ORIGINAL ARTICLE

# Trends and Practices in Limb Lengthening: An 11-year US Database Study

Ashish Mittal[1], Sachin Allahabadi[2], Rishab Jayaram[3], Abhinav Nalluri[4], Matt Callahan[5], Sanjeev Sabharwal[6]

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## Abstract

**Aim:** Over the past couple of decades, limb lengthening has evolved to encompass various implants and techniques. The purpose of this study was to (1) determine trends in the utilisation of various limb lengthening techniques for the femur and tibia in the United States, (2) determine trends in 1-year readmission rate following limb lengthening procedures and (3) to study the relationship of limb lengthening implant used and payment method used with the underlying diagnosis associated with limb shortening.

**Materials and methods:** Inpatient data were acquired using the Healthcare Cost and Utilisation Project (HCUP) database from 2005 to 2015 from seven states in the United States. Patients with an International Classification of Diseases (ICD)-9 code for limb lengthening of the femur or tibia were included. A total of 2,563 patients were included. Data were analysed using descriptive statistics, and chi-square test was used for comparison of subcategories. Linear regression analysis was used to examine trends over time.

**Results:** There was a strong linear trend towards increasing proportional use of internal lengthening of the femur from 2011 to 2015 ($R^2 = 0.99$) with an increase of 10.2% per year. A similar trend towards increasing proportional use of internal lengthening of the tibia was seen from 2011 to 2015 ($R^2 = 0.87$) with an increase of 4.9% per year. There was a moderate correlation showing a decrease in readmission rate of 1.07% per year from 2005 to 2015 ($R^2 = 0.55$). Patients with short stature had increased use of internal lengthening and self-payment compared to patients with congenital, post-traumatic or other diagnoses.

**Conclusion:** There was increasing use of internal lengthening techniques from 2011 to 2015. Patients with short stature had higher use of internal lengthening technique and self-pay for payment method.

**Clinical significance:** Intramedullary devices have seen increasing use for limb lengthening procedures. Lengthening technique and payment method may differ by underlying diagnosis.


**Keywords:** Distraction osteogenesis, External fixator lengthening, Hybrid lengthening, Intramedullary lengthening, Lengthening nail, Limb lengthening, Motorised implantable nail, Short stature.

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## Introduction

Limb lengthening procedures have seen an evolution in indications and technique over time. While external fixation has traditionally been the implant of choice for limb lengthening,[1–9] issues with prolonged external fixation including soft tissue transfixation, pin tract infections, joint stiffness, poor cosmesis, and patient discomfort have led to the development of alternative techniques for limb lengthening.[6,9–20]

Fully implantable internal lengthening devices rely on an intramedullary nail to progressively lengthen bone using a variety of mechanisms and have certain advantages over external fixation.[10,15,21–28] Hybrid, or 'integrated', fixation involves the simultaneous or sequential use of internal with external fixation such as 'lengthening over nail', 'lengthening over a plate' or 'lengthening and then nailing' with stabilisation of the internal fixation construct and removal of the external fixator during the consolidation phase of lengthening.[29,30] While limb lengthening procedures have historically been found to have a high rate of adverse events, it is believed that the advent of these new techniques may have lowered the rate of complications.[31]

The choice of lengthening technique and device may also depend on the patient's underlying diagnosis. Patients with

[1,4]Department of Orthopedic Surgery, St. Mary's Medical Center, San Francisco, California, United States of America

[2,5]Department of Orthopedic Surgery, University of California, San Francisco, California, United States of America

[3]Department of Orthopedic Surgery, University of Rochester, Rochester, New York, United States of America

[6]Department of Orthopedic Surgery, University of California, San Francisco; UCSF Benioff Children's Hospital, Oakland, California, United States of America

**Corresponding Author:** Sanjeev Sabharwal, Department of Orthopaedic Surgery, University of California, San Francisco; UCSF Benioff Children's Hospital, Oakland, California, United States of America, Phone: +510 428 3238, e-mail: sanjeev.sabharwal@ucsf.edu

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**Conflict of interest:** None

**Ethical Approval:** No Institutional Review Board approval was sought for this study as it was performed utilising a publicly available database.

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severe post-traumatic or congenital deformities may require multiplanar correction with the use of external fixation or hybrid lengthening techniques.[32,33] Patients with short stature or only leg length discrepancy without large angular deformities may be more amenable to treatment with internal lengthening devices. As lengthening techniques have evolved over time, it is currently unknown whether there has been a concurrent increase in the number of lengthening for short stature.[34] In contrast to patients with limb length discrepancy, these surgeries may not qualify for reimbursement by certain insurance carriers.

Currently, despite advances in limb lengthening technology for varieties of indications, little data exist on trends in utilisation of each of these implants and techniques. The purpose of this study was to (1) determine trends in utilisation of different lengthening techniques for limb lengthening of the femur and tibia in the United States from 2005 to 2015, (2) determine trends in 1-year readmission rate following limb lengthening procedures from 2005 to 2015 and (3) to assess variability in limb lengthening techniques and payment type based on underlying diagnosis during this time period.

## Methods

Inpatient data were acquired using the Healthcare Cost and Utilisation Project (HCUP) database from 2005 to 2015 involving seven states that were available to us: New York, California, Florida, Maryland, North Carolina, Utah and Nebraska. The HCUP database is de-identified and has the largest collection of longitudinal hospital care data in the United States with all-payer, encounter-level information.[35] The database during this timeframe utilised International Classification of Diseases (ICD)-9 procedure and diagnoses codes and includes patient demographics, admission diagnoses, procedures performed and rates of hospital readmission. Only patients who were readmitted for at least one overnight stay were recorded as a readmission.

A total of 3,979 inpatient admissions with ICD-9 procedure codes for limb lengthening of the femur (78.35), limb lengthening of the tibia (78.37) and both from 2005 to 2015 in the states available to us were included for analysis. Ninety-seven admissions were excluded due to having procedure codes for partial, total or revision hip arthroplasty, or total or revision knee arthroplasty. There were 394 admissions that subsequently excluded from analysis as they involved repeated admissions of patients with previous hospitalisation data within the database. A total of 118 patients undergoing combined femoral and tibial lengthening were excluded, and 807 patients who did not fit into any categories for lengthening technique based on ICD-9 coding were excluded from analysis. This yielded 2,563 patients that were included in the study. Patients were categorised based on bone lengthened (femur or tibia), lengthening technique and underlying diagnosis. Type of health insurance was recorded for patients. Readmission within 365 days following the index lengthening procedure was also recorded.

### Classification of Lengthening Technique

Patients were classified as having internal-only, external-only or hybrid lengthening based on ICD-9 coding (Appendix 1).

### Classification of Underlying Diagnosis

Underlying diagnosis was determined using ICD-9 admission diagnosis codes and regrouped as congenital, post-traumatic, and short stature diagnoses (Appendix 2). Patients that did not fit into either of these categories were classified as having an 'other' diagnosis. For patients that fit multiple categories, the first recorded admission diagnosis was considered as the primary diagnosis.

Of the 1,086 patients that underwent femoral only lengthening, 42.1% (457 of 1,086) underwent internal lengthening, 37.8% (410 of 1,086) underwent external lengthening and 20.1% (219 of 1,086) patients underwent hybrid lengthening. Of the 1,477 patients that underwent tibial only lengthening, 13.7% (203 of 1,477) underwent internal lengthening, 68.9% (1,018 of 1,477) underwent external lengthening and 17.3% (256 of 1,477) underwent hybrid lengthening.

### Statistical Analysis

Data were summarised for descriptive analyses. Chi-square test was utilised to compare categorical variables. Linear regression was performed to evaluate trends over time with $R^2$ values reported. Data analysis was performed on STATA v16.1 (StataCorp; College Station, TX). The level of statistical significance was set at 0.05.

## Results

Using available data, internal lengthening was the most frequently (42.1%) used technique for femoral lengthening, while the vast majority (68.9%) of tibial lengthening were performed using external fixation only.

Figures 1 to 4 demonstrate trends in implants used for femoral and tibial lengthening procedures over the years included. There was a strong linear trend toward increasing proportional use of internal lengthening of the femur from 2011 to 2015 ($R^2$ = 0.99) with an increase of 10.2% per year (Fig. 1). There was a corresponding decrease in proportion of external lengthening of the femur from 2011 to 2015 ($R^2$ = 0.87) with a decrease of 9.3% per year (Fig. 2). There was similarly a strong trend towards increasing proportional use of internal lengthening of the tibia from 2011 to 2015 ($R^2$ = 0.87) with an increase of 4.9% per year (Fig. 3). This was coupled with a

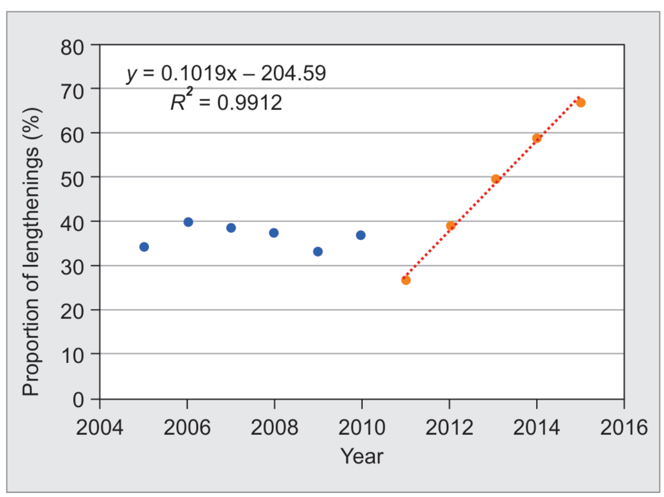


**Fig. 1:** Proportion of femoral lengthening procedures utilizing internal fixation from 2005 to 2015. Linear regression from the introduction of the PRECICE™ nail in 2011 and onwards demonstrates a strong linear fit ($R^2$ = 0.99) for increasing proportion of internal lengthening procedures

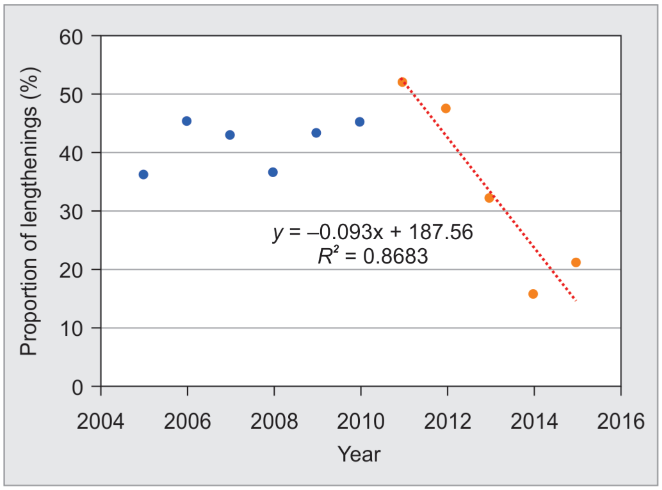


**Fig. 2:** Proportion of femoral lengthening procedures utilizing external fixation from 2005 to 2015. Linear regression from the introduction of the PRECICE™ nail in 2011 and onward demonstrates a strong linear fit ($R^2 = 0.87$) for decreasing proportion of external lengthening procedures

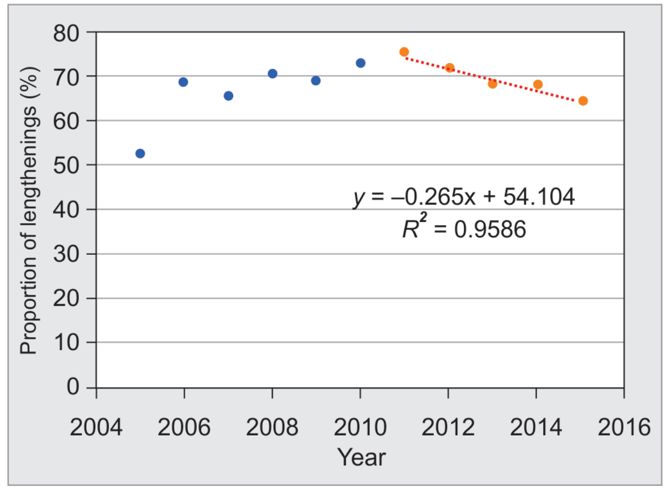


**Fig. 4:** Proportion of tibial lengthening procedures utilizing external fixation from 2005 to 2015. Linear regression from the introduction of the PRECICE™ nail in 2011 and onward demonstrates a strong linear fit ($R^2 = 0.96$) for decreasing proportion of internal lengthening procedures

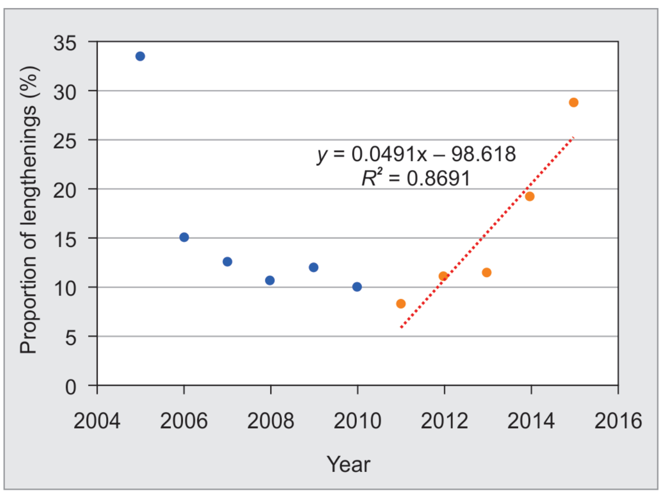


**Fig. 3:** Proportion of tibial lengthening procedures utilizing internal fixation from 2005 to 2015. Linear regression from the introduction of the PRECICE™ nail in 2011 and onward demonstrates a strong linear fit ($R^2 = 0.87$) for increasing proportion of internal lengthening procedures

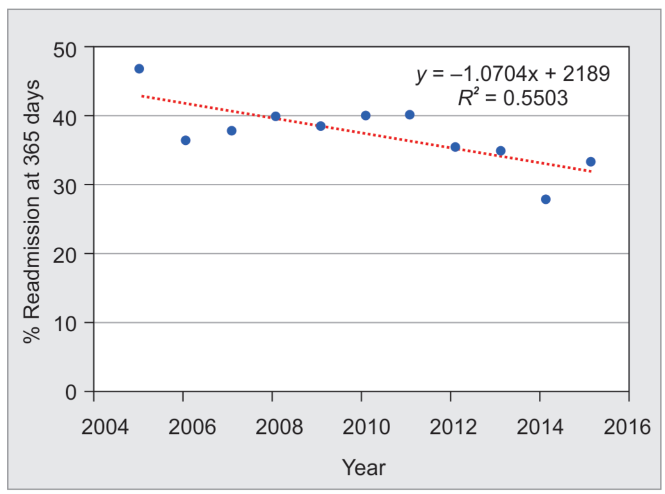


**Fig. 5:** This figure shows 365-day readmission rate from 2005 to 2015. There is a moderate linear fit ($R^2 = 0.55$) for decreasing readmission rate over time

decrease in proportion of external lengthening of the tibia from 2011 to 2015 ($R^2 = 0.96$) with a decrease of 2.7% per year (Fig. 4). There was no demonstrable trend in usage of hybrid lengthening devices.

The cumulative readmission rate over the study period was 37.3% (range: 28.0–46.9%). There was a moderate correlation showing a decrease in readmission rate of 1.07% per year from 2005 to 2015 ($R^2 = 0.55$) (Fig. 5).

When comparing techniques by underlying diagnosis, we found increased use of internal lengthening technique among patients undergoing lengthening for short stature when compared to patients with congenital, post-traumatic or other diagnoses (50.0% vs 23.6% vs 21.8% vs 27.5%; $p < 0.001$, Table 1). When comparing payment method by underlying diagnosis, we found that patients with short stature had a higher rate of self-payment compared to patients with congenital, post-traumatic and other diagnoses (25.0% vs 2.2% vs 3.2% vs 1.5%; $p < 0.001$, Table 2).

## Discussion

Based on our knowledge, this is the first study reporting on the trends in limb lengthening techniques using a national database. In this 11-year US-based study, we found a trend of increased proportional use of intramedullary lengthening devices and decreasing use of external fixator only devices in femoral and tibial lengthening from 2011 to 2015. We found a moderate correlation suggesting a slight reduction in the 1-year readmission rate per year among patients undergoing limb lengthening procedures. Furthermore, we noted that patients with an underlying diagnosis of short stature was associated with a greater use of an internal

**Table 1:** Proportional use of internal, hybrid and external lengthening for patients with congenital, post-traumatic, short stature and other diagnoses

| | *Internal (N = 660)* | *Hybrid (N = 475)* | *External (N = 1,428)* | *Total (N = 2,563)* |
|---|---|---|---|---|
| Congenital | 151 (23.6%) | 107 (16.7%) | 383 (59.8%) | 641 |
| Post-traumatic | 121 (21.8%) | 123 (22.2%) | 311 (56.0%) | 555 |
| Short stature | 28 (50%)* | 14 (25.0%) | 14 (25.0%) | 56 |
| Other | 360 (27.5%) | 231 (17.6%) | 720 (54.9%) | 1,311 |

*Significantly higher proportion of internal lengthenings with short stature on Chi-squared relative to each of congenital, post-traumatic and other diagnoses ($p < 0.01$ for each after Bonferroni correction)

**Table 2:** Proportional use of commercial insurance, government insurance, self-pay or other payor as payment method for patients with congenital, post-traumatic, short stature and other diagnoses

| | *Commercial (N = 1,590)* | *Government (N = 711)* | *Self-pay (N = 66)* | *Other payor (N = 196)* | *Total (N = 2,563)* |
|---|---|---|---|---|---|
| Congenital | 481 (75.0%) | 118 (18.4%) | 14 (2.2%) | 28 (4.4%) | 641 |
| Post-traumatic | 283 (51.0%) | 177 (31.9%) | 18 (3.2%) | 77 (13.9%) | 555 |
| Short stature | 35 (62.5%) | + | 14 (25.0%)* | + | 56 |
| Other | 791 (60.3%) | 411 (31.4%) | 20 (1.5%) | 89 (6.8%) | 1,311 |

*Significantly higher proportion of self-pay payment with short stature on Chi-squared analysis relative to each of congenital, post-traumatic and other diagnoses ($p < 0.0001$ for each after Bonferroni correction); + indicates values less than 10 (Details not published as per HCUP guidelines)

lengthening technique and were more likely to utilise self-pay as their payment method.

The trend of increasing use of internal lengthening from 2011 and 2015, while not previously reported, is consistent with corresponding innovations in intramedullary lengthening technology. The PRECICE™ nail was first approved for use by the FDA in 2011 and represented an attractive alternative method to external fixation for limb lengthening. At the time of its approval, the PRECICE™M nail was the only FDA-approved intramedullary lengthening device in the US due to recall of the ISKD™M in 2011. Suggested advantages of the PRECICE™ nail over alternative internal lengthening technologies included lengthening and shortening capability, superior rate control with distraction, improved strength of the nail and a wider range of size options for patients.[36] Several studies showed early promising results with PRECICE™ lengthening for adult and paediatric patients with improved cosmesis, better patient satisfaction and lower complication rates.[36–40] Furthermore, post-operative pain has been stated to be lower among patients undergoing PRECICE™ lengthening compared to its predecessors due to improved implant design and patient tolerance. Early reported complications with the PRECICE™ nail were infrequent but included preliminary breakages through the welds of the first-generation (P1) nail and failure to distract in select cases; these were addressed with a redesign of the nail (P2) that was introduced in 2013.

We noted that the increasing use of intramedullary lengthening was coupled with a corresponding decreasing use of external fixator lengthening from 2011 to 2015. While external fixator lengthening remained popular for lengthening during this time, issues with patient comfort and cosmesis likely contributed to the use of alternatives devices where feasible. Studies during this time suggested a lower rate of complication with internal lengthening compared to external lengthening.[22] The use of intramedullary lengthening has limited applications in patients with multiplanar deformities, history of infection, larger magnitude of deformities and paediatric patients with bones too small or open growth plates to accommodate a lengthening nail. Furthermore, concerns with newer devices including device-related corrosion and radiolucency formation may limit the use of internal lengthening devices in favour of external lengthening.[36–42]

The trend in increasing use of internal lengthening and decreasing use of external lengthening was nearly double in femoral lengthening procedures compared to tibial lengthening procedures. This is likely attributed to better patient tolerance of internal lengthening, especially with the femur and more limited use of internal lengthening with the tibia. With femoral lengthening procedures, an external fixator is more poorly tolerated compared to the tibia due to the larger soft tissue envelope of the femur and greater potential limitations in hip and knee range of motion. Furthermore, the limited increase in use of internal lengthening for the tibia may be secondary to lack of application in skeletally immature patients, and concerns with secondary deformities and poor regenerate formation with a proximal meta-diaphyseal tibial osteotomy.[43,44]

When comparing lengthening techniques based on underlying diagnosis, we found a greater use of internal lengthening techniques for patients with a diagnosis of short stature. Stature lengthenings are more likely to be amenable to internal lengthening, often due to the lack of associated limb deformity.[45] Furthermore, bilateral stature lengthenings are more amenable to internal lengthening or hybrid techniques compared to external fixator lengthening to allow for greater patient comfort and ease of rehabilitation.[46] In contrast, patients with congenital, post-traumatic, and other diagnostic categories are more likely to have complex multiplanar deformities requiring external fixator use. We noted similar use of internal lengthening between patients in other diagnosis categories. Patients with short stature were also more likely to have self-pay as their payment method. This may be attributed to lack of insurance coverage for lengthening procedures in this population, especially in those without any underlying aetiology such as skeletal dysplasia.

There was a moderate correlation ($R^2 = 0.55$) between readmission rate by year, with a linear model reduction in admission rate by approximately 1.07% each year (range: 28.0–46.9%). Previous studies reporting complications following limb lengthening procedures have noted rates ranging from 10 to 182%.[6–9,12,24,47–59] High variability in the rate of reported complications in the prior studies may also be attributed to differing definitions of categorizing complications. As many complications do not require readmission, our reported rates of readmission are understandably lower than the complication rates reported in most other studies. Although unconfirmed, slight decrease in readmission rates may be attributed to improvements in lengthening techniques and devices. Based on limited case series, the PRECICE™ nail has been reported to have lower reported rates of overall complications compared to some other internal and external devices.[34–37] Furthermore, improvements in technologies and better understanding of the pitfalls associated with limb lengthening may account for slight decreases in readmission during the study period.[32,60] Despite these changes, however, there remained a substantial rate of readmission during the study period.

There are several limitations to this study. First, our groupings based on aetiology and lengthening technique were based on the ICD-9 coding system, making the data lack granularity and be inherently subject to coding errors. Moreover, we were unable to ascertain information such as severity of the limb deformity and amount of lengthening, which are important variables that can impact the choice of lengthening technique, complication rates and need for readmission.[32,61] Our readmission data were limited to one year following the index lengthening procedure, which precludes information on complications and procedures performed at later time points. Furthermore, same day procedures such as implant removal were not included in this inpatient database study. Our data were limited to 2015, as this was the year that ICD-9 coding was transitioned to ICD-10. Due to significant changes in the coding system, we elected to avoid including combined ICD-9 and ICD-10 data. Further studies should expand on trends in limb lengthening from 2016 onwards. We excluded combined femoral and tibial lengthenings since the number of patients in this group ($n$ = 118) was substantially smaller than the cohorts in the femoral (1,086) and tibial (1,477) lengthening groups. We felt that these were inadequate numbers to elucidate true differences in trends between combined lengthenings and the individual femur and tibial lengthening groups. While we did not consider lengthening technique by age as a part of this study, we did consider lengthening based on underlying diagnosis (congenital, post-traumatic and other) which sheds light on possible differences that may exist between these patient cohorts. A recently published study by our group on this project includes this information regarding lengthening technique used with respect to paediatric and adult patients.[62] Finally, our data were also limited to lengthening done in certain states in the United States with lack of longitudinal data in some states, which limit the generalizability of our study, both nationally and internationally.

## Conclusions

There was increasing use of internal lengthening techniques from 2011 to 2015, with a corresponding decrease in the use of external lengthening. Patients with a diagnosis of short stature were associated with a greater use of internal lengthening technique and self-pay for payment method. We found a moderate trend in decreasing readmission rate by year, but with a high overall rate of readmission across the study period. The reported information from our preliminary study can serve as a guide for future investigators to study trends in the use of limb lengthening techniques and readmission rates in different patient populations.

### Clinical Significance

The introduction of newer intramedullary lengthening technology in the past decade may have resulted in greater use of internal lengthening techniques and decreasing use of external lengthening techniques. An underlying diagnosis of short stature may be associated with greater use of internal lengthening and self-payment relative to patients with other diagnoses.

## Orcid

*Sachin Allahabadi* https://orcid.org/0000-0002-1185-3039
*Sanjeev Sabharwal* https://orcid.org/0000-0003-3779-1419

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## Appendix 1: Classification of Lengthening Technique based on ICD-9 Coding

| | *ICD-9 code* | *Description* |
|---|---|---|
| Internal limb lengthening | 84.53 | Implantation of internal limb lengthening device with kinetic distraction |
| | 84.54 | Implantation of other internal lengthening device |
| | 78.55 | Internal fixation of the femur without fracture reduction |
| | 78.57 | Internal fixation of the tibia without fracture reduction |
| External limb lengthening | 78.15 | External fixator application of the femur |
| | 78.17 | External fixator application of the tibia |
| Hybrid limb lengthening | 78.15 and/or 78.17 + 78.55 and/or 78.57 | External fixator application of the femur and/or tibia + internal fixation without fracture reduction of the femur and/or tibia |

## Appendix 2: Classification of Preoperative Diagnosis based on ICD-9 Coding

| | ICD-9 code | Description |
|---|---|---|
| Congenital | 754.40 | Genu recurvatum |
| | 754.41 | Congenital dislocation of knee (with genu recurvatum) |
| | 754.42 | Congenital bowing of the femur |
| | 754.43 | Congenital bowing of the tibia and fibula |
| | 754.44 | Congenital bowing of unspecified long bones of the leg |
| | 755.30 | Unspecified reduction deformity of the lower limb |
| | 755.31 | Transverse deficiency of the lower limb |
| | 755.32 | Longitudinal deficiency of the lower limb, not elsewhere classified (NEC) |
| | 755.33 | Longitudinal deficiency, combined, involving the femur, tibia and fibula (complete or incomplete) |
| | 755.34 | Longitudinal deficiency, femoral, complete or partial (with or without distal deficiencies, incomplete) |
| | 755.35 | Longitudinal deficiency, tibiofibular, complete or partial (with or without distal deficiencies, incomplete) |
| | 755.36 | Longitudinal deficiency, tibia, complete or partial (with or without distal deficiencies, incomplete) |
| | 755.37 | Longitudinal deficiency, fibular, complete or partial (with or without distal deficiencies, incomplete) |
| | 755.4 | Reduction deformities, unspecified limb |
| | 755.60 | Unspecified anomaly of the lower limb |
| | 755.61 | Coxa valga, congenital |
| | 755.62 | Coxa vara, congenital |
| | 755.63 | Other congenital deformity of the hip (joint) |
| | 755.64 | Congenital deformity of the knee (joint) |
| | 755.69 | Other congenital anomaly |
| | 755.8 | Other specified anomalies of unspecified limb |
| | 756.89 | Other congenital diagnoses |
| Post-traumatic | 733.14 | Pathologic fracture of the neck of femur |
| | 733.16 | Pathologic fracture of the tibia and fibula |
| | 733.81 | Malunion of fracture |
| | 733.82 | Non-union of fracture |
| | 820.00 | Fracture of the neck of femur<br>transcervical fracture, closed intracapsular section, unspecified |
| | 820.01 | Fracture of the neck of femur<br>transcervical fracture, closed transepiphyseal |
| | 820.02 | Fracture of the neck of femur<br>transcervical fracture, closed transcervical NOS |
| | 820.03 | Fracture of the neck of femur<br>transcervical fracture, closed cervicotrochanteric section |
| | 820.09 | Fracture of the neck of femur<br>transcervical fracture, closed other (the head of femur or subcapital) |
| | 820.10 | Fracture of the neck of femur<br>Transcervical fracture, open<br>Intracapsular section, unspecified |
| | 820.11 | Fracture of the neck of femur<br>Transcervical fracture, open transepiphyseal |
| | 820.12 | Fracture of the neck of femur<br>Transcervical fracture, open transcervical not otherwise specified (NOS) |
| | 820.13 | Fracture of the neck of femur<br>Transcervical fracture, open cervicotrochanteric section |
| | 820.19 | Fracture of the neck of femur<br>transcervical fracture, open other (the head of femur or subcapital) |

*(Contd...)*

**Appendix 2:** (*Contd...*)

| ICD-9 code | Description |
|---|---|
| 820.20 | Fracture of the neck of femur<br>Pertrochanteric fracture, closed trochanteric section, unspecified |
| 820.21 | Fracture of the neck of femur<br>Pertrochanteric fracture, closed intertrochanteric section |
| 820.22 | Fracture of the neck of femur<br>Pertrochanteric fracture, closed subtrochanteric section |
| 820.30 | Fracture of the neck of femur<br>Pertrochanteric fracture, open trochanteric section, unspecified |
| 820.31 | Fracture of the neck of femur<br>Pertrochanteric fracture, open intertrochanteric section |
| 820.32 | Fracture of the neck of femur<br>Pertrochanteric fracture, open subtrochanteric section |
| 820.8 | Fracture of the neck of femur<br>Unspecified part of the neck of femur, closed |
| 820.9 | Fracture of the neck of femur<br>Unspecified part of the neck of femur, open |
| 821.00 | Fracture of other and unspecified parts of the femur, closed; Unspecified part of femur |
| 821.01 | Fracture of other and unspecified parts of femur, closed; Shaft |
| 821.10 | Fracture of other and unspecified parts of the femur, open; Unspecified part of the femur |
| 821.11 | Fracture of other and unspecified parts of femur, open; Shaft |
| 821.20 | Fracture of other and unspecified parts of the femur;<br>Lower end, closed unspecified part |
| 821.21 | Fracture of other and unspecified parts of the femur;<br>Lower end, closed; Condyle, femoral |
| 821.22 | Fracture of other and unspecified parts of the femur;<br>Lower end, closed; Epiphysis, lower (separation) |
| 821.23 | Fracture of other and unspecified parts of the femur;<br>Lower end, closed; Supracondylar fracture of femur |
| 821.29 | Fracture of other and unspecified parts of the femur;<br>Lower end, closed; Other |
| 821.30 | Fracture of other and unspecified parts of the femur;<br>Lower end, open unspecified part |
| 821.31 | Fracture of other and unspecified parts of the femur;<br>Lower end, open; Condyle, femoral |
| 821.32 | Fracture of other and unspecified parts of the femur;<br>Lower end, open; Epiphysis, lower (separation) |
| 821.33 | Fracture of other and unspecified parts of the femur;<br>Lower end, open; Supracondylar fracture of femur |
| 821.39 | Fracture of other and unspecified parts of the femur;<br>Lower end, open; Other |
| 823.00 | Fracture of the tibia and fibula<br>Upper end, closed tibia alone |
| 823.01 | Fracture of tibia and fibula<br>Upper end, closed fibula alone |
| 823.02 | Fracture of tibia and fibula<br>Upper end, closed fibula with tibia |
| 823.10 | Fracture of tibia and fibula<br>Upper end, open tibia alone |
| 823.11 | Fracture of tibia and fibula<br>Upper end, open fibula alone |
| 823.12 | Fracture of tibia and fibula<br>Upper end, open fibula with tibia |

| | |
|---|---|
| 823.20 | Fracture of tibia and fibula shaft, closed tibia alone |
| 823.21 | Fracture of tibia and fibula shaft, closed fibula alone |
| 823.22 | Fracture of tibia and fibula shaft, closed fibula with tibia |
| 823.30 | Fracture of tibia and fibula shaft, open tibia alone |
| 823.31 | Fracture of tibia and fibula shaft, open fibula alone |
| 823.32 | Fracture of tibia and fibula shaft, open fibula with tibia |
| 823.40 | Fracture of tibia and fibula Torus fracture, tibia alone |
| 823.41 | Fracture of tibia and fibula Torus fracture, fibula alone |
| 823.42 | Fracture of tibia and fibula Torus fracture, fibula with tibia |
| 823.80 | Fracture of tibia and fibula unspecified part, closed tibia alone |
| 823.81 | Fracture of tibia and fibula unspecified part, closed fibula alone |
| 823.82 | Fracture of tibia and fibula unspecified part, closed fibula with tibia |
| 823.90 | Fracture of tibia and fibula unspecified part, open tibia alone |
| 823.91 | Fracture of tibia and fibula unspecified part, open fibula alone |
| 823.92 | Fracture of tibia and fibula unspecified part, open fibula with tibia |
| 824.0 | Fracture of the ankle; medial malleolus, closed |
| 824.1 | Fracture of the ankle; medial malleolus, open |
| 824.2 | Fracture of the ankle; lateral malleolus, closed |
| 824.3 | Fracture of the ankle; lateral malleolus, open |
| 824.4 | Fracture of the ankle; Bimalleolar, closed |
| 824.5 | Fracture of ankle; Bimalleolar, open |
| 824.6 | Fracture of the ankle; Trimalleolar, closed |
| 824.7 | Fracture of ankle; Trimalleolar, open |
| 824.8 | Fracture of the ankle; unspecified, closed |
| 824.9 | Fracture of the ankle; unspecified, open |
| 827.0 | Other, multiple and ill-defined fractures of lower limb, closed |
| 827.1 | Other, multiple and ill-defined fractures of the lower limb, open |
| 928.10 | Crushing injury of the lower limb; lower leg |
| 928.11 | Crushing injury of the lower limb; knee |
| 928.21 | Crushing injury of the lower limb; ankle |