

TABLE E-1 Complications and Clinical Remarks for Pediatric Humeral Lengthening Procedures

Study	Complications (No.)	Clinical Remarks*
Janovec ¹² (1991)	Infection (4), radial nerve palsy (1), radial and ulnar nerve palsy (1), fracture (1)	Positive effect on psyche and aesthetics
McLawhorn et al. ⁷³ (2011)	Infection (2), contracture (2), premature consolidation (1)	MAC system well-suited for correction of humeral length discrepancies
Dal Monte et al. ⁸⁷ (1985)	Radial nerve palsy (3), screw breakage (3)	Temporary functional limitations of the shoulder, but thereafter good cosmetic appearance
Pawar et al. ⁷⁴ (2013)	Infection (3), radial nerve palsy (2), fracture (2)	Mean DASH score improved from 14 to 9 (n = 9); no shoulder or elbow stiffness observed
Ruette and Lammens ⁸⁹ (2013)	Infection (14), elbow flexion contracture (7), premature consolidation (6), radial nerve palsy (6), screw loosening (1), fracture (1), progressive bowing after removal (1)	Reliable method; patients would undergo the procedure again
Kashiwagi et al. ⁹² (2001)	Fracture (2), pin replacement (2), radial nerve palsy (2)	Physical improvements noted
Malot et al. ⁹⁰ (2013)	Fracture (3), varus angulation (2), infection (6), radial nerve palsy (1), elbow contractures (5)	Rosenberg score improved from 21 to 25; SF-36 improved significantly; all would do the procedure again
Hosny ⁹¹ (2005)	Infection (16), radial nerve palsy (1), fracture (2), repeated compression and distraction (4)	10 excellent and 6 good results
Bernstein et al. ^{135†} (2008)	Elbow subluxation (1), ulcer (3), loss of elbow motion (2), infection (1)	Better function and prosthetic fitting; 8 of 9 patients fitted with prosthesis
Kołodziej et al. ^{78†} (2005)	Radial nerve palsy (1), pseudarthrosis (1), incomplete fracture (1), infection (1)	Limb deformities corrected; residual forearm length discrepancy 2 cm and 3 cm
Popkov et al. ^{67†} (2010)	Regenerate defect (3), radial nerve palsy (1)	Maximum diminution of HI for patients with acquired discrepancy of forearm who had monofocal lengthening was 51.3%
Al-Sayyad ^{28†} (2012)	Infection (5)	All patients had union; postoperative angulation of 1° (anteroposterior radiograph) and 0.5° (lateral radiograph)
Tetsworth et al. ^{21†} (1991)	Infection (1/2), premature consolidation (1/1), angular deformity (2/2), radial nerve palsy (0/2), loss of wrist motion (0/2)	Functional, cosmetic, psychological improvements; function remained same or improved in 18 of 19 patients
Seitz et al. ^{134‡} (2010)	Pseudarthrosis (6%); premature consolidation (0.7%); soft-tissue injury (0.7%); tip necrosis, angular deformity, joint dislocation (0.7% each); major complications, 9%; minor complications, 46%	97% no pain, 88% no difficulty in activities of daily life; 67 excellent, 24 good, 3 fair, 6 poor; 92% were satisfied; better prosthetic fitting achieved

*MAC = Multi-Axial Correction external fixation system, DASH = Disabilities of the Arm, Shoulder and Hand, SF-36 = Short Form-36 score, and HI = healing index. †Humeral and forearm lengthening procedures were performed. The values in parentheses represent the humerus/forearm. ‡Humeral, forearm, and hand lengthening procedures were performed.

TABLE E-2 Complications and Clinical Remarks for a Pediatric Clavicular Lengthening Procedure

Study	Complications (No.)	Clinical Remarks
Sewell et al. ¹³² (2013)	Infection (2), pseudarthrosis (3)	Mean Oxford score improved from 28.5 to 41

TABLE E-3 Complications and Clinical Remarks for Pediatric Forearm Lengthening Procedures

Study	Complications (No.)	Clinical Remarks*
Ettl et al. ⁹⁸ (2005)	Fracture (2), pseudarthrosis (1), ulnar nerve palsy (1), radial nerve palsy (1), radial head dislocation (1)	4 improved, 4 were unchanged, and 2 had deteriorated pronation-supination; 2 improved, 7 were unchanged, and 1 had deteriorated elbow motion; 2 improved and 8 had unchanged wrist flexion-extension; 7 improved and 3 had unchanged wrist abduction-adduction
Vogt et al. ⁷¹ (2011)	Recurrence of ulnar shortening, overlengthening (1), infection, premature consolidation (1), screw loosening (2)†	5 improved, 4 were unchanged, and 3 had deteriorated pronation-supination; 1 improved, 10 were unchanged, and 1 had deteriorated elbow motion; 1 improved, 10 were unchanged, and 1 had deteriorated wrist flexion-extension; 7 improved, 5 were unchanged, and none had deteriorated wrist abduction-adduction
Matsubara et al. ⁹⁹ (2006)	Recurrence (4), infection (1)	6 improved and 1 had deteriorated pronation-supination
Bader and Grill ¹⁰⁰ (2000)	Fracture (1), screw loosening (2)	13 improved, 1 was unchanged, and 1 had deteriorated pronation-supination; 4 improved, 9 were unchanged, and 2 had deteriorated elbow motion; 4 improved and 11 had unchanged wrist motion
Masada et al. ¹⁰¹ (1989)	Radial nerve palsy (1)	Pronation-supination gain of 21° and 19°, respectively
Ip et al. ¹⁰² (2003)	Radial head dislocation (1)	Good range of motion in 5 of 6
Demir et al. ¹⁰³ (2011)	Fracture (2), infection (3)	Good results in 5 of 6 patients; mean DASH score of 8.1
Tang et al. ¹⁰⁴ (2013)	Pain (4), infection (6), pseudarthrosis (1), fracture (1)	10 excellent, 4 good results
Bilen et al. ¹⁰⁵ (2009)	Infection (2)	Radial articular angle reduced from 43° to 36°; carpal slip reduced from 70% to 55%
Litzelman et al. ¹⁰⁶ (2012)	Fracture (1), recurrence (1)	Good tolerance (score of 1), 71.5% would undergo procedure again; distraction recommended for patients with Masada type-2 deformity
Orhun et al. ¹¹⁵ (2003)	None	Satisfactory results reported

Jasiewicz et al. ¹¹⁶ (2006)	Wire breakage (1)	Full motion; grade-5 muscle activity
Catagni et al. ²⁰ (1993)	Ulnar nerve palsy (3), median nerve palsy (1), wound breakdown (1), temporary elbow contracture (1)	None
Farr et al. ⁹³ (2012)	Fracture (1), pseudarthrosis (1), pin-track infection (6)	Ulnar bowing, hand-forearm angle decreased, some recurrence noted
Matsuno et al. ⁹⁴ (2006)	Pseudarthrosis (1), pin loosening (1), infection (1)	Elbow motion preserved, wrist motion limited, pronation preserved, supination limited
Cattaneo et al. ⁹⁵ (2001)	Fracture (1), ulnar nerve palsy (1)	2 excellent, 1 good, 10 fair, and 1 poor outcome; 6 excellent, 6 good, and 2 fair aesthetic results
Rubin et al. ⁷⁹ (2013)	Radial nerve palsy (2), infection (1)	Patients satisfied, mean of 15° of forearm supination achieved
Mateev and Imanaliev ¹¹⁴ (2006)	Deep infection (1), infection (2)	Survival of the fibula in all patients
Zhang et al. ¹³⁶ (2007)	Infection (6), pseudarthrosis (3)	Radial deviation reduced from 54° to 5°, flexion increased from 37° to 52°, extension increased from 27° to 47°, grip strength markedly improved
Gündeş et al. ¹¹⁰ (2011)	Infection (1)	Mean DASH score of 2.07 and mean Mayo score of 89
Page and Szabo ⁸⁰ (2009)	Infection (1), skin tenting (1), dermatitis (1), wrist pain (1)	Mean VAS of 1, mean DASH score of 11, mean SF-12 of 82, mean Mayo score of 76; good radiographic outcomes
Bagatur et al. ¹¹² (2002)	Callus deformity	Satisfactory functional and cosmetic improvement
Horii et al. ¹³⁸ (2000)	Infection (1), callus deformity (8), temporary finger and wrist contracture	Moderate correlation between age and HI; fixation shorter for same length in patients with TU/PI
Cheng ¹⁴ (1991)	Infection (1)	More efficient function; pronation-supination improved 5°-10°

Jager et al. ⁸⁴ (2012)	Delayed union (6/1), bowing (4), fracture (3), pseudarthrosis (1), infection (7/2)‡	Amplitude of lengthening 40% greater in group B; HI improved by 30% overall; 82% and 86% of grasp and pinch strength, respectively, of contralateral side
Hill et al. ¹⁰⁷ (2011)	Infection (9), pseudarthrosis (5), premature consolidation (2), contracture (4), temporary sensory radial nerve palsy (1), cessation of lengthening prematurely (1)	None
Villa et al. ⁷⁷ (1990)	Radial nerve palsy (3), pseudarthrosis (1), malunion (2), fracture (2), reduction of motion (3), complex regional pain syndrome type II (1)	11 of 12 functionally and cosmetically improved; 9 psychologically improved; mild joint stiffness observed in 3 patients
Raimondo et al. ⁷⁶ (1999)	Infection (2), flexion contracture (2), pseudarthrosis (2)	Assistive function achieved, tasks easily performed, 3 patients said it is easier now; subjective function and appearance improved considerably; only 1 patient disappointed
Abe et al. ¹⁰⁸ (1996)	Infection (3), fracture (5), pseudarthrosis (2)	Elbow extension improved by 14°, flexion improved by 10°, pronation improved by 23°, supination decreased by 8°, radial deviation increased by 9°, ulnar deviation increased by 9°
Mader et al. ¹⁰⁹ (2003)	Fracture (1)	Radial articular angle improved in all 4 patients with hereditary exostosis; good motion improvement achieved
Taghinia et al. ⁹⁶ (2013)	Pain (5), premature consolidation (1), skin breakdown (1), radial nerve palsy (1), flexion contracture (1), distractor malfunction (2), cellulitis (2), elbow contracture (1), delayed union or nonunion (2), skin irritation (1)	Functional outcome much better in 7, better in 1, same in 1, worse in 1 patient
Launay et al. ⁹⁷ (2001)	Pseudarthrosis (6), axial deviation (3)	Recommend IM pin after axial corrective osteotomy; 12 had improved strength, 4 improved motion, and all had improved aesthetics
Pajardi ¹¹¹ § (1995)	Pain (4), infection (3), pseudarthrosis (4), lengthening failure (2)	None

*DASH = Disabilities of the Arm, Shoulder and Hand, VAS = visual analog scale, SF-12 = Short Form-12, HI = healing index, and IM = intramedullary fixation. †No exact numbers were given for recurrence and infection. ‡The values in parentheses are for external fixator group/fixator and intramedullary nail group (group B). §Forearm and hand lengthening procedures were performed.

TABLE E-4 Complications and Clinical Remarks for Pediatric Hand Lengthening Procedures

Study	Complications (No.)	Clinical Remarks*
Erdem et al. ¹²³ (2009)	Infection (3)	No MCP stiffness of >20°; 11 of 12 achieved full ADL
Kato et al. ¹²⁴ (2002)	Pseudarthrosis (1), hypertrophic scar (1)	All patients satisfied; MCP flexion increased
Sen et al. ¹²⁵ (2003)	Pseudarthrosis (1), infection (3)	Effective and reliable method
Bozan et al. ⁵³ (2006)	Infection (3)	MCP flexion improved from 71.6° to 76.3°; healing better if <18 years old
Houshian and Ipsen ¹¹⁷ (2001)	Fracture (1), infection (5), pseudarthrosis (1), dislocation metacarpal base (1)	Function improved in 13 of 14 patients
Arslan ²⁴ (2001)	Pin bending (1)	Pinch and function improved
Matev ¹¹⁸ (1979)	None	Carpometacarpal joint moved freely; good pinch strength
Seitz and Froimson ¹¹⁹ (1995)	Pseudarthrosis (1)	Substantial improvements achieved
Miyawaki et al. ⁸² (2002)	Fracture (1)	Pinch function improved (1.73 kg versus 1.70 kg)
Ogino et al. ¹²⁶ (1994)	Transitory sensory disturbance (1)	All patients improved
Hierner et al. ¹²⁸ (1998)	Infection (1), premature consolidation (1), fracture (3)	Second-line therapy due to lack of growth and joint movement
Rudolf et al. ¹²⁰ (2000)	Infection (3), pin breakage (3), pin loosening (3), fracture (1)	None
Salom et al. ⁶⁹ (1998)	Infection (5), lengthening failure (1), fracture (1), osteotomy to correct callus bowing (4), pseudarthrosis (5)	76% grasp and 79% pinch postoperatively
Rösslein ¹²¹ (1993)	None	None
Dhalla et al. ⁸³ (2001)	Infection (5), deep infection (2), pseudarthrosis (1), fracture (3), hardware loosening (3), angular deformity (3), painful tip prominence (3)	7 repeat surgeries; motion preserved in 14 of 16 patients within 5°; satisfaction of 100% (dual half-pin) and 90% (single half-pin/IM)
Matsuno et al. ⁶⁸ (2004)	Infection (2), angular deformity (2), pin loosening (2), osseous prominence (4)	If <7 years old, lengthened bones grew
Seitz and Froimson ¹²² (1991)	Pseudarthrosis (2), infection (1), hand deviation (1)	Substantial improvement of function; improved pinch; below instead of above-the-elbow prosthesis used

Pensler et al. ¹³⁹ (1998)	Angular deformity (2)	Safe, reliable, and predictable method
Hülsbergen-Krüger et al. ¹²⁹ (1998)	Infection (4), fracture (2), radial nerve palsy (1), elbow flexion contracture (5), unsatisfying soft-tissue coverage (1), severe infection (1), pseudarthrosis (1), joint subluxation (1), recurrence (1)	None
Vargel et al. ¹³⁰ (2015)	Pin loosening (6), infection (2)	Index-to-thumb pinch acquired by all patients; mean angular correction of 43°

*MCP = metacarpophalangeal joint, ADL = activities of daily living, and IM = intramedullary fixation.