

SPECIALTY UPDATE

What's New in Limb Lengthening and Deformity Correction

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This update summarizes select articles pertaining to limb lengthening and deformity correction that were published between January 1, 2014, and December 31, 2014.

Pediatric Lower-Limb Disorders

Guided Growth

Angular deformities in growing children can often be corrected with use of guided growth. Although two-hole 3.5-mm reconstruction plates with 4-mm cancellous screws provide an economical and effective alternative to design-specific, tension-band plating systems, their 10% screw breakage rate merits consideration of the use of larger (4.5-mm) cortical screws¹. Caution must be used when applying medial distal-femoral temporary tension-band plates to prevent impingement or injury to the medial patellofemoral ligament². Despite more implant-related complications, medial malleolar transphyseal screws in comparison with tension-band plates can result in faster corrections³. Ankle valgus in children with spina bifida can be effectively corrected with the use of a medial malleolar screw⁴. Following guided growth treatment, physical therapy readily resolves the delayed return to function that most commonly occurs in children who are older than eleven years of age and in patients who are undergoing bilateral procedures, distal femoral plating, or procedures involving four or more implants⁵. A modified technique for insertion of tension-band plates has decreased operative time and incision size⁶. Parallel compared with divergent screw configuration was favorable in a synthetic-bone guided-growth model⁷. Tension-band plates at the trochanteric apophysis may have a role as a

non-osteotomy containment strategy for Legg-Calvé-Perthes disease⁸.

Limb-Length Discrepancy

A comparison of lateral elbow and left hand radiographs for assessing skeletal maturity revealed that the elbow radiographs were preferred during the growth spurt and the hand radiographs were more useful following the growth spurt⁹. When evaluating the effectiveness of percutaneous physeal ablation with a drill and burr technique (the Canale method) compared with that of transphyseal screws (the Metaizeau method), the drill ablation was slightly more effective and had a lower complication rate¹⁰. Siedhoff et al. noted that temporary epiphysiodesis with use of either tension-band plates or staples can be effective for correcting leg-length discrepancy. However, growth following implant removal in skeletally immature patients was not documented¹¹. Eighteen patients underwent subtrochanteric femoral shortening of 2.5 cm to 5 cm with straight or blade plate fixation with a 28% complication rate, primarily related to delayed bone-healing¹².

Blount Disease

Clinical examination, including rotational profile and biplanar radiographs of both the femur and the tibia, is important for the comprehensive assessment and correction of tibial procurvatum, varus and internal rotation deformity, and femoral anteversion and varus^{13,14}. Despite having adequate surgical realignment of the lower extremity affected by Blount disease, body mass index tends to increase with time in the majority of these patients¹⁵. Acute deformity correction can be used in selected cases¹⁶. Overcorrection into valgus is not typically needed in younger children with Blount disease¹⁷. In patients

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treated with gradual correction using circular fixation, equivalent results were reported with or without fibular osteotomy¹⁸.

Congenital Limb Deformities and Deficiencies

A comprehensive review of the current classification systems and management strategies for fibular hemimelia was recently performed¹⁹. Fibular hemimelia is also associated with skeletal and soft-tissue anomalies of the knee²⁰ and possible absence of the peroneal artery in those with a completely absent fibula²¹. Patients with pre-axial limb deficiencies have a high prevalence of additional extremity, spine, or visceral anomalies^{22,23}. These associated anomalies also occur with other limb deficiencies and amniotic band syndrome²²⁻²⁴. Age-matched norms for joint range of motion and bone torsion were reported for four to sixteen-year-old children²⁵.

Skeletal Dysplasias

Comprehensive deformity correction strategies for children with Morquio syndrome, those with Ellis-van Creveld syndrome, and those with diastrophic dysplasia have been outlined by several authors²⁶⁻²⁸. Tension-band plating is effective for correcting angular deformities in a subgroup of patients with skeletal dysplasias²⁹. Fibular lengthening has been used to correct talar instability associated with multiple hereditary exostosis³⁰. Skeletal age typically lags behind chronologic age in children with multiple epiphyseal dysplasia and should be taken into account when making length predictions³¹. Focal fibrocartilaginous dysplasia is another benign cause of unilateral tibia vara that spontaneously resolves in all but the most severe cases³².

Circular External Fixation

The use of the Taylor Spatial Frame (Smith & Nephew) has been reported from different countries for the correction and lengthening of long bone deformities^{33,34}. The typical anteriorly based pin configuration in the tibia during lengthening is associated with developing an apex-anterior residual deformity that can be addressed with residual correction using the Taylor Spatial Frame software³⁵. Hinged circular external fixators have been applied for complete correction of knee flexion contractures in patients with hemophilia, with a 10° average recurrence at an eight-year follow-up³⁶.

Osteogenesis Imperfecta

The authors of two meta-analyses noted that, although oral or intravenous administration of bisphosphonates in children with osteogenesis imperfecta increases bone mineral density, evidence of reduction in fracture rates is inconclusive^{37,38}. Another study showed improved functional outcomes in children with osteogenesis imperfecta after pamidronate therapy³⁹. Intramedullary fixation with use of Kirschner wires is protective against fractures, especially when the length of the wire relative to the total bone is >70%⁴⁰.

Amputations

Minor differences in clinical outcomes following transtibial and Syme amputations in children were noted, including better ankle power in the transtibial group and better coronal plane hip power in the Syme group⁴¹. Westberry et al. reviewed 109 children (117 limbs) who had undergone Boyd amputations and noted good functional results, although there was a 14% complication rate and 24% of patients required additional procedures for optimization of the residual limb⁴².

Upper-Limb Trauma and Reconstruction

Pediatric and Adult Trauma

By identifying the course of the radial nerve around the elbow with use of magnetic resonance imaging (MRI) scans in children, a safe corridor for placing superolateral pins in the distal part of the humerus was elucidated⁴³. Children with posttraumatic segmental metadiaphyseal humeral bone loss and an intact periosteal sleeve can reconstitute the skeletal defect following external fixation stabilization⁴⁴. Adolescents sustaining a posterolateral elbow dislocation may be predisposed to develop cubitus valgus⁴⁵. Based on a systematic review of forty studies on posttraumatic cubitus varus, Solfelt et al. noted an overall complication rate of 14.5%, with no single technique being substantially safer or more effective⁴⁶. Although authors have questioned the surgical accuracy in identifying the rotational axis of the elbow with use of intraoperative fluoroscopy⁴⁷, a hinged external fixator may be a viable option for managing complex fracture-dislocations of the elbow in the elderly⁴⁸. Zhang et al. reported on sixteen adult patients with an infected nonunion of the forearm (average post-debridement defect of 3.8 cm), who had a satisfactory clinical and radiographic outcome following bone transport with external fixation⁴⁹.

Pediatric and Adult Reconstruction

Based on a systematic review of distraction osteogenesis in hand surgery, a higher complication rate was noted among adults, especially when undergoing posttraumatic reconstruction⁵⁰. Derotation osteotomy of the forearm was effective in correcting pronation deformities in young children with congenital radioulnar synostosis^{51,52}. Although soft-tissue distraction facilitates centralization for congenital radial longitudinal deficiency, it does not prevent recurrence of deformity⁵³. In adults with radial longitudinal deficiency, factors such as grip strength, forearm length, and digital motion are more important for the individual's activity than radial angulation at the wrist⁵⁴. In patients with multiple hereditary exostoses and a dislocated radial head, comprehensive treatment including excision of the forearm osteochondromas and gradual lengthening of the ulna improved clinical and radiographic parameters⁵⁵.

Lower-Limb Trauma in Adults

Acute Trauma

In a prospective randomized study on the surgical treatment of complex knee dislocations with ligament reconstruction, the

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risk of delayed ligament failure was significantly lower ($p < 0.001$) with adjunctive hinged external fixation (7%) compared with a hinged knee brace (21%)⁵⁶. In another prospective randomized study involving sixty-eight adults with open tibial shaft fractures, treatment with biplanar external fixation compared with reamed locked intramedullary nailing had similar healing rates and functional outcomes one year postoperatively⁵⁷. Based on a review of 112 high-energy tibial fractures treated with either Ilizarov or Taylor Spatial Frame fixation, the time to union was similar in both groups (median, 163 days)⁵⁸. In a review of complex fractures (eleven femoral fractures and fifty-seven tibial fractures) that were not amenable to standard open reduction techniques, treatment with ring fixation resulted in a 93% union rate⁵⁹.

The use of free flaps may be avoided in certain Gustilo-Anderson type-IIIB open tibial fractures by performing acute shortening and angulation at the fracture site, with use of local muscle flaps, followed by gradual restoration of normal length and angulation with use of external fixation⁶⁰. High-energy distal femoral fractures managed with provisional external fixation had better functional outcomes when converted to internal fixation than those treated definitively with external fixation⁶¹. Shah et al. reported a significant difference ($p = 0.033$) in the prevalence of deep infection between patients who had subsequent plate fixation that overlapped previous external fixator pin sites (24%) and those in whom the temporary pins were placed beyond the future plate fixation sites (10%)⁶². Patients with extra-articular distal tibial fractures treated with circular external fixators demonstrated earlier weight-bearing and superior function compared with those managed with plate fixation⁶³. Erdil et al. reported better functional results (American Orthopaedic Foot & Ankle Society [AOFAS] score) in patients with extra-articular distal tibial fractures treated with external fixation without an additional foot ring⁶⁴. External fixation may also be a useful adjunct when treating severely comminuted pilon fractures with fracture reduction and primary ankle arthrodesis using plate fixation⁶⁵.

Bone Defects

Various devices and techniques have been utilized to address traumatic bone defects. Post-debridement bone defects secondary to defects following severe tibial shaft fractures were treated with compression of the skeletal gap and distant distraction for smaller-size defects⁶⁶ and segmental bone transport for larger defects using monolateral⁶⁷ or circular external fixation⁶⁸. Acute shortening of tibial defects of ≤ 4 cm displayed no arterial changes as monitored by intraoperative Doppler ultrasound and hallux pulse oximetry⁶⁹. Five patients with tibial non-unions and bone loss were treated successfully with acute shortening and bone-grafting and gradual lengthening over a nail via a corticotomy at a different portion of the affected tibia⁷⁰. Other reported methods for managing posttraumatic skeletal defects or voids include the induced membrane technique⁷¹, hybrid grafting using demineralized bone matrix and tricalcium

phosphate⁷², nonvascularized fibular strut bone grafts⁷³, combined Papineau debridement and Ilizarov bone transport with postoperative negative-pressure wound closure⁷⁴, epidermatofascial osteoplasty⁷⁵, and use of megaprotheses⁷⁶.

Adult Lower-Limb Reconstruction

High Tibial Osteotomy

Prognostic variables following high tibial osteotomy in active adults with symptomatic genu varum remain a topic of great interest. In a randomized controlled trial, Duivenvoorden et al. reported similar radiographic outcomes six years postoperatively among patients who had undergone opening-wedge high tibial osteotomy compared with those who had undergone closing-wedge high tibial osteotomy. The closing-wedge group had fewer complications than the opening-wedge group (9% compared with 38%), but greater prevalence of conversion to total knee arthroplasty (22% compared with 8%)⁷⁷. Based on ninety-five patients evaluated for ten years following closing-wedge high tibial osteotomy⁷⁸, improved survival was associated with a preoperative age of younger than fifty-five years, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores of >45 points, and a body mass index of <30 kg/m². At a mean follow-up time of 5.8 years, the majority of patients (mean age, fifty years) who had undergone opening-wedge high tibial osteotomy for medial compartment osteoarthritis were able to return to physical activities such as jogging and downhill skiing⁷⁹. In another study on eighty-four patients (ninety-nine knees) who had undergone opening-wedge high tibial osteotomy⁸⁰, poor outcome was associated with an age of more than fifty-six years and postoperative flexion of $<120^\circ$. Given the divergent findings of two recent studies^{81,82}, the preservation of lower-limb alignment that is achieved following opening-wedge high tibial osteotomy needs further investigation. Despite complications, a single-stage total knee arthroplasty and high tibial osteotomy with use of rigid fixation for patients with extra-articular frontal-plane tibial deformity may be a viable option⁸³.

Foot and Ankle Reconstruction

Deformity Analysis

Based on multiplanar weight-bearing imaging, the foot deformity associated with posterior tibial tendon dysfunction primarily involves the talonavicular joint in the sagittal plane⁸⁴. In a case-control study using weight-bearing radiographs, Nosewicz et al. noted that varus and valgus talar tilt in the frontal plane did not reliably predict sagittal and horizontal positions. The authors recommended that three-dimensional analysis be performed prior to surgical balancing of the talar malposition⁸⁵.

Deformity Correction

Various techniques have been utilized to achieve tibiotalar arthrodesis for posttraumatic and other indications. Using a compressing retrograde intramedullary nail in thirty patients

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with hindfoot and ankle deformities, Brodsky et al. reported a 96.6% fusion rate and substantial improvement in AOFAS ankle/hindfoot and Short Form-36 (SF-36) scores⁸⁶. Twenty-five patients with tibial shaft malunion or nonunion and ankle or hindfoot arthritis were treated with a single-stage tibial realignment osteotomy and hindfoot arthrodesis with use of a retrograde tibiotalar calcaneal nail, with improvement in pain and function reported in the majority of cases⁸⁷. The technique of combined simultaneous internal lengthening and arthrodesis with the Ilizarov technique was used in fifteen high-risk patients with end-stage hindfoot arthrosis and prior surgical failures. Union was achieved in 73%, although 20% of patients eventually required a below-the-knee amputation for recalcitrant nonunion⁸⁸. In a multicenter, nonrandomized prospective study comparing ankle arthroplasty and ankle arthrodesis in 321 ankles with end-stage ankle arthritis, at a mean follow-up of 5.5 years, similar patient-reported clinical outcomes were noted, although revision rates (17% for ankle arthroplasty compared with 7% for ankle arthrodesis) and major complications (19% for ankle arthroplasty compared with 7% for ankle arthrodesis) were higher following ankle replacement⁸⁹.

Complex midfoot deformities can be safely treated with use of minimally invasive Gigli saw osteotomies and circular external fixation with acute and gradual correction⁹⁰.

Charcot Arthropathy

A combination of internal and external fixation can be used for tibio-calcaneal arthrodesis in patients with nonbraceable Charcot deformity of the hindfoot⁹¹. In diabetic patients undergoing surgical correction for Charcot foot deformity with ring fixators, there is greater risk for a stress fracture of the tibia when half-pins (16.7%) instead of tensioned fine wires (1.5%) are used for tibial stabilization⁹².

Arthrodiastasis

In a study of 111 patients who underwent distraction treatment for severe osteoarthritis of the ankle, the failure rate as defined by revision surgery was 17% at two years, 37% at five years, and 44% at twelve years. Female sex and greater functional disability at baseline were poor prognostic factors⁹³.

Oncologic Reconstruction

The management of proximal femoral deformities secondary to fibrous dysplasia is challenging⁹⁴. Based on radiographs of 127 affected femora, Ippolito et al. described six distinct patterns of coronal plane deformities, noting a tendency for progressive angulation in those with varus deformity⁹⁵. Intramedullary fixation with stabilization of the femoral neck remains the standard of care for complex deformities in such patients⁹⁶. Distraction osteogenesis with external fixation for pathologic fractures through certain unicameral and aneurysmal bone cysts may heal the lesion, along with addressing limb deformities and shortening⁹⁷.

Gilg et al. cautioned that the multiplier method may overestimate the adult height in children with certain bone sarcomas by an average of 2.3 cm, perhaps related to growth inhibition following chemotherapy⁹⁸. There are several biologic surgical options for managing large intercalary defects following oncologic resection in adolescents and young adults. Several authors reported satisfactory outcomes using vascularized fibular grafts⁹⁹⁻¹⁰¹ and bone transport with external fixation¹⁰² for addressing such skeletal defects.

Stature Lengthening

Treatment of idiopathic short stature (at least two standard deviations less than the mean height for the age, sex, and population) remains controversial^{103,104}. Although such children can gain about 5 cm (2 inches) of adult height following exogenous growth hormone administration, long-term effects of this treatment are unknown¹⁰³. Short stature may also be associated with certain skeletal dysplasias such as achondroplasia¹⁰⁵. Although substantial gains in height (15 to 18 cm [6 to 7 inches]) have been achieved with bilateral femoral and tibial lengthening¹⁰⁶, comorbidities such as spinal stenosis¹⁰⁷, the possibility of treatment complications, and limited information regarding long-term functional outcomes should be considered before undertaking limb lengthening in such patients¹⁰⁸. Given the lack of evidence-based guidelines and the emerging popularity of internal limb-lengthening implants, the indications for stature lengthening are debatable. Studies evaluating the effect of limb lengthening on the physical and psychosocial health of individuals undergoing stature lengthening are strongly encouraged^{104,109-111}.

Postoperative Complications and Their Management

Pin-Site Infections

There is a lack of consensus with regard to strategies to manage pin-site infections following external fixation. To prevent bacterial adhesion and to create robust osseointegration, various pin coatings including nanosilver, antibiotic, hydroxyapatite, nitric oxide, and chitosan have been suggested¹¹². Cam et al. noted a lower prevalence of pin-site infection with the use of chlorhexidine (9.2%) compared with povidone-iodine (27.9%) for pin-site care¹¹³. Shirai et al. reported a 3.6% superficial infection rate with iodine-coated half-pins¹¹⁴.

Fractures and Poor Bone Formation

A 16% fracture rate following lengthening in patients with achondroplasia and hypochondroplasia was reported, with the majority of fractures occurring in the first several days after frame removal. Lateral or central callus formation was a risk factor for early fracture and a sclerotic regenerate was a risk factor for late fractures¹¹⁵.

The safety and efficacy of the off-label use of bone morphogenetic proteins (BMPs) in long bone nonunions and as an adjunct for arthrodesis were recently reviewed and the possibility of aseptic wound edema was highlighted¹¹⁶.

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Fourman et al. reported a significantly higher fusion rate ($p < 0.001$) with rhBMP (recombinant human BMP)-2 (93%) compared with controls (53%) in patients with comorbidities undergoing ankle arthrodesis¹¹⁷. Investigators compared the progenitor cell concentration of three commercially available bone marrow aspirate concentration systems and found that the Harvest SmartPrep 2 system was superior to the Biomet and Arterioocyte systems¹¹⁸. Hernigou et al. identified district sectors of the ilium for safe and effective procurement of bone marrow aspirate^{119,120}. Lee et al. performed a randomized, blinded controlled trial using platelet-rich plasma with bone marrow aspirate concentration for tibial lengthenings and demonstrated a small effect of improved bone-healing and earlier weight-bearing in the treatment arm. The clinical importance of these findings remains questionable¹²¹. A randomized study revealed a 27% reduction in external fixation time with the use of low-intensity pulsed ultrasound for tibial osteoplasty¹²². Using motorized external lengtheners with incremental lengthening 1400 times per day compared with manual lengthening four times per day showed no difference in time to union for tibial lengthenings¹²³.

Contractures and Joint Problems

A double-blinded randomized trial in patients undergoing bilateral tibial lengthening demonstrated no improvement in postoperative pain or ankle joint mobility following botulinum toxin A injection in the calf muscles of the experimental group¹²⁴. An average of 24° of dorsiflexion was gained after gastrocnemius-soleus complex recession during tibial lengthening, and recession was more likely to be needed in patients undergoing lengthenings of >42 mm and for congenital etiologies¹²⁵.

Miscellaneous

Complications are common in patients undergoing distraction osteogenesis and occurred in fifty-seven (77%) of seventy-four procedures in sixty-three patients. Based on multivariate analysis, patient age of eighteen years or older and a prolonged bone-healing index were identified as independent risk factors for complications¹²⁶. The risk for venous thromboembolism in adult patients undergoing elective limb lengthening and deformity correction is low and the authors suggested that given the expense and potential complications of chemoprophylaxis, routine use of such chemical agents may not be justified¹²⁷.

New Tools and Techniques

Imaging

A computer-based model suggested that in patients with hindfoot deformity, assessment of mechanical axis deviation using the ground reaction point of the hindfoot rather than the center of the ankle as the distal reference point may be more accurate¹²⁸. EOS imaging with three-dimensional reconstruction may be a reliable means of detecting segmental torsion of the lower extremities¹²⁹. EOS biplanar imaging yielded valid weight-bearing foot and ankle radiographic alignment parameters¹³⁰.

Computer-Aided Software

Normal lower-limb alignment was achieved in 85% of femoral deformities using a six-axis computer-aided fixator system compared with 55% of femoral deformities using a traditional Ilizarov apparatus. Furthermore, the correction time was reduced by 2.3 times for complex deformities in the six-axis correction group¹³¹.

Lengthening Using Intramedullary Nail

An osteotomy proximal to the bending point of a tibial nail may cause sagittal translation while performing tibial lengthening over a nail. Apparently, this translational deformity did not adversely affect bone-healing¹³².

Early successes indicate that the recent advent of reliable remote-controlled motorized lengthening nails is an exciting advancement in the field of orthopaedics¹³³. In a matched-pair study, patients undergoing femoral lengthening using a motorized intramedullary nail demonstrated better consolidation indices, better knee mobility, and decreased complication rates compared with conventional external fixation¹³⁴. In another study, lengthening goals were achieved in all twenty-four patients with use of the PRECICE magnetic intramedullary nail, with one implant-related complication¹³⁵. Schiedel et al. reported twenty-six procedures using the PRECICE nail; of these twenty-six implants, two broke and two failed to function¹³⁶. Another series included twenty-one patients with congenital limb shortening who were treated with use of the first-generation PRECICE nail and, although seven needed an unplanned return to the operating room, the nail reportedly lengthened in a reliable and controlled fashion¹³⁷. The magnetically activated PHENIX nail is another device that has been successfully used for lengthening and deformity correction of long bones¹³⁸. Femoral lengthening with acute deformity correction (5° to 22°) was performed in twenty-two patients with the retrograde FITBONE motorized femoral nail, with two patients having device-related complications¹³⁹. The use of the Intramedullary Skeletal Kinetic Distractor (ISKD) in thirty-five cases of intramedullary lengthening was associated with abnormal distraction rates in 60% of segments, with other complications occurring in 53% of patients¹⁴⁰. Authors of another study with twelve patients undergoing lengthening using the ISKD nail reported four cases (33%) of abnormal distraction rate among other complications¹⁴¹. Bone transport with a motorized intramedullary nail has also been reported¹⁴². Although there is cautious optimism with the new generation of lengthening nails, in-depth, patient-centered outcomes, comparative studies, and experience from other centers are needed before this technology is universally adopted over conventional techniques for limb lengthening and deformity correction.

Upcoming Events

The ILLRS (International Limb Lengthening and Reconstruction Society) Congress is planned for November 4 to 7, 2015, in Miami, Florida. LLRS Specialty Day will be held at the annual AAOS meeting on March 5, 2016, in Orlando, Florida. Details are available at the Limb Lengthening and Reconstruction Society (LLRS) web site: www.llrs.org.

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Evidence-Based Orthopaedics

The editorial staff of *The Journal* reviewed a large number of recently published research studies related to the musculoskeletal system that received a higher Level of Evidence grade. In addition to articles published previously in this journal or cited already in the Update, twelve other articles with a higher Level of Evidence grade were identified that were relevant to limb lengthening and deformity. A list of those titles is appended to this review after the standard bibliography. We have provided a brief commentary about each of the articles to help guide your further reading, in an evidence-based fashion, in this subspecialty area.

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- 142.** Kold S, Christensen KS. Bone transport of the tibia with a motorized intramedullary lengthening nail - a case report. *Acta Orthop.* 2014 Apr;85(2):211-3. Epub 2014 Jan 30.

Evidence-Based Articles Related to Limb Lengthening and Deformity Correction

- Aiona M, Do KP, Emara K, Dorociak R, Pierce R.** Gait patterns in children with limb length discrepancy. *J Pediatr Orthop.* 2015 Apr-May;35(3):280-4.
Using three-dimensional gait analysis for forty-three children with >2 cm of leg-length discrepancy, the location of the discrepancy (the femur compared with the tibia) affected the compensatory mechanisms and the amount of excessive energy expenditure.
- Bell JC, Wolf EJ, Schnell BL, Tis JE, Potter BK.** Transfemoral amputations: is there an effect of residual limb length and orientation on energy expenditure? *Clin Orthop Relat Res.* 2014 Oct;472(10):3055-61.
Although young adults with longer residual femoral stump (57% to 86% of intact femoral length) following posttraumatic amputations walked faster than those with shorter stumps, the authors were unable to find a demonstrable difference in energy expenditure between the two groups. However, this study may have been underpowered for detecting clinically important differences in energy expenditure, and femoral stump length was used as a dichotomous variable rather than as a continuous one.
- Bertol MJ, Van den Bergh R, Trelles Centurion M, Kenslor Ralph DH, Basimuoneye Kahutsi JP, Qayyum Qasemy A, Jean J, Majuste A, Kubuya Hangi T, Safi S.** Saving life and limb: limb salvage using external fixation, a multi-centre review of orthopaedic surgical activities in Médecins Sans Frontières. *Int Orthop.* 2014 Aug;38(8):1555-61.
Based on experience of the same humanitarian organization in three resource-challenged disaster regions at different time points, there was a progressive decrease in the rate of primary amputations compared with attempted limb salvage with external fixation for managing open fractures. Although the final clinical outcome and the rate of secondary amputations were not available, the authors stressed the importance of appropriate training and availability of external fixators for the front-line medical providers in such humanitarian medical missions.
- Das SP, Ganesh S, Pradhan S, Singh D, Mohanty RN.** Effectiveness of recombinant human bone morphogenetic protein-7 in the management of congenital pseudoarthrosis of the tibia: a randomised controlled trial. *Int Orthop.* 2014 Sep;38(9):1987-92.
In this small, prospective randomized study involving children (mean age, 4.1 years) with Crawford type-IV lesions, the addition of bone morphogenetic protein-7 (BMP-7) to intramedullary Kirschner wire fixation and autogenous bone graft did not improve the time to healing of the congenital tibial pseudoarthrosis.

- Dawson J, Kiner D, Gardner W 2nd, Swafford R, Nowotarski PJ.** The reamer-irrigator-aspirator as a device for harvesting bone graft compared with iliac crest bone graft: union rates and complications. *J Orthop Trauma.* 2014 Oct;28(10):584-90.
In this prospective, randomized, multicenter trial involving adult patients with posttraumatic nonunion or segmental bone defects, the rates of union and time to union were similar between the group treated with autograft obtained from the iliac crest and the group who had the graft harvested with use of the Reamer-Irrigator-Aspirator (RIA) device. There was less operative time and donor-site discomfort among patients in the RIA group.

- Demiralp B, Ege T, Kose O, Yurttas Y, Basbozkurt M.** Amputation versus functional reconstruction in the management of complex hind foot injuries caused by land-mine explosions: a long-term retrospective comparison. *Eur J Orthop Surg Traumatol.* 2014 May;24(4):621-6.
In this retrospective comparison of below-the-knee amputation and soft-tissue and skeletal reconstruction (using muscle flaps and distraction osteogenesis) for managing complex open hindfoot injuries caused by land-mine explosions, the authors reported that the reconstruction group had a better psychological profile despite needing to undergo more procedures.

- Karaman O, Ayhan E, Kesmezacar H, Seker A, Unlu MC, Aydingoz O.** Rotational malalignment after closed intramedullary nailing of femoral shaft fractures and its influence on daily life. *Eur J Orthop Surg Traumatol.* 2014 Oct;24(7):1243-7.
In this retrospective series of twenty-four patients with isolated femoral shaft fractures treated with antegrade femoral nailing, rotational malalignment of $\geq 10^\circ$ (using postoperative computed tomographic scans) was fairly common (42%). Functional limitations such as stair-climbing and anterior knee pain were more common in patients with rotational malalignment.

- Niinimäki T, Eskelinen A, Ohtonen P, Puhto AP, Mann BS, Leppilähti J.** Total knee arthroplasty after high tibial osteotomy: a registry-based case-control study of 1,036 knees. *Arch Orthop Trauma Surg.* 2014 Jan;134(1):73-7.
Based on a Finnish registry, the survivorship of total knee arthroplasty after high tibial osteotomy was 95.3% at five years, 91.8% at ten years, and 88.4% at fifteen years. Although these values were slightly lower (hazard ratio, 1.40) than age and sex-matched patients who had undergone primary arthroplasty without prior osteotomy, given the potential benefits of the osteotomy in younger patients, the authors were encouraged by the overall results.

- Pfztner T, Abdel MP, von Roth P, Perka C, Hommel H.** Small improvements in mechanical axis alignment achieved with MRI versus CT-based

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patient-specific instruments in TKA: a randomized clinical trial. *Clin Orthop Relat Res.* 2014 Oct;472(10):2913-22.

In this randomized trial, although the use of patient-specific instrumentation for total knee arthroplasty was associated with slightly superior radiographic limb alignment compared with the use of conventional instrumentation, there were no differences in the short-term clinical outcome between the groups. These findings make one question the added value of the more expensive patient-specific instrumentation for knee arthroplasty.

Portner O. High tibial valgus osteotomy: closing, opening or combined? Patellar height as a determining factor. *Clin Orthop Relat Res.* 2014 Nov;472(11):3432-40.

This retrospective case series suggested that a closing-wedge osteotomy had a tendency to create patella alta and an opening-wedge osteotomy may lead to patella infera, but a combined lateral closing-medial, opening-wedge osteotomy did not substantially alter the postoperative patellar height. The preoperative height of the patella should be considered when contemplating a high tibial osteotomy in adults with medial compartment arthritis associated with genu varum.

Preston S, Howard J, Naudie D, Somerville L, McAuley J. Total knee arthroplasty after high tibial osteotomy: no differences between medial and lateral osteotomy approaches. *Clin Orthop Relat Res.* 2014 Jan;472(1):105-10.

In this single-center, retrospective review, the functional outcomes and five-year survivorship for total knee arthroplasty after conversion from either a lateral closing-wedge high tibial osteotomy or a medial opening-wedge high tibial osteotomy was similar. Longer follow-up with prospectively collected data would be helpful to confirm these findings.

Samora JB, Klingele KE, Beebe AC, Kean JR, Klamar J, Beran MC, Willis LM, Yin H, Samora WP. Is there still a place for cast wedging in pediatric forearm fractures? *J Pediatr Orthop.* 2014 Apr-May;34(3):246-52.

In this case series, children with forearm fractures that were treated with wedging of the cast because of unacceptable angulation following closed reduction demonstrated improved radiographic alignment, especially in the sagittal plane. These results suggest that cast wedging may be a viable (and often forgotten) treatment option in the management of certain pediatric forearm fractures.