative, 13.33 mm; first follow-up, 13.27 mm; last follow-up, 13.16 mm) and ulnar variance (postoperative, −0.10 mm; first follow-up, −0.05 mm; last follow-up, −0.12 mm) significantly improved as compared to the M-PP and M-C groups. While the patients in the M-C group experienced significant re-displacement at the first and last follow-ups, in the S-PP group the range of wrist motion including extension (89.94%), radial deviation (90.69%), and supination (90.25%), ulnar deviation (89.81%) and qDASH score (2.70), and grip strength (92.50%), pronation (90.50%), and Modified Mayo Wrist Score (MWS) (90.94, the excellent rate reached up to 75%) improved as compared to the M-PP group, M-C group, or both groups at the last follow-up. The conclusion was that S-PP improved fracture reduction and wrist function and can serve as an efficacious technique for A_2 (AO/OTA) and A_3 type of DRFs in the elderly with limited dorsal comminution, including intra-articular fractures with displacement less than 2 mm [6].

14.3.3 Dorsal Bridge Plate

In a systematic review (level IV of evidence) published in 2021, Fares et al. presented patient demographics, injury characteristics, results, and side events associated with dorsal bridge plating (DBP) in the treatment of DRFs [7]. Average age was 55 years, median follow-up was 24 months, and the most common indication was comminuted (92%), intra-articular (92%) DRF caused by fall (58%), or motor vehicle collision or motorcycle collision (27%). A minority of patients had open fractures (16%) and most of these were cases of polytrauma (65%). The median time from placement to DBP removal was 17 weeks (mean, 119 days). At the final follow-up, the mean wrist ROM was 45° flexion, 50° extension, 75° pronation, and 73° supination. The mean DASH score was 26.1, and the mean qDASH score was 19.8. The overall rate for any complication was 13%; the most common was hardware failure (3%) followed by symptomatic malunion or nonunion (3%) and persistent pain after hardware removal (2%). In this study, DBP was found to be utilized most commonly in intra-articular, comminuted DRF reporting overall functional wrist ROM, moderate patient-reported disability, and a 13% complication rate at follow-up [7].

14.3.4 IlluminOss System

Van Oijen et al. assessed the functional and clinical results after treatment of DRFs with the IlluminOss® System in adult patients. A retrospective case series was carried out in a single-level two-trauma center [8]. All consecutive adult patients with a DRF, treated with the IlluminOss® System between August 01, 2012, and August 15, 2015, were included in this study. Baseline patient characteristics and clinical data were retrospectively extracted from the medical records. Radial inclination, volar/dorsal tilt, ulnar variance, and radial length were measured on the latest available standard radiographs. Besides, patients were prospectively subjected to physical examination and were asked to complete the DASH, Patient-Rated Wrist Evaluation (PRWE), and Short Form-36 (SF-36) questionnaires. Twenty-six patients with 31 DRFs were included. The median age at the time of trauma was 77 years and 96% were females. Five patients developed a total of seven complications. Due to persisting pain, one reoperation was carried out, removing a small prominent part of the implant. Both patient-reported outcome scores and radiographic outcomes were good to excellent. It was stated that the IlluminOss® System appeared to be a feasible alternative to treat DRFs with seemingly good clinical and functional result. One out of seven complications required surgical intervention. These results justified more detailed prospective research [8].

14.3.5 Volar Locking Plate Preserving Pronator Quadratus Through the Minimally Invasive Approach

According to Fan et al., the VLP technique with an L-shaped incision of the pronator quadratus (PQ) muscle through the classic volar Henry approach is a popular technique for treating DRFs. Recently, they revised and improved this traditional technique by performing mini-invasive surgery [9]. They assessed the clinical effects after fixation of DRFs with VLPs while preserving the PQ through the minimally invasive approach. Fifty-eight patients (38 males and 21 females) with an age range of 22–72 years (mean age 44.6 years) and with DRFs underwent open reduction and internal fixation with VLPs. The patients were classified as 23A-2 through 23C-2 according to the AO/OTA fracture classification system. The group that received VLPs of distal radius performed with the traditional method through the Henry approach involved 33 patients (21 males and 12 females) and the group that received PQ through the minimally invasive approach group involved 25 patients (16 males and 9 females). Fan et al. compared the two groups for wrist pain, forearm ROM, grip strength, preoperative complications, and wrist functional recovery score. The minimum follow-up for the whole cohort was 1 year. The differences between the two groups were significant in terms of wrist pain, forearm ROM, grip strength, and wrist function at 1, 2, and 6 weeks postoperatively, but insignificant at 3 and 12 months postoperatively. In the minimally invasive group, a case of limited extension of the forefinger 3 months postoperatively was encountered. No significant differences were found for preoperative complications and radiographs postoperatively. The conclusion was that fixation with VLPs through the minimally invasive approach was a satisfactory and optional technique in the treatment of DRFs. This method yielded better early wrist function, shortened rehabilitation time, and high psychological satisfaction [9].

14.3.6 Bridge Plating with Bone Graft Substitutes in Combination with Systemic Romosozumab Administration

Uemura et al. have published a case report of a distal radius nonunion in which they used romosozumab (a humanized, anti-sclerostin monoclonal antibody used to treat osteoporosis, which augments bone formation and decreases bone resorption). It enhances fracture healing and systemic romosozumab administration may have therapeutic potentials for accelerating bone healing of nonunions. A 61-year-old heavy smoker male with distal radius nonunion who achieved successful bone union by combination therapy of romosozumab and spanning distraction plate fixation with bone graft substitutes was presented [10]. Through the dorsal approach, atrophic comminuted nonunion of the distal radius was sufficiently debrided. Reduction of the distal radius was performed using indirect ligamentotaxis, and a 14-hole locking plate was fixed from the third metacarpal to the radial shaft. A beta (β) tricalcium phosphate block was mainly packed into the substantial metaphyseal bone defect with additional bone graft from the resected ulnar head. Postoperatively, systemic administration of monthly romosozumab was continued for 6 months. Complete bone union was achieved 20 weeks postoperatively and the plate was, then, removed. During romosozumab treatment, bone formation marker levels increased rapidly and finally returned to baseline, and bone resorption marker levels remained low. In conclusion, the combination of systemic romosozumab administration and grafting β-tricalcium phosphate with bridge plating provided an efficacious treatment alternative for difficult cases of comminuted distal radius nonunion with risk factors such as smoking, diabetes, and fragility [10].

14.3.7 Combined Palmar and Dorsal Plating of Four-Part Distal Radius Fracture

In 2021, Kibar analyzed the radiological and clinical results of four-part intra-articular DRF treated with a volar anatomically locked plate and 2-mm low-profile plates using both the volar and dorsal approaches [11]. The retrospective study included 20 patients (8 males, 12 females; mean age 47; range, 25 to 67 years) who received open reduction and internal fixation with combined volar and dorsal plating to treat complex four-part DRFs (shaft, radial styloid area, dorsal medial facet, volar medial facet). According to the AO/OTA classification, all fractures were 2R3-C3. The mean follow-up time was 21 months. Union was achieved in all fractures. The mean tourniquet time was 103 min. The mean DASH questionnaire score was 10, and the mean Visual Analog Scale (VAS) score was 2.1. According to MWS, five patients had excellent, six had good, six had satisfactory, and three had poor outcomes. The mean grip strength was 25.2 (range, 15–40) kg and 78% of the opposite side. The mean wrist flexion was 48.7° (range, 30° to 80°), extension was 52.2° (range, 25° to 80°), the radioulnar deviation arc was 40.7° (range, 30° to 55°), and the mean forearm rotation arc was 152.3° (range, 130° to 170°). The conclusion was that this plating method with a dual approach may be an alternative for four-part intra-articular DRFs given its early mobility advantage and satisfactory functional and radiological outcomes [11].

14.3.8 Cobra Prosthesis in Complex Distal Radius Fractures

According to Benedikt et al., the Cobra prosthesis provides an alternative treatment option for complex fractures where conservative therapy seems not acceptable and osteosynthesis seems not possible [12]. In a retrospective follow-up study, they investigated the clinical and radiological midterm result of the Cobra implant in complex DRFs of elderly patients. Thirteen patients (mean age 73.5 years, range 65–87 years) were retrospectively assessed with at least a 1-year follow-up after surgery. Objective and subjective clinical parameters as well as the radiological results and side events were analyzed. The mean follow-up period was 31.2 months. Seven cases required a cemented prosthesis. The mean relative ROM compared to the healthy side was 72.3% and 51.8% for extension and flexion, respectively, and 87.9% and 85.7% for pronation and supination, respectively. The mean grip strength was 78.3% compared to the non-operated side. Eight patients were very satisfied, and five patients were partly satisfied with the outcome. The DASH, PRWE, Michigan Hand Outcome questionnaire (MHOQ), and Lyon Scores averaged 39.1, 36.2, 64.9, and 63.3 points, respectively. The mean VAS score for pain was 1.1 at rest and 3.2 during activities. Perioperative complications included one dissection of the extensor pollicis longus tendon, one heterotopic ossification, one radiocarpal dislocation, and two cases of an ulnar impaction syndrome due to implant subsidence. The conclusion was that the prosthetic treatment of complex DRFs in elderly patients with the Cobra implant led to clinically and radiologically satisfactory midterm outcomes. The Cobra prosthesis can be regarded as a feasible salvage option for complex DRFs when osteosyntheses may not be possible and nonoperative treatment will lead to further functional restrictions and wrist pain when performing activities of daily life in high functional demand patients [12].

14.4 Do We Need to Restore Anatomy to Have Satisfactory Clinical Result?

Marchewka et al. assessed the long-term results and complications associated with conservative and operative treatment of DRFs to determine if restoration of radiographic parameters influenced functional results [13]. They analyzed 207 patients with isolated DRFs (mean age 64 years, women 150 [72.5%], 101 treated operatively, 106 treated nonoperatively). There were no significant differences in sex, age, and AO/OTA-type fracture between study groups. After 3.9 years, clinical, functional, and radiological assessment was conducted using the DASH, PRWE, 9-Hole Peg Test (9-HPT), and grip and pinch strength tools. Marchewka et al. found higher rates of malunion in the nonoperative group ($p < 0.0001$) and worse radiologic parameters such as volar tilt ($p < 0.0001$) and teardrop angle ($p < 0.0001$) versus the operative cohort. Nevertheless, radiological parameters were not correlated with DASH and PRWE results. Moreover, patients aged 50 years and above treated operatively had similar functional outcomes (DASH, PRWE) to those treated nonoperatively. The conclusion was that restoration of anatomic and thus radiologic parameters of the radius may not be obligatory to get a satisfactory functional result in patients with DRF aged 50 years or above. The patient is the most important "factor" in determining the adequate and successful treatment technique for DRFs [13].

14.5 Treatment of Malunited Distal Radius Fracture

14.5.1 Corrective Osteotomy: 2D Imaging Techniques for Preoperative Alignment Planning Versus a Novel Patient-Specific Plate Which Features Navigation and Fixation of Bone Segments As Preoperatively Planned in 3D

According to Dobbe et al., corrective osteotomy of a malunited DRF conventionally relies on 2D imaging techniques for alignment planning and evaluation. However, this approach results in suboptimal bone repositioning, which is associated with poor patient outcomes. In a case series, Dobbe et al. assessed the utilization of novel patient-specific plates (PSPs), which feature navigation and fixation of bone segments as preoperatively planned in 3D (level of evidence IV) [14]. Ten participants with distal radius malunion underwent CT scans for preoperative alignment planning. Patient-specific guides and plates were designed, 3D-printed, and sterilized for utilization in corrective surgery of the distal radius. Pre- and postoperative outcomes were compared in regard to clinical, functional, and radiographic results. The application of a PSP was successful in seven of the ten cases. After treatment, the residual alignment error was diminished by approximately 50% compared with conventional treatment. The use of PSPs reduced pain significantly. Pre- and postoperative outcomes were pooled and showed significant correlations between pain and malpositioning; the range of pro- and supination motion, the MHOQ score, the EuroQol EQ-5D-5L questionnaire (EQ-5D-5L) score, and dorsovolar angulation; and MHOQ score and proximodistal translation. The conclusion was that the correlation between malalignment and MHOQ score, EQ-5D-5L score, pain, and ROM showed that alignment should be restored as well as possible. Compared to the conventional approach, which relies on 2D imaging techniques (Fig. 14.2), corrective osteotomy based on 3D preoperative planning and intraoperative fixation with a PSP has been shown to ameliorate bone alignment and diminish pain [14].

14.5.2 Corrective Osteotomy Through Planning with Prototyping in 3D Printing

According to Belloti et al., about one-third of DRFs can result in malunion with restriction of movement and pain in the wrist; the treatment in these cases consists of corrective osteotomy of the deformity. Due to its 3D complexity, careful preoperative planning is a paramount step in correction. The prototyping from the 3D reconstruction of the CT scan of the affected wrist allows the real understanding of the deformity. Patients with malunion of the distal radius with indication for surgical treatment were included in the group of corrective osteotomies through planning with prototyping in 3D printing [15]. The postoperative

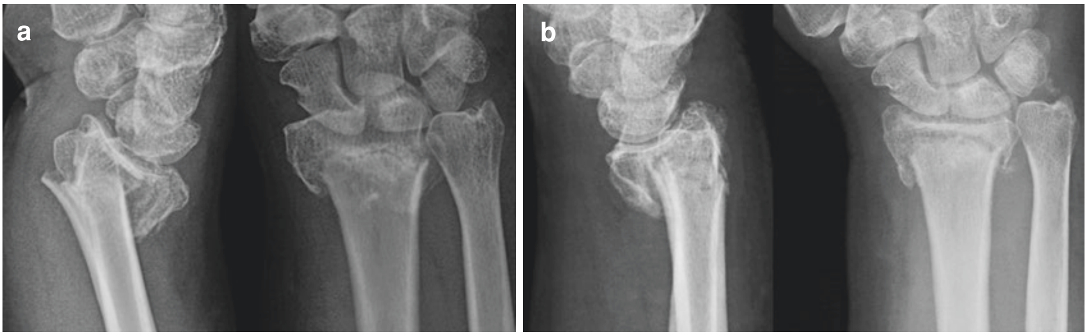

Fig. 14.2 (**a**, **b**) Conservatively treated wrist fracture (**a**) with malunion (**b**)

functional result was evaluated by the DASH and VAS. Radiographic data including radial inclination, volar tilt, and joint step were recorded from standard posteroanterior and lateral radiographic views. A total of nine patients were included. The mean age was 47 years. The average postoperative DASH value of the patients was 24.9 and VAS was 3.6. Radiographically, the palmar tilt had an average improvement of 25.22°, and the radial inclination had an average improvement of 2°. The conclusion was that corrective osteotomy through planning with prototyping in 3D printing was an efficacious technique of treating symptomatic distal radius malunions. The possibility of performing the osteotomy in a 3D model, simulating the surgery, makes the procedure more predictable [15].

14.6 Comparative Studies

14.6.1 Comparison of Surgical Effects Between Extension and Flexion Type of Distal Radius Fracture

Zhang et al. compared the therapeutic effects of internal fixation with VLP in treating extension and flexion type of DRF [16]. They analyzed 103 patients with DRF. According to the original fracture displacement direction, patients were divided into extension fracture (Colles) group and flexion fracture (Smith) group. In the Colles fracture group, there were 24 males and 44 females aged from 20 to 79 years old with an average of 59 years old; according to the AO/OTA classification, 9 patients were of type A2, 13 patients of type A3, 16 patients of type C1, 17 patients of type C2, and 13 patients of type C3; the time from injury to operation ranged from 2 to 9 days with an average of 3.9 days. In the Smith fracture group, there were 15 males and 20 females, aged from 27 to 87 years old with an average of 60.1 years old; according to the AO classification, 4 patients were of A2, 7 patients of A3, 14 patients of C1, 5 patients of C2, and 5 patients of C3; the time from injury to operation ranged from 2 to 6 days with an average of 4.1 days. Operation time, fracture healing time, and postoperative complications were recorded between the two groups. The DASH score at 6 and 8 weeks and 6 and 8 months were used to evaluate the functional recovery of the affected limbs during each follow-up. The volar tilt, radial inclination, and radius height were measured at 8 months after the operation. The Mayo score was measured at 8 months after the operation to assess the recovery of limb function. All patients were followed up for 8–30 months with an average of 14.8 months, and there was no difference in follow-up between the two groups ($p > 0.05$). There were no statistical differences in operation time, fracture healing time, and postoperative complications between groups ($p > 0.05$). The DASH scores at 6 and 12 weeks in the Colles fracture group were 37.24 and 19.68, while in the Smith fracture group were 39.05 and 23.44; the Colles fracture group results were better than that of the Smith fracture group ($p < 0.001$), while there were no differences in the DASH score at 6 and 8 months between the two groups ($p > 0.05$). The volar tilt of the Smith fracture group (11.1°) was better than that of the Colles fracture group (8.6°), and there were no significant differences in radial inclination and radius height between groups ($p > 0.05$). Moreover, there was no significant difference in the MWS ($p > 0.05$). The conclusion was that patients with Colles fracture and Smith fracture could receive good reduction and fixation through VLP. The radiographic parameters of both groups recovered satisfactorily after the operation. Recovery of the volar tilt of the Smith fracture group was better than that of the Colles fracture group, and early recovery function of the Colles fracture group was better than that of the Smith group, but there was no significant difference in long-term wrist joint function and incidence of postoperative complications between the two groups [16].

14.6.2 A Comparison of Six Outcome Measures Across the Recovery Period After Distal Radius Fixation: Which to Use and When?

According to Fang et al., many standardized outcome measures exist to measure recovery after surgical fixation of DRFs; however, choosing the optimal instrument is difficult. In a study with level II of evidence, Fang et al. assessed the responsiveness, ceiling/floor effects, and criterion validity over multiple time intervals across a 2-year follow-up period for six commonly utilized instruments [17]. A total of 259 patients who received open reduction and internal fixation for DRF between 2012 and 2015 were recruited. Patients were administered the PRWE, qDASH, Green and O'Brien score (Cooney modification) (CGNO), Gartland and Werley score (Sarmiento modification) (SGNW), flexion-extension arc (FEArc), and grip fraction test (GripFrac) at 1.5, 3, 6, 12, and 24 months postoperatively. Responsiveness was assessed by calculating the standardized response means (SRM) and Cohen's *d* effect sizes (ES) and by correlating each instrument's change scores against those of qDASH and PRWE, which were also utilized as external comparators to evaluate criterion validity. Ceiling/floor effects were calculated for all measures at each time point. The SRM (1.5–24 months) were 1.81, 1.77, 1.43, 1.16, 2.23, 2.45, and ES (1.5–24 months) were 1.81, 1.82, 1.95, 1.31, 1.99, and 2.90 for qDASH, PRWE, CGNO, SGNW, FEArc, and GripFrac, respectively. Spearman correlation coefficients against qDASH at 24 months were 0.809, 0.248, 0.563, 0.285, and 0.318 for PRWE, CGNO, SGNW, FEArc, and GripFrac, respectively. Significant (>15% of patients reaching maximum score) ceiling effects were observed before 6 months for PRWE and SGNW. This study supported the use of qDASH, PRWE, FEArc, and GripFrac up to 6 months postsurgery and qDASH and PRWE after 6 months [17].

14.6.3 Surgical Plating Versus Closed Reduction

In 2021, Lawson et al. evaluated whether current surgical treatment for displaced DRFs provided better patient-reported wrist pain and function than nonsurgical treatment in patients 60 years and older. In this multicenter randomized clinical trial and parallel observational study, 300 eligible patients were screened from 19 centers (trial registration, http://anzctr.org.au; identifier, ACTRN12616000969460) [18]. A total of 166 participants were randomized to surgical or nonsurgical treatment and followed up at 3 and 12 months by blinded assessors. Those 134 individuals who declined randomization were included in a parallel observational cohort with the same treatment options and follow-up. The primary analysis was intention to treat; sensitivity analyses included as-treated and per-protocol analyses. Surgical treatment was open reduction and internal fixation using a VLP. Nonsurgical treatment was CR and cast immobilization. The primary outcome was the PRWE score at 12 months. Secondary outcomes were the DASH questionnaire score, health-related quality of life, pain, major complications, patient-reported treatment success, bother with appearance, and therapy use. In the 300 study participants (mean age, 71.2 years; 269 [90%] female; 166 [81 VLP and 85 CR] in the randomized clinical trial sample and 134 [32 VLP and 102 CR] in the observational sample), no clinically important between-group difference in the 12-month PRWE scores (mean score of 19.8 for VLP and 21.5 for CR; mean difference, 1.7 points) was observed. No clinically important differences were found in the quality of life, wrist pain, or bother at 3 and 12 months. No significant difference was found in total complications between groups (12 of 84 [14%] for the CR group vs 6 of 80 [8%] for the VLP group; risk ratio [RR], 0.53; 95% CI, 0.21–1.33). Patient-reported treatment success favored the VLP group at 12 months (very successful or successful: 70 [89%] vs 57 [70%]; RR, 1.26; 95% CI, 1.07–1.48; p = 0.005). There was greater use of postoperative physical therapy in the VLP group (56 [72%] vs 44 [54%]; RR, 1.32; 95% CI, 1.04–1.69; p = 0.02). This randomized clinical trial found no between-group differences in improvement in wrist pain or function at 12 months from VLP fixation over CR for displaced DRFs in older people [18].

14.6.4 Plaster Immobilization Versus Anterior Plating for Dorsally Displaced Distal Radius Fractures

A prospective, multicentered, randomized trial analyzed results of 3- and 12-month follow-ups of 159 elderly patients aged more than 75 years with isolated DRF, treated by anterior locking plate or CR and cast immobilization (level III of evidence) [19]. The primary outcome was the PRWE score. The PRWE score at 12 months was not significantly different between the two groups; however, the radiological results and complications rates were worse in the CR group [19].

14.6.5 5 Cast Immobilization Versus Volar Locking Plate

Hasselund et al. compared operative and nonoperative treatment for displaced DRFs in patients aged over 65 years [20]. A total of 100 patients were randomized in this non-inferiority trial, comparing CR and cast immobilization with operation with a VLP. Patients with displaced AO/OTA A and C fractures were eligible if one of the following were found after initial closed reduction: (1) dorsal angulation >10°, (2) ulnar variance >3 mm, or (3) intra-articular step-off >2 mm. The primary outcome measure was the qDASH after 12 months. Secondary outcome measures were the PRWHE, EQ-5D-5L, ROM, grip strength, "satisfaction with wrist function" (score 0 to 10), and complications. In all, 89 women and 11 men were included. The mean age was 74 years (65–91 years). Nonoperative treatment was non-inferior to operation with a five-point difference in median qDASH score after 12 months (p = 0.206). After 3 and 6 months, the qDASH scores favored the operative group (p = 0.010 and 0.030, respectively). The median values for PRWHE were 19 in the operative group versus 10 in the nonoperative group at 3 months (p = 0.064), 9 versus 5 (p = 0.020) at 6 months, and 2 versus 0 (p = 0.019) after 12 months. ROM was similar between the groups. The EQ-5D-5L index score was better (mean difference 0.07) in the operative group at 3 and 12 months (p = 0.008 and 0.020, respectively). The complication rate was similar (p = 0.220). The operated patients were more satisfied with wrist function (median 8 vs 6) at 3 months (p = 0.002; 9 versus 8 at 6 months, p = 0.002; and 10 vs 8 at 12 months, $p < 0.001$). The conclusion was that nonoperative treatment was non-inferior to operative treatment based on the qDASH score after 1 year. Patients in the operative group had a faster recovery and were more satisfied with wrist function. Results from previous trials comparing operative and nonoperative treatment for displaced DRFs in the elderly vary between favoring the operative group and showing similar results between the treatments. This randomized trial suggested that most elderly patients may be treated nonoperatively [20].

14.6.6 Open Reduction and Volar Locking Plate Versus External Fixation with or Without Supplementary Pinning Versus Percutaneous Pinning

According to Chung et al., DRFs are common injuries among older adults and can result in substantial disability. Current evidence regarding long-term results in older adults is scarce. Chung et al. compared results across treatment groups at 24 months among adults with DRFs who participated in the WRIST trial [21]. The Wrist and Radius Injury Surgical Trial (WRIST) randomized, international, multicenter trial was conducted from April 1, 2012, through December 31, 2016 (trial registration, ClinicalTrials.gov; identifier, NCT01589692). Participants were adults aged 60 years or older with isolated, unstable DRFs at 24 health systems in the United States, Canada, and Singapore. Participants were randomized to open reduction and VLP, external fixation (EF) with or without supplementary pinning (EFP), and closed CR and percutaneous pinning (CRPP). The remaining participants chose closed reduction and casting. The primary outcome was the 24-month MHQ summary score. Secondary outcomes were scores on the MHQ subdomains hand strength and wrist motion. A total of 304 adults were recruited for the study, and 187 were randomized to undergo surgery, 65 to VLP, 64 to EFP, and 58 to CRPP; 117 participants opted for closed reduction and casting. Assessments were completed at 24 months for 182 participants (160 women [87.9%]; mean [SD] age, 70.1 [8.5] years). The mean MHQ summary scores at 24 months were 88 for VLP, 83 EFP, 85 for CRPP, and 85 for casting, with no clinically meaningful difference across groups after adjusting for covariates ($\chi 23 = 1.44$; $p = 0.70$). Pain scores also did not differ across groups at 24 months ($\chi 23 = 2.64$; $p = 0.45$). MHQ summary scores changed from 82 (95% CI, 80–85) to 85 (95% CI, 83–88) ($p = 0.12$) between 12 and 24 months across groups. The rate of malunion was higher in the casting group (26 participants [59.1%]) than in the other groups (4 participants [8.0%] for VLPS, 8 participants [17.0%] for EFP, and 4 participants [9.8%] for CRPP; $\chi 23 = 43.6$; $p < 0.001$), but malunion was not associated with the 24-month result difference across groups. This study did not find clinically meaningful patient-reported outcome differences 24 months after injury across treatment groups, with little change between 12 and 24 months. These findings suggested that long-term results need not necessarily be considered in deciding between treatment options. Patient needs and recovery goals that fit to relative risks and benefits of each treatment type will be more valuable in treatment decision-making [21].

14.6.7 Variable-Angle Volar Plate Versus Bridging External Fixator with K-Wire Augmentation in Comminuted Distal Radius Fractures

Mishra et al. compared the functional results between variable-angle volar plating and EF with K-wire augmentation in open reduction and internal fixation of DRFs [22]. A total of 62 adult patients with comminuted intra-articular DRFs were randomized into two groups: volar plate group and EF group. These patients aged between 18 and 60 years had unilateral fractures and agreed to be included in the study. Patients with a history of fracture, bilateral fracture, other associated injuries, delayed injury for more than 2 weeks, open fracture, preexisting arthrosis or disability, psychiatric illness, and pathological fracture were excluded. Patients were followed up at 6 weeks, 3 months, 6 months, and 1 year. The assessment of pain, functional activity, ROM, and grip strength was done at each stage of follow-up. The pain and functional activities were assessed by the PRWE and DASH scores. Patients in the volar plate group had superior PRWE and DASH scores at each stage of follow-up. At 1-year follow-up, the mean PRWE scores were 7.48 for the volar plate group and 7.35 for the EF group, while the mean DASH score was 4.65 for the volar plate group and 5.61 for the EF group, showing better flexion and extension ROM. They also had better pronation and supination ROM at initial follow-up; however, the difference was attenuated by 1 year. The volar plate group had significantly better grip strength than the EF group. Complication rates were higher in the EF group. The conclusion was that fixation with variable-angle volar plate resulted in early wrist mobilization, better ROM, less pain and disability, and early return of function [22].

14.6.8 Bilateral Distal Radius Fractures: External Fixation Versus Plate-Screw Treatment

Dagtas and Ünal compared the results of two surgical treatment options, EF or open reduction and internal fixation (ORIF), in patients with bilateral DRFs [23]. Twenty-one patients (11 males and 10 females; mean age, 40.0 years; range, 20–67 years) who underwent ORIF ($n = 10$) or EF ($n = 11$) due to bilateral DRF were retrospectively analyzed. The qDASH was used to calculate functional and symptomatic evaluation. The MWS was utilized to assess pain, functional status, ROM, and grip strength and the MHQ was used to measure hand performance in daily life. The operation time was statistically significantly longer in the ORIF group, compared to the EF group ($p < 0.001$). Radial shortening was statistically significantly greater in the EF group, compared to the ORIF group ($p < 0.001$). While the qDASH score was lower in the EF group on day 15 and at 1 and 2 months ($p < 0.001$, for each), it was similar between the groups at 1 year ($p = 0.507$). The MWS was higher in the EF group on day 15 and at 1 and 2 months and 1 year ($p < 0.05$, for each). While the MHOQ score was higher in the EF group on day 15 and at 1 and 2 months ($p < 0.001$, for each), it was similar between the groups at 1 year ($p = 0.557$). The conclusion was that in bilateral DRF cases, hand functions in the first 2 months after treatment were better in the EF group, compared to the ORIF group. This functional difference between the two groups gradually decreased in the first year and reached similar levels. This study demonstrated that EF can be a good alternative in the surgical treatment of bilateral DRFs owing to its acceptable outcomes, particularly in the short term [23].

14.7 Predictors of Management of Distal Radius Fractures in Patients Aged >65 Years

According to Walsh et al., treatment of DRFs in patients aged >65 years is controversial. They performed a study to identify what patient and fracture characteristics may influence the decision to pursue surgical versus nonsurgical treatment in patients aged >65 years sustaining a DRF. They queried their institutional DRF database for patients aged >65 years who presented to a single academic, tertiary center hand clinic over a 5-year period [24]. In all, 164 patients treated operatively were identified, and 162 patients treated nonoperatively during the same time period were selected for comparison (total $n = 326$). Demographic variables and fracture-specific variables were recorded. Patient and fracture characteristics between the groups were compared to determine which variables were associated with each treatment modality (operative or nonoperative). The average age in their cohort was 72 years, and 274 patients (67%) were women. The average Charlson Comorbidity Index (CCI) was 4.1. The CCI is a validated tool that predicts 1-year mortality based on patient age and a list of 22 weighted comorbidities. Factors associated with operative treatment in their population were largely related to the severity of the injury and included increasing dorsal tilt (odds ratio [OR], 1.09; 95% confidence interval [CI], 1.05–1.12; $p < 0.001$) and AO classification type C fractures (OR, 5.42; 95% CI, 2.35–11.61; $p < 0.001$). Increasing CCI was the only factor independently associated with nonoperative management (OR, 0.84; 95% CI, 0.72–0.997; $p = 0.046$) (Fig. 14.3). Fracture severity

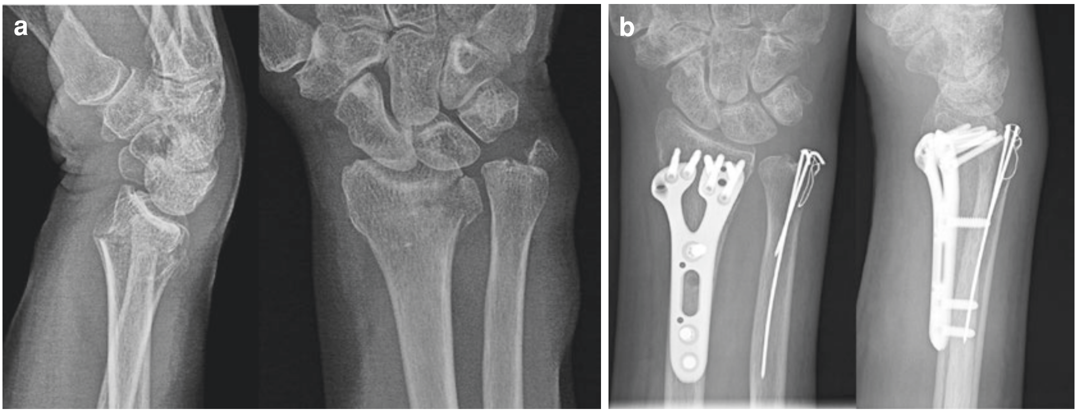

Fig. 14.3 (**a**, **b**) Distal radius and ulna fracture (**a**) treated with ORIF (open reduction and internal fixation)

was a strong driver in the decision to pursue operative management in patients aged >65 years, whereas increasing CCI predicted nonoperative treatment [24].

14.8 Conclusions

Distal radius fractures (DRFs) in the elderly population above 65 years of age represent 18% of all fractures and are therefore the second most common fracture in the elderly. The prevalence of DRFs is augmenting as life expectancy grows, leading to a larger population of patients who are at risk for these fractures. Most patients with minimally displaced DRFs can be treated nonoperatively with CR and 5-week cast immobilization, with satisfactory outcomes. However, DRFs in the elderly are often comminuted and intra-articular, therefore requiring surgical treatment. Three-dimensional preoperative planning for the osteosynthesis of DRFs has been proved to be reproducible with an error of about 2 mm for each reference point. It has been reported that Steinmann pin retractor-assisted CR combined with PP ameliorates fracture reduction and wrist function and can serve as an efficacious technique for A_2 (AO/OTA) and A_3 type of DRFs in the elderly with limited dorsal comminution, including intra-articular fractures with displacement less than 2 mm. DBP has been used most commonly in intra-articular, comminuted DRFs with overall functional wrist ROM, moderate patient-reported disability, and a 13% complication rate at follow-up. IlluminOss® System is a feasible alternative to treat DRFs with seemingly good clinical and functional result. However, one out of seven complications required surgical intervention. Fixation with VLP through the minimally invasive approach is a satisfactory and optional technique in the treatment of DRFs. This technique yields better early wrist function, shortens rehabilitation time, and obtains high psychological satisfaction. The plating method with a dual approach (dorsal and volar) may be an option for four-part intra-articular DRFs given its early mobility advantage and satisfactory functional and radiological results. It has been reported that prosthetic treatment of complex DRFs in elderly patients with the Cobra implant led to clinically and radiologically satisfactory midterm outcomes. However, the Cobra prosthesis still does not represent a gold standard but can be regarded as a feasible salvage option for complex DRFs when osteosynthesis may not be possible and nonoperative treatment will lead to further functional restrictions and wrist pain when performing activities of daily life in high functional demand patients. Restoration of anatomic and thus radiologic parameters of the radius may not be obligatory to achieve satisfactory functional result in patients with DRF aged 50 years or above. It has been reported that the patient is the most important "factor" in determining the adequate and successful treatment method for DRFs. A randomized clinical trial found no between-group differences in improvement in wrist pain or function at 12 months from VLP fixation over CR and cast immobilization for displaced DRFs in older people. Other randomized trial suggested that most elderly patients may be treated nonoperatively. A randomized study compared open reduction and VLP, external fixation with or without supplementary pinning, PP, and CR and casting. The study did not find clinically meaningful patient-reported outcome differences 24 months after injury across treatment groups, with little change between 12 and 24 months. Other reports compared a variable-angle volar plating and external fixator with K-wire augmentation in open reduction and internal fixation of DRFs. The conclusion was that the technique resulted in early wrist mobilization, better ROM, less pain and disability, and early return of function. It has been reported that factors associated with operative treatment in elderly patients are largely related to the severity of the injury and included increasing dorsal tilt and AO/OTA classification type C fractures. Increasing Charlson Comorbidity Index (CCI) was the only factor independently associated with nonoperative treatment. This study stated that fracture severity was a strong driver in the decision to pursue operative treatment in patients aged >65 years, whereas augmenting CCI predicted nonoperative treatment.

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