

Appendix

TABLE E-1 Characteristics and GRADE Study Quality Description of Each Included Study*

*HFA = hand-forearm angle; AROM = active range of motion; 2D = 2-dimensional; DASH = Disabilities of the Arm, Shoulder and Hand; VAS = visual analog scale; NA = not applicable; SD = soft-tissue distraction; AP = anteroposterior; PUFU = Prosthetic Upper Extremity Functional Index; CHEQ = Children’s Hand Use Effectiveness Questionnaire; PODCI = Pediatric Outcomes Data Collection Instrument; MTP = metatarsophalangeal; UL = ulnar length; AHA = Assisting Hand Assessment; QuickDASH = abbreviated version of the DASH; and SF-12 = Short Form-12.

Bora 1981¹⁰ (same series as 1970 paper: Bora FW Jr, Nicholson JT, Cheema HM. Radial meromelia. The deformity and its treatment. J Bone Joint Surg Am. 1970 Jul;52[5]:966-79)

Methods	Centralization without prior distraction Retrospective cohort study
Participants	21 wrists (13 patients); Bayne unspecified Setting: Pennsylvania, U.S.A. 1955-1980
Interventions	Nonoperative (4 wrists, 3 patients) Centralization (14 wrists, 8 patients) Arthrodesis/fibular bone graft (3 wrists, 2 patients)
Outcomes	Ulnar length (% of normal), ulnar bow, HFA, wrist/elbow/digital AROM
Notes	Average 14.6-year follow-up (range, 10.0-25.0 years)

Study Quality		
Criterion	Authors’ Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	Low	Retrospective cohort study
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	Moderate	Consistent methodology used
Control of confounding - radiographic (HFA/ulnar length)	Very low	Retrospective cohort study
Control of confounding - clinical (wrist AROM)	Very low	Retrospective cohort study
Follow-up - radiographic (HFA/ulnar length)	Moderate	Range, 10-25 years post-surgery
Follow-up - clinical (wrist AROM)	Moderate	Range, 10-25 years post-surgery

Methods	Centralization without prior distraction Case series
Participants	12 wrists (9 patients); 6 Bayne II, 3 Bayne III, 3 Bayne IV Setting: Connecticut, U.S.A. 1961-1981
Interventions	Centralization group
Outcomes	Radial deviation (degree of recurrence), wrist AROM
Notes	Average 10-year follow-up (range, 1-20 years)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	Very low	Uncontrolled case series
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Methodology not stated
Measurement of exposure and outcome - clinical (wrist AROM)	Low	Methodology not stated
Control of confounding - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	Very low	Uncontrolled case series
Follow-up - radiographic (HFA/ulnar length)	Very low	Range, 1-20 years post-surgery
Follow-up - clinical (wrist AROM)	Very low	Range, 1-20 years post-surgery

Methods	Centralization without prior distraction Case series
Participants	11 wrists (9 patients); 4 Bayne III, 7 Bayne IV Setting: Tehran, Iran 1990-2002
Interventions	Centralization
Outcomes	HFA, ulnar bow, wrist AROM (incomplete data)
Notes	Average 7.5-year follow-up (range, 4-14 years)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	Very low	Uncontrolled case series, most data missing
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	Low	Methodology not stated
Control of confounding - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	Very low	Uncontrolled case series
Follow-up - radiographic (HFA/ulnar length)	Very low	Range, 4-14 years post-surgery
Follow-up - clinical (wrist AROM)	Very low	Most data missing; range, 4-14 years post-surgery

Methods	Centralization without prior distraction Case series
Participants	25 wrists (21 patients); 17 Bayne IV, 8 Bayne III Setting: Washington, U.S.A. 1960-1993
Interventions	Intervention group only: centralization
Outcomes	HFA (after Manske), hand-forearm position, ulnar and humeral length AROM digits and wrist, grip, and pinch strength Jebsen-Taylor test, DASH VAS pain/appearance
Notes	Average 20-year follow-up 3 wrists recentralized and 2 fused due to recurrent deformity

Criterion	Study Quality	
	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	Very low	Uncontrolled case series
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	Moderate	Consistent methodology used
Control of confounding - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	Very low	Uncontrolled case series
Follow-up - radiographic (HFA/ulnar length)	Moderate	Range, 7-39 years post-surgery
Follow-up - clinical (wrist AROM)	Moderate	Range, 7-39 years post-surgery

Methods	Centralization without prior distraction Case series
Participants	19 wrists (14 patients); 16 Bayne IV, 3 Bayne III Setting: Philadelphia, U.S.A. 1974-1992
Interventions	Intervention group only: centralization
Outcomes	Total angulation (HFA and ulnar bow at rest)
Notes	Average 6.5-year follow-up 4 wrists revised due to recurrent deformity

Criterion	Study Quality	
	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Low	Range, 3-14 years post-surgery
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization without prior distraction Case series
Participants	21 wrists (17 patients); 19 Bayne IV, 2 Bayne III Setting: St Louis, Missouri, U.S.A. 1970-1980
Interventions	Notched centralization
Outcomes	HFA and hand-forearm position (describes Manske method), ulnar bow
Notes	Average 34-month follow-up (range, 12-90 months)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Measurement at different lengths of follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Measurement at different lengths of follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization without prior distraction Case series
Participants	31 wrists (27 patients); Bayne status of operated patients not stated Setting: Edinburgh, Scotland 1960-1993
Interventions	Intervention group only: centralization
Outcomes	HFA (method used not stated), ulnar and humeral length AROM digits
Notes	Average 20-year follow-up 3 wrists recentralized and 2 fused due to recurrent deformity

Criterion	Study Quality	
	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Moderate	Range, 7-39 years post-surgery
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Case series
Participants	13 wrists (13 patients); 11 Bayne IV, 2 Bayne III Setting: Paris, France Date not specified, published 2015
Interventions	Intervention group only: centralization
Outcomes	HFA (after Manske), hand-forearm position
Notes	Immediate postop. results only

Criterion	Study Quality	
	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Immediate postop. results only
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	29 wrists (23 patients); 18 Bayne IV, 4 Bayne III, 7 Bayne II Setting: Los Angeles, U.S.A. 1984-1997
Interventions	Centralization (n = 14) or radialization (n = 15) after soft-tissue distraction
Outcomes	HFA, hand-forearm position, ulnar bow (after Manske)
Notes	

Criterion	Study Quality	
	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Short, variable follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	446 wrists (342 patients); 254 Bayne IV, 192 Bayne III Setting: New Delhi, India January 1985-December 2004
Interventions	Nonoperative group: serial casting, stretching, and splinting (n = 137) Intervention group: serial casting, stretching, then centralization (n = 202) or radialization (n = 107)
Outcomes	HFA (after Manske), hand-forearm position, “wrist” and digital AROM, VAS appearance and pain, grip strength, PUFQI questionnaire
Notes	Average 14-year follow-up

Criterion	Study Quality	
	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	Low	Retrospective cohort study
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	Low	Retrospective cohort study
Control of confounding - radiographic (HFA/ulnar length)	Moderate	Wide range of prognostic factors recorded
Control of confounding - clinical (wrist AROM)	Moderate	Wide range of prognostic factors recorded
Follow-up - radiographic (HFA/ulnar length)	Moderate	Appropriately long and equal follow-up
Follow-up - clinical (wrist AROM)	Moderate	Appropriately long and equal follow-up

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	12 wrists (10 patients); all Bayne IV Setting: Sydney, Australia 1989-199? (published 1996)
Interventions	Non-distraction group: centralization (n = 5) or radialization (n = 1) Distraction group: distraction, then centralization (n = 2) or radialization (n = 4)
Outcomes	HFA (after Manske), hand-forearm position
Notes	Average 22-month follow-up (SD, 19 months)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Case series
Participants	8 wrists (6 patients); all Bayne IV Setting: St Louis, U.S.A. October 2002-November 2004
Interventions	Ilizarov distractor, then centralization
Outcomes	HFA(after Manske), hand-forearm position, active wrist extension, radial deviation and passive ulnar deviation (clinical)
Notes	Average 17-month follow-up

Criterion	Study Quality	
	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Case series
Participants	18 wrists (14 patients); 12 Bayne IV, 6 Bayne III Setting: Delhi, India April 2003-April 2006
Interventions	Semicircular distractor, then centralization
Outcomes	Anteroposterior (after Manske) and lateral HFA, AROM at shoulder/elbow/"wrist"/fingers, ulnar length, ulnar bow, unspecified appearance/overall satisfaction questionnaire
Notes	Average 31-month follow-up

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	Very low	Uncontrolled case series No preop. data stated
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Low	Consistent methodology used, but 2D radiographs liable to varied projection with limb rotation
Measurement of exposure and outcome - clinical (wrist AROM)	Low	No preop. data stated
Control of confounding - radiographic (HFA/ulnar length)	Low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	Low	Uncontrolled case series
Follow-up - radiographic (HFA/ulnar length)	Very low	Relatively short follow-up
Follow-up - clinical (wrist AROM)	Very low	Relatively short follow-up, and no preop. data recorded

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	26 wrists (20 patients); 24 Bayne IV, 2 Bayne III Setting: St Louis, Missouri, U.S.A. Pre-1997 cohort vs. 1997-2009 cohort
Interventions	Notched centralization cohort vs. soft-tissue distraction then un-notched centralization
Outcomes	HFA and hand-forearm position (after Manske), volar subluxation, ulnar length
Notes	Average 10-year follow-up for centralization alone, 6 years for distraction and centralization cohort

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Measurement at different lengths of follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Groups well matched by gross severity, but syndrome, etc. not recorded
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Measurement at different lengths of follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	14 wrists (11 patients); Bayne type unspecified Setting: Philadelphia, Pennsylvania, U.S.A. Timeframe not specified
Interventions	Soft-tissue distraction then centralization cohort vs. ulnar distraction then ulnar osteotomy
Outcomes	Total resolved angle of deformity (= ulnar bow plus wrist angle in AP and lateral planes, standardized on a normogram)
Notes	Average 40-month follow-up for centralization cohort, 43 months for osteotomy cohort

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	NA	Not measured
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Measurement at different lengths of follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Moderate differences in age and angulation between groups
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Measurement at different lengths of follow-up (23-59 months postop.)
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Case series
Participants	4 wrists (3 patients); all Bayne IV Setting: New Jersey, U.S.A. Timeframe not specified
Interventions	Soft-tissue distraction then centralization plus Evans bilobed dorsal flap Note: no carpal resection or tendon transfers
Outcomes	HFA and hand-forearm position (after Manske)
Notes	Average 26-month follow-up (range, 22-34 months)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	NA	Not measured
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Measurement at different lengths of follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	18 wrists (17 patients); Bayne (Heikel) III and IV Setting: Jaipur, India January 2004-April 2008
Interventions	Serial corrective casting or soft-tissue distraction, then centralization (16 cases) or radialization (2 cases). Adjunctive ulnar osteotomy in 8 cases
Outcomes	Finger and elbow AROM, resting radial deviation and volar flexion (measured clinically), HFA, ulnar bow, ulnar length (radiographic)
Notes	Average 18-month follow-up (range, 8-30 months)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	NA	Wrist AROM not measured
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Measurement at different lengths of follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	8 wrists (7 patients); Bayne III and IV Setting: Boston, U.S.A. 1990-2006
Interventions	Soft-tissue distraction, then centralization (7 wrists) or radialization (1 wrist)
Outcomes	HFA, hand-forearm position (radiographic)
Notes	Average 8-year follow-up (range, 1-16 years)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Retrospective cohort study (but n = 1 in radialization cohort)
Eligibility criteria - clinical (wrist AROM)	NA	Wrist AROM not measured
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	NA
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	32 wrists (26 patients); Bayne III and IV Setting: London, U.K. 1996-2002
Interventions	Soft tissue distraction, then centralization (7 wrists) or radialization (25 wrists); 11 radialized wrists subsequently required secondary centralization
Outcomes	HFA, hand-forearm position, ulnar length, carpal length (radiographic), AROM wrist and digits, power, DASH, CHEQ, VAS appearance
Notes	Average 15-year follow-up (all followed to skeletal maturity)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	Low	Retrospective cohort study
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Moderate	All patients followed to skeletal maturity
Measurement of exposure and outcome - clinical (wrist AROM)	Moderate	All patients followed to skeletal maturity
Control of confounding - radiographic (HFA/ulnar length)	Low	Retrospective cohort study
Control of confounding - clinical (wrist AROM)	Low	Retrospective cohort study
Follow-up - radiographic (HFA/ulnar length)	Moderate	All patients followed to skeletal maturity
Follow-up - clinical (wrist AROM)	Moderate	All patients followed to skeletal maturity

Methods	Centralization after soft-tissue distraction Case series
Participants	8 wrists (8 patients); Bayne III and IV Setting: Paris, France 2003-2008
Interventions	Soft-tissue distraction, then radialization (8 wrists)
Outcomes	HFA
Notes	Average 2.6-year follow-up (range, 1-4 years)

Criterion	Study Quality	
	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Centralization after soft-tissue distraction Case series
Participants	29 wrists (25 patients); Bayne II, III, and IV Setting: Bombay, India 1998-2005
Interventions	Soft-tissue distraction, then radialization plus a bilobed skin flap (29 wrists)
Outcomes	Ulnar length, distal ulnar width, HFA, volar subluxation
Notes	Average 6.5-year follow-up (range, 0.5-8 years)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	NA	NA
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	NA	NA
Control of confounding - radiographic (HFA/ulnar length)	Low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	NA	NA
Follow-up - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Follow-up - clinical (wrist AROM)	NA	NA

Methods	Vascularized proximal fibular epiphysis transfer Case series
Participants	4 wrists (4 patients); Bayne III Setting: Guangzhou, China 2007-2009
Interventions	Vascularized proximal fibular epiphysis transfer (4 wrists)
Outcomes	HFA, forearm length, wrist AROM
Notes	Average 3.5-year follow-up (range, 2-5 years)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	Very low	Uncontrolled case series
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	Very low	Short, uneven-length follow-up
Control of confounding - radiographic (HFA/ulnar length)	Low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	Low	Uncontrolled case series
Follow-up - radiographic (HFA/ulnar length)	Very low	Short, uneven-length follow-up
Follow-up - clinical (wrist AROM)	Very low	Short, uneven-length follow-up

Methods	Centralization after soft-tissue distraction Case series
Participants	18 wrists (16 patients); Bayne II, III, and IV Setting: Dallas, Texas, U.S.A. ca. 1998-2015
Interventions	Soft-tissue release and bilobed flap (18 wrists)
Outcomes	HFA, wrist AROM, DASH, PODCI, VAS appearance and satisfaction
Notes	Average 9.2-year follow-up (range, 3-16 years)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	Very low	Uncontrolled case series
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Uneven-length follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	Very low	Uneven-length follow-up
Control of confounding - radiographic (HFA/ulnar length)	Low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	Low	Uncontrolled case series
Follow-up - radiographic (HFA/ulnar length)	Very low	Uneven-length follow-up
Follow-up - clinical (wrist AROM)	Very low	Uneven-length follow-up

Methods	Centralization after soft-tissue distraction Case series
Participants	19 wrists (18 patients); Bayne III and IV Setting: Tampere, Finland ca. 1998-2015
Interventions	Soft-tissue distraction and vascularized 2nd MTP joint transfer (19 wrists)
Outcomes	HFA, ulnar length, ulnar bow, wrist AROM, Vilkkki score
Notes	Average 11-year follow-up (range, 4-19.5 years)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Very low	Uncontrolled case series
Eligibility criteria - clinical (wrist AROM)	Very low	Uncontrolled case series
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Uneven-length follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	Very low	Uneven-length follow-up
Control of confounding - radiographic (HFA/ulnar length)	Low	Uncontrolled case series
Control of confounding - clinical (wrist AROM)	Low	Uncontrolled case series
Follow-up - radiographic (HFA/ulnar length)	Very low	Uneven-length follow-up
Follow-up - clinical (wrist AROM)	Very low	Uneven-length follow-up

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	25 wrists (20 patients); Bayne II, III, and IV Setting: Sweden (multicenter study) ca. 1993-2011
Interventions (Note that some patients had multiple treatments to the same limb, or different treatments to each limb if bilaterally affected)	Non-notched centralization ± prior soft-tissue distraction (6 wrists, 6 patients) Radialization ± prior soft-tissue distraction (12 wrists, 11 patients) Callus distraction of ulna (3 wrists, 3 patients) Nonsurgical treatment (6 wrists, 5 patients)
Outcomes	HFA, UL, hand-forearm position, ulnar bow, body length, shoulder/elbow/wrist/digit AROM, grip strength, sensibility, box and block, AHA, CHEQ, appearance
Notes	Average age, 10.5 years (age at surgery not specified; range, 4-17 years)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Nonrandomized retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	Low	Nonrandomized retrospective cohort study
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Uneven-length follow-up, covering growth period
Measurement of exposure and outcome - clinical (wrist AROM)	Very low	Uneven-length follow-up, covering growth period
Control of confounding - radiographic (HFA/ulnar length)	Low	Nonrandomized retrospective cohort study
Control of confounding - clinical (wrist AROM)	Low	Nonrandomized retrospective cohort study
Follow-up - radiographic (HFA/ulnar length)	Very low	Uneven-length follow-up, covering growth period
Follow-up - clinical (wrist AROM)	Very low	Uneven-length follow-up, covering growth period

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	29 wrists (20 patients); Bayne II, III, IV, V Setting: Sweden (multicenter study). Time of treatment not specified
Interventions	Centralization ± prior soft-tissue distraction (17 wrists, 12 patients) Radialization ± prior soft-tissue distraction (3 wrists, 2 patients) Nonsurgical treatment (6 wrists, 3 patients)
Outcomes	HFA, hand-forearm position, total carpal-forearm length, body length, elbow/wrist/digit AROM, grip strength, sensibility, box and block, Sollerman test, QuickDASH, SF-12, appearance
Notes	Average age, 26.5 years (age at surgery not specified; range, 18-60 years)

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Nonrandomized retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	Low	Nonrandomized retrospective cohort study
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Moderate	Uneven-length follow-up, but all skeletally mature
Measurement of exposure and outcome - clinical (wrist AROM)	Moderate	Uneven-length follow-up, but all skeletally mature
Control of confounding - radiographic (HFA/ulnar length)	Low	Nonrandomized retrospective cohort study
Control of confounding - clinical (wrist AROM)	Low	Nonrandomized retrospective cohort study
Follow-up - radiographic (HFA/ulnar length)	Moderate	Uneven-length follow-up, but all skeletally mature
Follow-up - clinical (wrist AROM)	Moderate	Uneven-length follow-up, but all skeletally mature

Methods	Centralization after soft-tissue distraction Retrospective cohort study
Participants	64 cases; 26 treated operatively, with results described Setting: Helsinki, Finland (multicenter study). Time of treatment not specified
Interventions	Centralization (22 wrists, 15 patients) Nonsurgical (52 wrists, 37 patients)
Outcomes	Wrist position (radial abduction, volar flexion, pronation/supination), wrist mobility, forearm length, elbow motion, digital motion
Notes	Follow-up of centralized patients, 9.6 years; range, 1.9-28 years Follow-up of nonsurgical patients, 12.6 years; range, 0.5-48 years

Study Quality		
Criterion	Authors' Judgment of Quality	Support for Judgment
Eligibility criteria - radiographic (HFA/ulnar length)	Low	Nonrandomized retrospective cohort study
Eligibility criteria - clinical (wrist AROM)	Low	Nonrandomized retrospective cohort study
Measurement of exposure and outcome - radiographic (HFA/ulnar length)	Very low	Uneven-length follow-up
Measurement of exposure and outcome - clinical (wrist AROM)	Very low	Uneven-length follow-up
Control of confounding - radiographic (HFA/ulnar length)	Low	Nonrandomized retrospective cohort study
Control of confounding - clinical (wrist AROM)	Low	Nonrandomized retrospective cohort study
Follow-up - radiographic (HFA/ulnar length)	Very low	Uneven-length follow-up
Follow-up - clinical (wrist AROM)	Very low	Uneven-length follow-up

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TABLE E-2 Full Data Set*

Study	No. of Patients	No. of Limbs	Method	Bayne	Preop.			Follow-up† (yr)	Postop.		
					HFA† (deg)	UL† (cm)	Wrist AROM† (deg)		HFA† (deg)	UL† (cm)	Wrist AROM† (deg)
Bora 1981 ¹⁰	3	4	Nonsurgical	?				14.6	96.3 ± 4.8		17.5 ± 2.9
Kotwal 2012 ⁸	103	137	Nonsurgical (serial casting)	III, IV	66 ± 21		58 ± 21	13.1	85 ± 23		63 ± 25
Ekblom 2013 ²⁴	5	6	Nonsurgical	II, IV (no III)				8.3	53.5 ± 41.7	11.12 ± 2.38	64.2 ± 35.1
Ekblom 2014 ⁹	3	6	Nonsurgical	IV, V				35.7	48 ± 26.1		45 ± 34.8
Heikel 1959 ¹¹	15	22	Centralization	?				9.6	33.0 ± 22.7		39.6 ± 23.7
Bora 1981 ¹⁰	8	14	Centralization	?				14.6	30.7 ± 6.2		29.3 ± 14.1
Goldfarb 2002 ¹	21	25	Centralization	III, IV	63 ± 21			20.0	25 ± 28.8	12 ± 2.95	31 ± 32.5
Damore 2000 ³²	14	19	Centralization	III, IV	83 ± 14			6.5	61 ± 27		
Lamb 1977 ³³	27	31	Centralization	?	78 ± 16			5.0	22 ± 9		
Nanchahal 1996 ³⁶	5	5	Centralization	IV	39 ± 36			2.7	17 ± 12		
Manske 1981 ²⁸	17	21	Centralization	III, IV	57.9 ± 29.5			2.8	26.5 ± 19.3		
Manske 2014 ¹⁹	10	13	Centralization	III, IV	53 ± 31			10.0	27 ± 24	12.6 ± 3	
Watson 1984 ²⁶	9	12	Centralization (non-notched)	II, III, IV				10.0	14.2 ± 13.3		31.8 ± 7.3
Ekblom 2014 ⁹	12	17	Centralization	III, IV				24.4	32.1 ± 27.9		38.8 ± 29.4
Shariatzadeh 2009 ³¹	9	11	Centralization	III, IV	75 ± 20			7.5	52 ± 5		
Ekblom 2014 ⁹	2	3	Radialization	III, IV				20.0	6.7 ± 23.1		50 ± 32.8
Nanchahal 1996 ³⁶	1	1	Radialization	IV	-30			1.6	-35		
Romana 2015 ³⁴	13	13	SD + centralization	III, IV	52 ± 27			0.0	11 ± 4		
Nanchahal 1996 ³⁶	1	2	SD + centralization	IV	90 ± 0			1.6	35 ± 4		
Kampfen 2015 ²³	6	7	SD + centralization	III, IV	63.6 ± 43.7	7.04 ± 14		13.6	9.4 ± 13.6	11.11 ± 1.99	25 ± 18
Goldfarb 2006 ³⁷	6	8	SD + centralization	IV	74 ± 25			1.4	-5 ± 22		
Kanojia 2008 ³⁸	14	18	SD + centralization	III, IV	68 ± 26	7 ± 1		2.6	5 ± 10	10 ± 2	33 ± 12.5
Manske	10	13	SD + centralization	III, IV	53 ± 26			6.0	36 ± 20	10.4 ± 2.1	

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2014 ¹⁹											
McCarthy 2009 ³⁹	6	8	SD + centralization	?	76 ± 20.75			3.3	50 ± 10.25		
Sabharwal 2005 ⁴⁰	3	4	SD + centralization	IV	86 ± 14.5			2.2	14 ± 5		
Saini 2009 ⁴¹	15	16	SD + centralization	III, IV	63.1 ± 26.7	5.8 ± 1.1		1.5	8.8 ± 13.1	7.3 ± 1.2	
Geck 1999 ³⁵		14	SD + centralization	II, III, IV	69.3 ± 26			4.2	11.2 ± 19.8		
Ekblom 2013 ²⁴	6	6	SD + centralization (non-notched)	II, III, IV				10.9	24 ± 29.5	12.02 ± 2.6	25.8 ± 20.1
Taghinia 2007 ²⁵	7	8	SD + centralization	IV	96.1 ± 13.4			9.1	17.5 ± 16.6		
Kotwal 2012 ⁸	239	309	SD + centralization or radialization	III, IV	63 ± 19		57 ± 22	13.9	12 ± 16		41 ± 24
Taghinia 2007 ²⁵	1	1	SD + radialization	IV	93			1.0	-30		
Kampfen 2015 ²³	14	14	SD + radialization	III, IV	54.6 ± 23.2	6.79 ± 1.56		11.1	5.5 ± 13.5	13.87 ± 2.59	42 ± 24
Dana 2012 ⁴²	8	8	SD + radialization	III, IV	61.1 ± 26.3			2.6	43.5 ± 14		
Thatte 2008 ⁴³	25	29	SD + radialization + bilobed flap	II, III, IV	74.5 ± 32.5	5 ± 0.71		6.5	9.7 ± 7.4	8.1 ± 2.1	
Ekblom 2013 ²⁴	11	12	SD + radialization	II, III, IV				10.8	29.3 ± 24.6	13.35 ± 3.69	51.3 ± 35
Geck 1999 ³⁵		15	SD + radialization	II, III, IV	55.1 ± 26			4.2	13 ± 19.8		
Nanchahal 1996 ³⁶	3	4	SD + radialization	IV	35 ± 36			1.0	5 ± 12		
Saini 2009 ⁴¹	2	2	SD + osteotomy + radialization	IV	50 ± 21.2	6 ± 2.1		1.5	0 ± 0	8.1 ± 1.3	
Kampfen 2015 ²³	10	11	SD + radialization, secondary centralization	III, IV	44.9 ± 22	5.46 ± 1.8		12.5	0.1 ± 10.5	12.97 ± 2.56	
Yang 2015 ⁴⁴	4	4	Vascularized fibular epiphysis transfer	III	39 ± 17.1	8.5 ± 2.1	78.8 ± 14.4	3.5	11.5 ± 6.4	12.8 ± 3.2	96.3 ± 20.6
Vuillermin 2015-2016 ^{12,13‡}	16	18	Soft-tissue release	II, III, IV	88 ± 18.8	6.4 ± 0.6		9.2	64 ± 13.3	16.1 ± 1.4	73
Vilkkki 2008 ²⁷	18	19	SD + vascularized 2nd MTP joint transfer	III, IV	61.6 ± 23.7	8.1 ± 2		11.0	27.9 ± 14.4	15.4 ± 2.5	83.2 ± 21.9
McCarthy 2009 ³⁹	5	6	Ulnar osteotomy + ex-fix	?	65 ± 21			3.6	80 ± 29.5		

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*HFA = hand-forearm angle, UL = ulnar length, AROM = active range of motion, SD = soft-tissue distraction, MTP = metatarsophalangeal, and ex-fix = external fixation. †Values are given as the mean, with or without the standard deviation. ‡Ulnar length data for Vuillemin taken from 2016 paper on same series¹³.

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