Cosmetic Stature Lengthening Frequently Asked Questions (FAQ’s)  (Please read this document carefully as it contains the answers to most of your questions)

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Address: Kimmel Building, 901 45th St , West Palm Beach, 33407, Florida, USA
Frequently Asked Questions (FAQ's)

Who requests this operation?

The majority of people who seek this surgery are unhappy with their body image. Body image is the way we perceive ourselves. As it relates to height it is the way we perceive our own height and our body proportions (limb length relative to trunk length).

Is there a name for this condition?

The psychologist that I worked with for over 20 years and who evaluated almost all of my patients with this condition between 1988 and 2008, Dr. Walter Windisch, called this condition Height Dysphoria (Dysphoria literally means unhappy, the opposite of euphoria). In other words unhappy with your height. Another term that has been used is one I coined; Height Neurosis.

There is also a rarer version of Height Dysphoria, which is body dysmorphic disorder. This is not a neurosis but is actually a psychosis. It is very important to differentiate the two. The latter should not be treated with surgery.

What is the normal range of adult height in the population?

When assessing distribution of height in the population, we consider the normal bell curve. We divide people by distribution around the mean (average). Normal height is considered ± 3 standard deviations (SD) from the mean. Stature below 3 SD from the mean in persons without a medical condition such as dwarfism or growth hormone deficiency is considered constitutional short stature. A physician defines the normal range of height between the 5th and 95th percentiles. The lower limit of so-called normal stature for men is 5'5" (166 cm) and for women is 5'0" (153 cm).

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**What is the relationship of height to Height Dysphoria**

While a person’s actual height is related to the condition there is no height threshold under which you cannot suffer from height dysphoria. Most of us would assume that you could only suffer from Height Dysphoria if you are ‘short’. The problem is that the perception of who is short varies from person to person. That threshold differs along racial, national and cultural lines: 5’10” is tall in India but short in Holland.

The following anecdote illustrate the point: A man flew all the way from Holland to see me regarding stature lengthening. He was 5’11” tall. He said that since he was a teenager he has suffered from feeling short. He is the shortest male in his family and even his sister is his height. All of his friends are much taller. He reminded me that the Dutch are the tallest people in the world. He is the same height as me. I have never perceived myself as short nor have any of my family or friends. I therefore had difficulty considering him for stature lengthening. I sent him for psychologic evaluation. The psychologist report showed he suffered from the same body image problem as all of the other patients we had evaluated. Despite his seemingly tall height he suffered from Height Dysphoria.

When we studied the relationship of starting height to the diagnosis of Height Dysphoria we found that patients starting height varied from 4’10” to 5’11” for males and 4’6” to 5’8” for women. While more of the patients were at the lower end of this spectrum, the fact that some were at the upper end clearly demonstrated that height is not the primary problem. The primary problem is the psyche’s perception of height and proportion.

**Is there a height threshold above which stature lengthening is not appropriate?**

Based on the above findings the answer should be no. I have learned to remove my personal bias regarding height from the evaluation. It is the patient’s perception that counts. As regards risks of the procedure they are no greater if you are taller. In fact they should theoretically be less since the percent increase in length of a longer bone is less.

**What method do we use for stature lengthening?**

At the Paley Institute we use the most cutting edge technology available in the world today. We use implantable limb lengthening for stature lengthening. This involves inserting a telescopic intramedullary nail (tube-like device into the marrow cavity of the bone). The best device available today is the PRECICE from Ellipse Technologies. It is currently the only FDA approved device on the market. The Precice has
excellent rate control and patients claim has little pain associated with the lengthening process. The Precice is the only device on the market that has a reverse mechanism. The ability to go reverse is a very important safety feature.

**How much height can I gain with the Precice?**

Most patients desire 3 inches (7.5cms) of stature gain and some more than that. The PRECICE2 (developed through collaboration of Ellipse with Dr. Paley) is now FDA approved for use. The Precice2 can lengthen 8cms. Patients who want more than this should consider a second lengthening of the other bone (femur first and then tibia second or vice versa). The total height gain with two lengthenings is up to 14.5cms (8cms in the femurs and 6.5cms in the tibias. (8cms is not well tolerated in the lower leg and exceeding 6.5cms can lead to more serious complications). Of course the cost of two lengthenings is twice that of one lengthening. Although the device can go to 8cms, not every patient can safely achieve this much. We will only allow lengthening to the tolerance of the patients bone and soft tissues.

**What is the safe amount that can be lengthened and why can more length not be done?**

The limits of lengthening are the soft tissues. The risk of complications from lengthening increase with increased length. Up to 5cms is a low risk lengthening. Between 5-8cms is medium risk and over 8cms is high risk. For example to achieve 10cms of lengthening it is much safer to lengthen the femur and tibia each by 5cms than to lengthen either bone by 10cms.

**What are the advantages of the new Precice2**

The Precice1 was developed by Ellipse Technology working with a team of orthopedic surgeons including Dr. Paley. Precice1 was designed for the treatment of leg length discrepancy. The Precice2 was spearheaded and developed by Dr. Dror Paley and Ellipse Technologies with the special considerations of the stature lengthening patients in mind. As such it is the first implantable nail to be designed towards the requirements of the stature lengthening patient. The Precice2 can lengthen up to 8cms for implant diameters of 8.5mms, 10.7mms, and 12.5mms. The Precice2 8.5mm nails was designed with smaller diameter bones in mind. These are normally found in children, patients with dwarfism and more petite adults (often seen in the bones of many Asian women). The strength of the Precice2 is up to 4 times stronger allowing for increased weightbearing. Furthermore, the driveshaft connection strength has been increased in strength by up to three fold which will reduce the risk of nail mechanism failure when a patient makes excessive bone which can prematurely consolidate (heal) and arrest the lengthening process. In short, the Precice2 permits greater lengthening with a stronger nail, stronger drive shaft with a larger diameter size range to accommodate all size patients.
What is the cost of surgery and physical therapy by the Precice method?

The cost of surgery with physical therapy is $85,000 (Precice2) for bilateral femoral lengthening and $95,000 for bilateral tibial lengthening (Precice 2). For individuals who undergo femoral lengthening followed by tibial lengthening we offer a package price of $170,000 (Precice 2). In some select individuals we will consider simultaneous femur and tibia lengthening at one surgery for a total cost of $150,000. Please note that there is a higher risk for fat embolism which can lead to death if both femur and tibia devices are inserted at one time. Although we have never had this complication, it remains a serious theoretical risk. It remains safer to do the two lengthening surgeries on separate dates separated by at least two to three weeks apart.

Are there any additional unexpected costs from the initial surgery?

Some patients require a fascia or tendon lengthening to PREVENT complications. The need for this is determined at the first consultation. Dr. Paley performs three muscle length tests (Ober test, Popliteal Angle measurement, and Ely test) to determine if the iliotibial band-fascia lata, hamstrings, and rectus femoris muscles are too tight. It is not possible to advise a patient of this without seeing them first. The greater the amount of lengthening the more likely is the need for such soft tissue releases. For example, every patient with an 8cm lengthening requires an iliotibial band release while only 50% require this if less than 5cms is carried out. The additional cost for these ranges from $5000 for iliotibial band only vs $7500 for iliotibial band plus hamstrings, if needed. For tibial lengthening if the Achilles tendon is too tight as determined by the Siverskiold test (physical examination) then a gastro-soleus recession is required prior to lengthening (additional cost of $5000). If these structures are tight before surgery and not prophylactically lengthened then muscle/joint contractures that require later more expensive surgery are required (in the lay literature these are referred to as duck ass deformity for tight iliotibial band and fascia lata, and ballerina feet for tight Achilles tendon). Prophylactic anterior compartment release is often done at the time of tibial lengthening. There is no additional charge for this procedure. This is done to prevent compartment syndrome.

Will insurance pay for cosmetic stature lengthening surgery?

Cosmetic surgery of any kind is not covered by medical insurance. Therefore cost is probably the number one limiting factor for most individuals seeking cosmetic stature lengthening. Not only will insurance not pay for the surgery, but, if a complication arises that requires additional surgery, insurance will not pay for the costs associated with treating the complication.

Can I get the surgery cheaper in other countries and is it safe?

Costs vary by country, center, surgeon and technique. The cost of the device contributes a lot to the cost of the procedure. External fixators while expensive when new can be reused. Therefore the cost of reused external fixators is very
cheap. The experience undergoing this surgery with bulky painful external fixators, with all of their complications including infections, joint stiffness, and scars cannot be compared to having the procedure done with the newest, safest technology with few scars and little pain. Many patients choose to go overseas for treatment only because of cost. There are many centers where you put yourself at risk of disaster and permanent disability. I have had to fix the complications of surgery of many of these patients that had lengthening done overseas. Since this surgery is very lucrative it is open to abuse all over the world including in the US. It is very difficult for the consumer to discern where to go. All limb lengthening surgeons or centers are not the same. Just because it is cheaper does not mean that the patient will get the desired result. I have come to the conclusion that in many cases you get what you pay for. While the cost in the US is higher the safety factor is also proportionally higher. In the past 5 years I have seen and operated upon 20 American and foreign patients who went to have cosmetic stature lengthening at overseas less expensive centers. The cost to reconstruct and ‘rescue’ their limbs was as high or higher than the cost to undergo the procedure at the Paley Institute in the first place. The final result although improved after I operated upon these patients is not as good as if I had done the surgery originally. Finally, the Precice is the most advanced method and safest method for cosmetic lengthening with less pain and lower complications than other methods.

**How experienced is the Paley Institute at limb lengthening?**

Dr. Dror Paley is the most experienced limb lengthening surgeon in the world for both stature lengthening and for lengthening for limb length discrepancy. He has performed over 17,000 limb lengthening surgeries since 1986. He has the best track record of success with all types of limb lengthening. This is very important as regards safety.

**What is the most important consideration when choosing a limb lengthening surgeon and center?**

SAFETY is number ONE. Limb lengthening can lead to many complications. Unlike other cosmetic surgery, limb lengthening can lead to chronic pain and disability. Therefore the most important factor to consider is NOT COST, but rather safety. There are many centers around the world offering stature lengthening at cheaper prices than at the Paley Institute. There are no other centers offering limb lengthening as safely as at the Paley Institute. SAFETY is the most important consideration when choosing where to go. Safety comes from EXPERIENCE and organization. At the Paley Institute we provide the most experienced limb lengthening team in the world with the best safety track record in the world. The multidisciplinary organized team of surgeons, anesthesiologists, medical doctors, nurses, physician assistants, physical and occupational therapists, orthopedic technologists, etc. all of which are dedicated to the limb lengthening process make this process safe, secure and as streamlined as possible.
Can I get financing to help pay for the surgery?

We do not provide financing. However, we can give you the name of one or two financing companies to contact directly. For this info please contact our practice administrator Craig Nesta cnesta@lengthening.us

What is covered in the cost of surgery?

1) Hospital stay for up to 4 days. There is a surcharge for patients staying longer than this
2) All hospital charges relating to the operating room and recovery room
3) Implant costs: Two PRECICE lengthening rods. Each Precice costs $13,000 Therefore just the cost of the implants for bilateral implantable lengthening implants is $26,000.
4) Anesthesiologist fees
5) Surgeons fees
6) Surgery assistant fees
7) Hospitalist fees (internal medicine doctor available during the entire hospital stay)
8) Radiologist fees
9) All x-rays: femurs- up to 9 weeks (surcharge after 9 weeks); tibias- up to 13 weeks (surcharge after 13 weeks)
10) All office visits: femurs- up to 11 weeks PRECICE2; tibias- up to 13 weeks PRECICE2 (surcharge after 13 weeks)
11) Transportation to and from the office and hospital (5 days per week) for office visits if you stay at one of the approved extended stay hotels (see list below)
12) Wheelchair, walker, crutches and bedside commode as needed for post surgery; provided as part of discharge from hospital.

What is covered in the physical therapy fees?

1) Daily, 5 days per week, one hour of physical therapy at the PALLI outpatient rehab center (there is no PT on weekends); femurs- up to 11 weeks PRECICE2 (surcharge after 11 weeks); tibias- up to 13 weeks PRECICE2 (surcharge after 13 weeks).  
2) Transportation to and from the PT center to extended stay hotels on the approved list. PT is located next to our office and on the grounds of the hospital campus.

What is not covered?

1) Medications and pharmaceuticals (pain medicine and anticoagulants)
2) Accommodations in West Palm Beach
3) Travel to and from WPB
4) Travel to the hospital on weekends (although the hotel shuttles will usually provide this for free)
5) Food and other supplies during the stay in WPB
6) Entertainment or Internet
7) Home health aids (nurses, homemaker, etc)

When do I have to send the payment and do I need to leave a deposit to hold the surgery date?

Full payment is due two weeks before surgery or the surgery will be cancelled. Payment can be made by wire transfer or certified check but not by credit card. A non-refundable deposit of $10,000 is due at least six weeks before surgery. The deposit can be made by credit card on the phone or by wire transfer. We will not hold a surgery date for more than 3 days without a deposit. *Cancellation or change of surgery date by the patient or their family with less than six week notice results in loss of the deposit.* The deposit is fully refundable if changes or cancellation of surgery are more than six weeks before the booked surgery date. The deposit money is part of the total fee and will be credited to the total amount due if it is not lost due to late cancellation or changes. In the case of late cancellation, rebooking of surgery will require another deposit.

How much money should I keep in reserve in case of a complication?

Complications although infrequent can occur and may require surgery to treat and to prevent a negative outcome. An example is premature consolidation of the bone which requires rebreaking the bone. Another is nerve entrapment which requires nerve decompression. Another is muscle contracture which requires lengthening of muscles, tendons or fascia. Finally there can be failure of bone healing after the end of the distraction phase requiring repair of nonunion. The cost to treat most of these complications ranges from $12-$35,000.

What is the likelihood of complications that would require additional surgery?

The likelihood of complications that require additional surgery for treatment is less than 5%.

How are the scars from surgery?

We use a minimally invasive method to put the Precice device into the bones. A half inch incision is made at the hip area, and 4 or 5 quarter inch incisions are made on the side of the thigh. These scars are so small they are not very noticeable.

How painful is limb lengthening?

Immediately after surgery, there is post surgery pain. Most patients have epidural anesthesia or PCA (patient controlled analgesia). Both of these methods offer excellent post operative pain control for about two days. After that most patients are switched or oral pain medication. After discharge all patients receive a
prescription for oral pain medication. During the first two weeks after surgery most patients still feel some post surgical pain. Once this is gone the comfort level is greatly improved. The most painful times are during stretching exercises during physical therapy and when going to sleep. We often prescribe some medication to help with sleep. Most patients do not complain of much pain during the daytime. the actual lengthening of the nail each day is usually painless.

**What can I do to prepare for surgery?**

a) Education: Read all printed materials we provide. Book a consultation and come with your questions written down so you can get the answers you need. Email us any additional questions you may think of later.

b) Physical preparation:

Stretching exercises may help.

For femur lengthening:

1) iliotibial band; lie on your side, extend your hip so your thigh is in line with your body and flex your knee. In that position, try and bring the flexed knee towards the ground. Also can do cross leg stretches with the hip straight. These stretches the IT band.

2) quadriceps and especially the rectus femoris muscle (bend knee with straightening of hip at same time. Can be done standing pulling foot behind butt and leaning back or kneeling with leaning back).

3) Hamstrings: knee straightening while flexing hip.

For tibial lengthening:

1) Achilles tendon: heel cord; maximum dorsiflexion (foot up) with full knee extension (straight).

c) Stop smoking and exposure to second hand smoke.

d) Stop all anti-inflammatory meds.

e) Socio-economic preparation:

Organize your life so you can put it on hold for at least three months. You will need to stay in West Palm Beach for at least 9 weeks. You may not be able to go back to work since you will still be wheelchair dependent when you return home for at least one month. Prepare your finances so you can not only afford this surgery but also afford any possible complications from this surgery that can arise. These are not common but can be costly when they do occur.
Be prepared to be single minded and not distracted during the process so you can devote all your energies and attention to the limb lengthening process and rehabilitation.

Visit West Palm Beach and check out where you will stay and the lay of the land. Arrange for someone to come with you or be prepared to hire home health to help you (see separate section on this).

Organize a leave of absence from your job so that you don't feel the pressure of the need to get back to work.

**Do I need a psychological evaluation before surgery?**

For my first twenty one years I used a psychologist to evaluate all my patients before surgery. After more than 20 years I have gotten fairly good at doing this evaluation myself. The purpose of this evaluation is to make sure we are not operating upon patients with a body dysmorphic psychosis as well as to make sure that patients have realistic expectations and have the proper support required to undergo this procedure.

**Do I need to book a consultation before surgery?**

Yes. Although the information provide via email is very educational, we need to assess you and you need to become as prepared as possible for the surgery. We have found that patients who do now come for a consultation are not as prepared for the surgery and have much more difficulty when they undergo this procedure.

We make exceptions to this only for patients coming from overseas and book the consultation the week before surgery. Please note that this is not optimal since these patients are less prepared for surgery than those that come in for a consultation well in advance.

**How do I book a consultation?**

Please call the Paley Advanced Limb Lengthening Institute 877 765-4637 (Toll Free) 561 844-5255 (Main). You may also contact Kathleen Koster kkoster@lengthening.us who make appointments for consultations in my office.

**How do I book a surgery date?**

Please contact Rebeca Mones our surgery scheduler. You can either call the Paley Advanced Limb Lengthening Institute 877 765-4637 (Toll Free) 561 844-5255 (Main) or email her directly at rmones@lengthening.us . To secure a surgery date she will ask you to make a deposit on your credit card as explained in a previous section.
**Will I need to come in the day before surgery?**

You will have a preoperative visit with the surgery team to go over the consent form and all of the paperwork. You will also have an appointment with our preoperative nurse and anesthesiologist. You will be given instructions for surgery. You should not eat or drink after midnight and you should come in two hours before your scheduled surgery to the preop area.

**How long is the hospitalization?**

The hospitalization is usually 3-4 nights. At St. Mary’s Hospital this is in a private room on the newly renovated surgical care unit in the Waters 3 Pavilion.

**What will happen during the hospitalization?**

After surgery you will be taken to the recovery room for an hour or two before going to your room. If you have family or friends, the surgery team will come out to talk to them after the operation. You will have an IV and a Foley catheter (bladder catheter). The Foley will remain in place until the epidural catheter is removed. If no epidural then the Foley can be removed one or two days later. While in hospital you will start on a blood thinner to prevent blood clots. The nurses will make sure you are comfortable and positioned in such ways as to prevent pressure sores. You will have blood test drawn each morning to check your blood level. If your blood level is low a transfusion may be ordered. Each morning the surgical team will come by to check upon you. This will include physician assistants, nurse practitioners and doctors. The epidural or PCA will be discontinued usually after two days. A physical therapist will come each day to start teaching you to move around and to become more independent. You will learn skills such as transfers to and from wheelchair and bedside commode, etc. Once you are mobile enough you will be discharged from hospital with instructions.

**Will I leave the hospital with a wheelchair, walker, and/or crutches?**

Yes. You will be given a wheelchair and a walker to take with you. You will be taught how to do transfers to chair and toilet. You will either get crutches in hospital or during your outpatient physical therapy.

**What medications will I take after discharge from the hospital?**

Blood thinner to prevent blood clots: Xarelto 10 mg daily ($313.99 per month times 4 months)

Pain medicine (as needed): Percocet 5/325 # 90 pills an 8-10 day supply ($44.97); we refill this as needed during the lengthening.

Muscle relaxant (optional): Valium 5 mg # 90 pills one month supply ($24.00)
Where will I stay after discharge from hospital?

There are several options.

1) The most common place to stay is at one of our extended stay hotels which are on 45th St. This is a few miles west of the hospital on the same street as the hospital. The cost of stay at these hotels is between $63-99 per night. Cost may vary with season and availability. High season is winter and low season is summer. Please book as far in advance as possible especially in season.

(Shuttle service provided to hospital)
Homewood Suites By Hilton – 561-682-9188
Residence Inn By Marriott – 561-687-4747
Springhill Suites By Marriott – 561-689-6814

(Near Airport, shuttle service not provided)
Doubletree By Hilton – 561-689-6888

2) Renting a condominium or house.
3) Staying at another hotel.

Is transportation available to and from the hospital to place of residence?

Wheelchair transportation vans are available to take you to and from the hospital only if you stay at the extended stay hotels listed above.

How long do I need to stay in West Palm Beach?

You need to stay until the end of the distraction phase (lengthening). The distraction phase length for femur lengthening is one day for each mm of planned lengthening. E.g. 65mms = 65 days. We don't start lengthening for between 0-7 days depending on the age of the patient. Therefore if we don't start lengthening until the 5th day, 70 days for 65 mms and 85 days for 80mms. Tibia lengthening is ¾ mm per day compared to 1mm/day for femur lengthening. For tibia lengthening the distraction phase for 65 mm is 13 weeks plus one week before we start lengthening and 16 weeks for 80mms

Will I need help to look after myself?

Yes. You either need to come with someone who can help look after you or else you will need to hire a home health aid. We can help you arrange for this. The hourly cost of this is approximately $18/hr. In the first week after discharge from hospital you will require more hours of help and less help as time goes on. You need to budget for this if you are coming alone. At the very least every one needs help for the first two weeks after discharge from hospital. If you do not have anyone with you this will cost you at least 16 hours a day of help at $18 per hour (for two weeks the cost can be up to about $4000).
How much weightbearing is allowed during lengthening?

During distraction the bone ends are held separated by the implantable rod. This rod is secured to the bone by screws at either end. The diameter of the rod ranges from 8.5-10.7-12.5mms. The screws have a diameter ranging from 4-5mms. With enough repeated loading the screws of any implant will bend or break. No implant is immune to this. The heavier the patient the greater this risk. This is true of any implantable lengthening nail no matter what the material it is made of and no matter what you are told by the manufacturer or the surgeon.

We permit full WB when we see complete bridging of the bone on the x-ray. At that point the bone is taking the load and protecting the rod. During the lengthening we allow WB using crutches or a walker and unweighting the legs using the arms. The amount of WB allowed depends on several factors: the weight of the patient, the diameter of the rod and the bone being lengthened. For the largest diameter Precice2, 12.5mms, we allow up to 75 lbs (34 kgs) on each leg. This means that when a patient is standing on two legs with two crutches on the ground they can take up to 150lbs or (68 kgs). However, when walking and transferring load from one leg to the other a patient MUST USE TWO CRUTCHES on the ground and unweight themselves to the 75lbs (34kgs) weight with each step. Patients must NEVER walk with one crutch during the distraction phase no matter how much they weigh. During the consolidation phase the same rules apply until the surgeon increases the WB quota. To know how much WB is being done a patient can stand on a bathroom scale till it reaches the desired e.g. 75lbs number. For the smaller diameter rods 10.7mms and 8.5mms no more than 50lbs (23kgs) is allowed per leg.

Am I allowed to drive?

Patients undergoing implantable limb lengthening can drive once they are not taking narcotics during the day. They do however need to be able to get in and out of the car on their own. Stand up with crutches or walker and transfer to a wheelchair on their own for complete independence.

How often will I have physical therapy?

Daily, 5 days a week for the entire distraction phase. (7 days a week is available for an additional payment of $220 per session-please inquire regarding this)

During consolidation phase the patient needs to continue with PT but less often (2-3 days per week). This is usually done closer to home since most patients depart from West Palm Beach to return home. If you plan to stay locally for some time we can arrange physical therapy at our center.

Daily home exercises are required by the patient throughout both distraction and consolidation phases.
Who does the actual lengthening and where?

The lengthening is done by the patient at their residence wherever they are staying. Ideally, the lengthening is done in ¼ mm increments, 4 times a day instead of a full millimeter once a day. The lengthening is done using a special device called the ERC device. Our orthopedic technologist trains each patient to do this until they are comfortable using the ERC device. Each patient receives one to take with them and returns this device at the end of the lengthening. Patients who cannot do their own lengthening can have it done once a day, a full millimeter at a time by our orthopedic technologist.

How often am I seen by the doctor or physician assistant?

Every two weeks.

When will I have x-rays done?

Every two weeks one x-ray of each lengthening segment is taken.

Once I am done lengthening how soon can I go home?

Immediately.

What is the follow-up after I go home?

Send weekly x-rays to Dr. Paley. The best way is to email these to dpaley@lengthening.us. If you cannot figure out how to email x-rays mail the disc to:

Paley Advanced Limb Lengthening Institute
Kimmel Building,
901 45th St.
West Palm Beach, Florida 33407

When can I resume full weightbearing without support?

After reviewing the x-rays, Dr. Paley will email you how they look and whether you can resume full WB. This usually happens after one or two months from the end of distraction.

When can I return to sports?

You have to regain your motion and then your muscle strength before returning to sports. If you work hard at this you can go back as early as six months after surgery. This is individualized by the doctor for each patient.
What are the results from internal lengthening of the femur and tibia?

I have performed implantable lengthening of the femur for 17 years, and have used the Alibizzia, the ISKD and now the Precice. I have the world’s largest experience with the ISKD and the Precice devices. To date all of my patients have achieved the goals of treatment and have returned to full activities including sports.

Will I require a blood transfusion?

Some patients lose enough blood to require a blood transfusion before surgery. Therefore autodonation is an option but not required. We use blood from the blood bank if needed. The loss of blood occurs not only during surgery but also after surgery for a couple days. The transfusion if needed almost always occurs one or two days after surgery. The risks from this are very minimal. Twenty-five percent of our patients require transfusion.

Do I need to have the nails removed?

Yes. All of these nails should be removed. Removal timing is not critical, but most often is done one or two years after the original surgery. The reason to remove the nails is that they are made from titanium and since they have moving parts and generate metal ions over the course of many years. While they are inert and there is no urgency to remove them it is recommended to remove them one or two years after insertion.

What is the cost of removal of the Precice devices?

The cost of removal is separate and is not included in the treatment. The cost of removal is $17,500 to be paid in conjunction with that surgery.

How soon can I have another lengthening (e.g. both tibias)?

If you choose to have a second lengthening done. An interval of six months is recommended between lengthenings. It is possible to overlap the femur and tibia lengthenings and this option can be discussed with Dr. Paley.

Can I have lengthening of the femur and tibia together at the same time to save time and expense?

Although femur and tibia lengthening can be done at the same time we prefer not insert the femur and tibia rods in at the same time due to the theoretical risk of fat embolism from reaming the medullary canal of more than two bones at a time. To insert 4 rods at the same surgery would increase the chance of fat embolism and death. We have done this successfully without complication but do not recommend it.

The main benefits are decreasing time to go through the procedures twice as well as decreasing costs by incurring only one hospital admission and one anesthesia cost.
At present we would discourage you from considering this option. If you really want to do them together then stagger the two surgeries by two to four weeks.

What are the main potential complications that can occur?

No one wants unexpected problems, complications and costs. For these reasons I am very conservative regarding many aspects of the limb lengthening process. I try and anticipate problems and prevent complications. Many complications lead to additional surgery and therefore to additional costs. The following is a list of some of the potential complications:

Fat Embolism

This is a complication that is very rare and which can be prevented by venting the bone during the reaming (drilling) of the medullary canal of the bone. The way I vent the canal is to drill holes at the planned level of the osteotomy prior to the reaming process. As the pressure builds up in the canal the reamings squirt out the holes preventing fat embolism. Fat embolism can make a patient very sick requiring stay in the ICU. Patients can even die from fat embolism. I have only seen fat embolism twice in my patients. Both occurred more than 10 years ago before I developed a special venting method to prevent this complication. Fortunately both patients recovered uneventfully. I have never had a patient die from this procedure!

Deep Vein Thrombosis (DVT) and Pulmonary Embolism (PE)

DVT can occur after any orthopedic surgery or after any fracture. Fortunately we have a very low rate of this complication. Prevention is key. We use anticoagulants after surgery in the hospital and each patient is sent home with a prescription for an anticoagulation drug to be taken until the end of the distraction phase. The cost of this medicine must be borne by the patient and is not included in our cost estimate. While I have seen very few cases of DVT fortunately none of them resulted in PE. PE occurs if the clot dislodges and wanders to the lungs. It can cause shortness of breath, chest pain and even death. This is why we are careful to protect against this. Taking oral contraceptives and smoking increases the risk of DVT. All of our patients are placed on an anticoagulant, usually Xaralto a new low risk medication. The patient needs to pay for this drug as an outpatient and the cost is not included with the surgery.

Premature consolidation: in this complication the patient bone bridges the gap and prevents further lengthening. Premature consolidation (PC) can occur with any method if the patient is a very rapid bone healer. The patient in these cases is able to make bone faster than the speed at which the bone is being lengthened. The only way to prevent this is to speed up the lengthening intentionally for a week or two. The Precice nail with its rate control allows the surgeon to do this. If premature consolidation does occur it requires an outpatient small surgery to rebreak the bone.
through a tiny incision. With the ISKD and Albizia premature consolidation was a well recognized complication due to the lack of control of rate of lengthening. Since lengthening in both of these devices occurred by movement through the osteotomy site and since movement through the osteotomy site can cause pain and muscle spasm, the patients muscles sometimes would prevent the movement and therefore the lengthening from occurring. In other cases both the ISKD and the Albizia have had broken mechanisms that fail to lengthen during the distraction phase leading to PC. The treatment in these cases was to not only rebreak the bone but also to change the device to a new device. Although in each such case the company provided a new device at no additional cost, the patient still had to bear the cost of an additional outpatient surgery. With the Precice this complication almost never occurs.

**Delayed or failure of consolidation:** slow or failed bone healing can occur with any lengthening surgery. The best treatment is prevention. We start by identifying factors that may slow healing prior to surgery: low Vit D level, smoking including second hand smoke, anti-inflammatory medicine use, anti-convulsant medication use, menopause, other medication use e.g. acutane. We also recommend supplements to help the bone heal faster ([www.bonehealthnow.com](http://www.bonehealthnow.com); order Silical, Silical2 and Boost). If a patient's blood work shows a low Vitamin D, then Vit D supplements are recommended. We try and identify these factors in advance of surgery. In surgery we there are several steps that help maximize the bone healing: e.g. we use a technique originally developed by Dr. Paley in 1990 to allow bone marrow to surround the area of the bone cut. This is done by making drill holes at the level of the planned osteotomy before reaming the bone. Stable fixation is also important so the choice of nail length and diameter are important as well as the level of the osteotomy. Even the type of osteotomy affects the rate of bone healing. Cutting the bone with multiple drill holes and an osteotome is the most minimal invasive way while using an intramedullary saw or performing an open osteotomy have higher failure rates. All of these are surgeon controlled parameters and are based on surgeon knowledge and experience. Choosing the wrong level or method of osteotomy or the wrong diameter or length of implant can significantly impact the result. The next most important factor is the rate of distraction. Lengthening too quickly can lead to delay or complete or partial failure of bone formation. Too rapid distraction was the most common cause of poor bone formation with the ISKD. This is not a problem with the Precice since it has complete rate control. Poor bone healing can be recognized during the lengthening process. Once it is recognized the rate of distraction should be slowed. With the Precise the lengthening can be reduced to any level or even stopped. If despite these changes the bone healing remains poor, the lengthening can be reversed until better bone formation is seen. The bone can then be relengthened. This can only be done with the Precise. Going reverse is not possible with the ISKD, Albizia or the Fitbone. This is a huge advantage that is possible with external fixation and now with the Precice.

If delayed healing occurs despite all of the above steps we start using the accordion technique. Using an ERC device the bone is compressed one mm per day and
distracted one mm per day. This cycle is repeated several times a day. This stimulates bone healing and avoids the need for surgery.

Delay or failure of bone formation can delay weightbearing and increase the period of disability and recovery. Furthermore it can lead to the need for surgery to get the bone to heal. Such surgery requires a bone graft and is not a small operation and can be quite costly. Therefore having a device like the Precice that can prevent or treat the problem is a major advance.

**Nerve injury:** nerve injury can occur with any lengthening surgery but is usually uncommon if the rate of distraction does not exceed 1mm per day and if the amount of lengthening is restricted. Rate control is the most important factor to prevent nerve damage. Recognition of nerve symptoms is important. The lengthening should be stopped or slowed in such cases. If any motor symptoms (weakness or paralysis of muscles) occurs a nerve decompression should be done as soon as possible. This is a small outpatient surgery. In most cases it is the peroneal nerve that gets into trouble. It is important that the surgeon know how to decompress this nerve to prevent foot drop. Delay in decompression can lead to permanent foot drop. With the Precice and complete rate control, nerve injury is very rare and greater lengthening can be performed safely.

**Muscle contractures:** muscles normally get tight with lengthening. A muscle contracture occurs when a muscle gets tight enough to prevent a joint from moving through its entire range of motion. To prevent muscle contractures physical therapy (PT) is essential. The patient should do daily stretches of the muscles and joints at risk. E.g. knee joint and quadriceps muscles for femur lengthening and ankle joint and Achilles tendon for tibial lengthening. In addition to formal PT the patient should do their own stretches at home several times per day. PT is essential to the lengthening process. It is however expensive. I will not consider doing a lengthening if a patient is not willing to do PT. This is not an option for reducing cost. The controlled rate of lengthening with the Precice makes the risk of muscle contractures and muscle spasm less. The Precise does not obviate the need for PT. Maintaining range of motion and preventing contractures during lengthening decreases the rehabilitation time to return to normal function after the lengthening is finished. A fixed contracture of the knee or ankle can lead to disability and the need for more prolonged PT and the expenses associated. If despite additional PT the contracture does not resolve additional surgery to lengthen muscles, tendons and fascia may be required. I try and anticipate this and prophylactically lengthen certain soft tissue structures to prevent contractures (e.g. iliotibial band). If this is done at the initial surgery the additional cost is small. If soft tissue lengthening surgery is required at a later date the cost is much higher since one also has to pay for the hospital costs.

**Fibular complications:** with tibial lengthening the fibula has to be lengthened too. The implantable lengthening device only lengthens and fixes the tibia. The fibula has to be fixed to the tibia so that it lengthens together with it. If the fibula is not fixed or not fixed adequately it will not lengthen as much as the tibia and will lead to severe
consequences including subluxation and arthritis of the ankle and flexion contracture of the knee. The method of fixation is critical. Many surgeons only fix the lower end of the fibula to the tibia. This can lead the fibula to prematurely consolidate and to pull down and dislocate from the tibia at its upper end. It is important to fix the fibula at both ends. With external fixation the fibula can be fixed with the wires of an external fixator. With implantable lengthening the fibula must be fixed with screws to the tibia; one screw at the upper end and one at the lower end. The angle, level, position, diameter, and type of screw are all important. E.g. a common mistake is to put the screw in horizontally between the two bones. This is not strong enough to prevent the fibula from pulling away from the tibia at the ankle. This is very subtle and even a few millimeters of difference in length of the fibula at the ankle lead to short term and/or long term consequences for the patient. Removing a segment of the fibula to prevent the fibula from not separating is another common method that should be abandoned. It leads to a nonunion of the fibula which can lead to a stress fracture at a later date in the tibia. Furthermore it usually does not prevent the fibula from pulling away from the tibia. Therefore fibular complications have nothing to do with the type of implantable lengthening device but rather with the method the surgeon chooses to fixate the fibula to the tibia and the method of cutting the fibula bone.

Historical perspective on implantable limb lengthening devices:

I have been performing Limb Lengthening Surgery since 1986. The two main indications for such surgery are limb length equalization for limb length discrepancy (LLD) and stature lengthening for short stature. Since 1986 I have performed over 17,000 limb lengthening surgeries. This is more than any other surgeon in the US or the world. The majority of these surgeries were for LLD. Over 1500 were for short stature related to dwarfism and cosmetic reasons.

Dr. Paley’s history with cosmetic lengthening for stature is as follows:

Dr. Paley started with the Ilizarov method for lengthening of both tibias in 1987 and soon after switched to the lengthening over nail method he had developed in 1990. Although his results were excellent, the scars, the pain, the suffering, the pin site infections were not conducive to a cosmetic procedure.

He sought a fully implantable lengthening solution. When the Alibizzia nail, developed by Guichet became available he worked with the French company that made the nail to develop a tibial lengthening Albizzia for stature lengthening. He started using this in 1996. The severe pain experienced by patients from the 15° rotation of the thigh through the break in the bone, as well as several implant failures lead him to stop using this non-FDA approved device. In 2001, when the ISKD, developed by Dr. Cole was approved by the FDA and marketed by Orthofix became available, Dr. Paley was the first surgeon after Dr. Cole to implant this
device. This device turned out not to be a great device for stature lengthening. Although he performed over 350 ISKD implantable limb lengthenings, more than anyone in the world, the lack of rate control with this device caused many complications. The other problem with the ISKD was frequent malfunction of the mechanism, which for unexplained reasons would fail to lengthen in the middle of the distraction phase. This lead to increased numbers of procedures to treat complications. For stature patients this also meant increased costs. Despite this his final results were excellent in almost every patient with the ISKD. The ISKD, the Albizzia and the Fitbone are all contemporary devices. They can all be considered first generation lengthening nails. They all suffer from significant mechanical and other problems.

The first second generation device on the market is the Precice. On December 1, 2011, Dr. Paley implanted the first 3 Precice nails in the United States. By November 2013, he performed over 155 Precice cases (more than any other surgeon worldwide). These cases include femoral, tibial and humeral lengthening with the Precice. The results with this device were excellent. The most serious shortcomings of the device were breakages of the nail that occurred in three cases and breakages of the mechanism that occurred in 5 cases. All the breakages of the device occurred at the welds connecting the mechanism to the rest of the nail. The mechanism breakages occurred between the magnetic driveshaft to gear coupling of the nail mechanism when too much resistance from dense bone formation occurred. Dr. Paley was the first to identify these problems and together with Ellipse Technologies they set out to redesign the nail without welds and with a stronger coupling. The improved device is called the Precice2 and has increased the strength of the nail shell by up to 4X and of the mechanism by up to 3X. This is expected to eliminate the uncommon problem of breakage and mechanism failure and allow for increase weightbearing. Dr. Paley was the first surgeon to implant the Precice 2 for stature lengthening in Nov. 2013. He has now successfully used this device in over 20 stature cases.

Here are the links to first PRECICE lengthenings we performed in the news:

http://newsok.com/edmond-woman-takes-steps-to-lengthen-legs/article/3634689


History of Implantable Limb Lengthening

Surgical limb lengthening dates back to the turn of the 20th century with the publication of Codivilla. Over the first half of the 20th century, the lengthening devices ranged from the traction Thomas splint device of Codivilla, to various bed mounted and semi-portable external fixation devices. The early limb lengtheners employed distraction osteogenesis to fill the distraction gap produced by their fixators. It was not however until the 1950’s and 60’s that the biology of distraction osteogenesis became understood. This was largely due to Ilizarov and his group in Kurgan, USSR. Despite their ability to predictably achieve desired length, external fixators are plagued by high complication rates secondary to pin tract infections, associated risk of deep infection, neurovascular injuries, prolonged treatment time until removal, muscular and soft tissue transfixation that lead to contractures and stiffness, pain and discomfort, refracture after removal of the fixators, as well as, psychosocial burden, requirement to perform daily pin cleaning and physical awkwardness.

Due to all of the above reasons many postulated and conceived of internal implants to achieve limb lengthening. Implantable Limb Lengthening using distraction osteogenesis also takes it origins in the Soviet Union. Alexander Bliskunov from Sinneropel, Ukraine first published his method in 1983. This was before most of the Western world had heard of Ilizarov. Bliskunov developed a telescopic lengthening nail that used a crankshaft connected to the pelvis to drive his mechanism and lengthen the femur. Rotational motion of the femur produced lengthening of the nail. The rotation was through the hip joint and not through the osteotomy. His technology was not available outside of the Soviet Union. Even today it is only used by a few in Ukraine.

Over the last three decades, other fully implantable lengthening nails have been developed. Baumgart and Betz from Germany developed a motorized nail in 1991 (now called Fitbone). The Fitbone (Wittenstein, Igersheim, Germany) is a fully implantable lengthening nail whose mechanism is driven by an internal motor that requires an external transmitter. An antenna comes out of one end of the nail and is implanted subcutaneously. It is powered and controlled by radiofrequency and the lengthening is performed at night when the patient is in bed to mimic natural growth. Data is limited, as there are only three studies in the English literature that have reviewed a total of 37 implants, although they report good overall results. The series by Singh et al. reported that 3/24 nails in 2 patients required later bone grafting. They also had 2 implants that needed to be removed and exchanged for large diameter implants because the gears in the original nails were not strong enough to achieve distraction. Baumgart et al. reported that 2/12 nails had faulty motors that required re-operation and only one patient required a later bone graft procedure. The Fitbone is the only motorized nail available. It is on limited release. To obtain permission to use it one has to either receive agreement from Dr. Baumgart or the Wittenstein company.
Guichet and Grammont from France, developed a telescopic nail in 1994 using a ratchet mechanism which rotated the two segments of the nail through the osteotomy and callus of the distraction gap. The Gradual Lengthening Nail also known as Albizzia (Depuy, Villerbuane, France) was later modified and released as the Betzbone and the Guichet nail for use by its two namesakes respectively. It takes 20 degrees of rotation to move the ratchet one notch. Each notch is 1/15 of a millimeter. Many reports exist of patients suffering from severe pain and discomfort, which limit their ability to independently perform the lengthenings. In some cases, these patients required readmission to the hospital with general anesthesia and closed manipulation. In other reports, 12% of the lengthenings remained incomplete because the patients were simply unable to tolerate the pain of the manipulation.

Using the same concept of lengthening by rotation through the callus, Cole developed a double clutch mechanism to cause distraction. Only 3-9 degrees of rotation was required to cause the nail to lengthen. The intramedullary Skeletal Kinetic Distractor [ISKD] (Orthofix, Inc., McKinney, Texas) was FDA approved in 2001. It was recently removed from the market and is no longer available. Since the lengthening was so easy to activate, and since there was no ‘governor’ to the lengthening mechanism, the nail is free to lengthen at any rate. Too rapid distraction was a frequent complication. This was referred to as a ‘runaway nail’ or ‘runaway lengthening’. Due to the uncontrolled lengthening rate and rhythm the ISKD had a very high complication rate. The nail would often lengthen at a rate that exceeded the ability for distraction osteogenesis of bone and histogenesis of soft tissues leading to many complications. Restriction of activities and bracing were required to try and prevent and control too rapid lengthening. Failure of bone formation required separate bone grafting procedure for deficient regenerate

Arnaud Soubieran from France developed the Phenix nail. The Phenix has a mechanism activated by a large external, hand held magnet. By rotating the magnet around the leg an internal crankshaft mechanism in the nail was rotated. This lead to traction on a wire pulley, which caused distraction of the nail. The mechanism for the Phenix was first used in a spinal distractor, and, in a lengthening prosthesis manufactured by the same company. Rotating the magnet one direction leads to lengthening while rotating it the other way leads to shortening. This device was self marketed by Soubieran until 2012 at the time of his accidental death. The Phenix produced excellent results in the small number of cases in which it was used. There were anecdotal reports that the nail was not able to lengthen against too much force. A version of his mechanism is contracted to Smith and Nephew and awaits FDA clearance and release.

Ellipse Technologies (Ellipse Technologies, Irvine, California) developed the Precice nail with a team of surgeons (Dr. Paley included) headed by Dr. Stuart Green. Ellipse used the same mechanism that they had developed for their spinal growing rod called “the MAGEC System”. There is a magnetic metal spindle that is connected to a series of gears. The gears are connected to a coupling, which is connected to a
threaded drive shaft. The mechanism is activated by an external remote control (ERC) device. The ERC employs two motor driven rotating magnets to magnetically couple to and rotate the magnetic metal spindle. The ERC performs 30 revolutions per minute. It takes 7 minutes and 210 revolutions to achieve one mm of lengthening. Facing the ERC one direction causes the nail to lengthen, while facing it the other direction would go in the reverse (shortening) direction. The Precice is the second FDA cleared implantable lengthening nail device (July 2011) and the first one to have bidirectional control (lengthening and shortening). I had the privilege of implanting the first Precice nail in the US on Dec. 1, 2011. The initial experience with this device in the US and several countries around the world has been excellent. Nevertheless, there have been many lessons from the learning curve of this device.

Device evolution is part of progress. Dr. Paley had the privilege of being involved in the development of four of the implantable lengthening nails that are used today. He was a consultant to the Medinov of the Landinger group (Nancy, France) regarding the Albizzia nail and designed and first implanted their tibial nail (femoral nail developed by Guichet and Grammont). This non-FDA approved device was used as a compassionate use device in the US in the mid 1990’s by Dr. Paley. This experience uncovered an essential design problem that led to frequent failure due to wear ratchet gear. Hardening the metal used for this part solved this problem. The current Albizzia has also been strengthened to use cobalt chrome instead of stainless steel to permit greater weight bearing in bilateral lengthening cases. It is currently marketed as either the Guichet nail or Betz bone device by these two surgeons respectively. Despite the increased strength of cobalt chrome there continue to be fatigue failures of the stainless steel screws due to excessive loading, as a reminder that unprotected weightbearing until distraction gap consolidation is not a good idea. Dr. Paley was also the first user of the ISKD device after its inventor Dean Cole, MD. As a consultant to Orthofix at that time, the company was advised in the first year of ISKD device use (2001-2002), that the lack of rate control was a major problem. Certainly many of the problems of not being able to get the nail going which plagued the Albizzia, were solved by the smaller degree of rotation required to actuate the lengthening. These were replaced by the ‘runaway’ phenomenon of too rapid distraction. While surgeons worked around this problem by decreasing patient activity, using bulky braces such as hip-knee-ankle-foot orthotics, no fix to the problem was offered by the company. The device was finally withdrawn from the market in 2011. It is unknown whether an ISKD2 with better rate control will be available in the future. Dr. Paley also worked with Arnaud Soubieran while he was developing the Phenix nail. There were many trials and tribulation with the initial mechanism. After Soubieran solved most of these, the Dr. Paley introduced this nail to Smith and Nephew and worked briefly as a consultant for them on this device. In 2010, Dr.Paley elected to leave the Smith and Nephew team and to become part of the Precice nail development team headed by Stuart Green, MD. In that capacity he worked with former company engineer Scott Pool to redesign the Precice, leading to the release and FDA clearance of the Precice 2 in Nov. 2013.
The future for non-invasively adjusted limb lengthening devices is very exciting. Future innovation will likely produce a bone transport nail to treat bone defects, limb lengthening plate for children with open growth plates, and gradual deformity correction plates. Miniaturization and new mechanisms will allow greater application of such technology. Adjustable nails could eventually replace simple locking nails for trauma, allowing adjustability of length postoperatively. The same technology as applied to prostheses will also find its way from growing prostheses for bone tumors in children to adjustable length joint replacement for the treatment of arthritis.

**Surgical Technique:**

Preoperative planning is important before surgery to determine the ideal nail length, insertion point (e.g. trochanteric vs piriformis), osteotomy level and direction of the nail (antegrade vs retrograde). The nail length and osteotomy level are very interrelated. To avoid too much friction the osteotomy level is planned to leave one to three centimeters of the wider tube of the nail engaged in the opposite segment of the bone (this is explained in detail below). When there is a larger femoral bow we prefer to make the osteotomy at the level of the apex of the bow. Working backwards this can help calculate the ideal length of the nail to use. In most cases a relatively short nail is used compared to nailing for fixation of fractures. The femur can be reamed with flexible or straight rigid reamers. The latter are less available and less forgiving. However they conform to the shape of the nail better and are preferred if available. Piriformis start is preferred in most adult femurs unless there is a coxa breva or valga. In children with open proximal femoral physes, a trochanteric start point is preferred to minimize the risk of avascular necrosis. Retrograde nailing is used in the femur in conjunction with angular deformity correction of the distal femur or if there is a quadriceps lag that needs to be tightened (one case in the series below had retrograde nailing for the quadriceps lag). Retrograde tibial nailing is used in patients with pantalar arthrodesis.

**Dr. Paley's Surgical Technique Femur:**

Step 1: The patient is positioned supine on a radiolucent operating table. A radiolucent bump (usually a folded towel or sheet) is placed underneath the ischium on the operative side. This allows good visualization of the hip on both AP and cross table lateral views.

Step 2: Using the image intensifier (fluoroscopy) the tip of the level of the greater trochanter is marked on the skin. Knowing the length of the nail to be used for the surgery, a ruler is used to mark the distal end of the nail.

Step 3: The level of the osteotomy is determined by knowing the amount of distraction planned. One must plan to end up with the larger diameter of the nail always engaged on both sides of the distraction gap at the end of lengthening. Assuming one wants to have 2cms of the larger diameter of the nail engaged, then add 2cms plus the 3cms of smaller diameter nail, which is exposed plus the
distraction amount. This total measured from the distal end of the nail represents the level of the desired osteotomy that will leave at least two cms of the larger diameter of nail always engaged.

Step 4: Make a 1cm incision laterally at the level of the osteotomy. Drill holes using a 4.8mm drill bit. I prefer one entrance and three exit holes; anteromedial, anterolateral, and medial. Then make two more holes anterolateral and posterolateral at the level of the other holes. These holes will serve to vent the canal from fat emboli and to allow the reamings that spill out to help fertilize the bone formation at the distraction gap.

Step 5: Get your starting point using a Steinmann pin in the piriformis fossa for adults or children with closed growth plates. Enlarge this opening using an ACL reamer. For open growth plates insert the Steinmann pin into the tip of the greater trochanter.

Step 6: Open the fossa or trochanter with an ACL reamer.

Step 7: Insert a beaded guide rod down the femur.

Step 8: Ream in one mm increments until there is chatter and then in ½ mm increments. Ream to 12.5 mm for the 10.7mm nail and to 14.5 for the 12.5mm nail.

Step 9: Prepare the nail for insertion. Precice 2, the nail is not modular and one must choose the length of the entire nail in advance.

Step 10: Apply the proximal targeting device and test its alignment to the screw holes by insertion the drill guides and bits.

Step 11: Place the nail under the beam of the image intensifier to see if the mechanism is not pre‐distracted. Save this image for reference.

Step 12: Remove the initial beaded guide wire used for reaming, as the nail is not cannulated. Insert the nail into the canal up to the level of the planned osteotomy (drill holes).

Step 13: Have one assistant lift the foot off the table. Have the other assistant lift the proximal end of the nail using the insertion guide. The two assistants are applying an extension moment to the femur to prevent displacement of the femur during the osteotomy.

Step 14: Use a sharp osteotome to osteotomize the femur through the one cm lateral incision. The femur will easily break through the six drill holes. Listen for the break and once it occurs withdraw the osteotome. Test that the femur is fractured while maintaining the extension moment. Move the femur gently into varus and valgus and watch it move on the image intensifier.

Step 15: Once the break is confirmed to be complete, advance the nail by gently hammering on the impactor until the upper end is at the level of the base of the
piriformis fossa or just inside the greater trochanter for piriformis and trochanteric nails respectively.

Step 16: Lock the nail proximally with two screws. For distal locking screws, my personal preference is to insert a long 1.8mm wire into the locking hole, followed by a 3.8mm cannulated drill for the distal 10.7 nails and a 4.8mm cannulated drill for the distal 12.5mm drills. In the 10.7 over drill with a solid 4.0 mm drill after removing the cannulated one.

Step 17: Lock the nail distally with two screws. Avoid inserting the antero-posterior middle screw because it can act as a stress riser for fracture of the femur.

Step 18: Insert the end cap into the proximal part of the nail.

Step 20: Close all the incisions

Step 21: Insert the ERC device into a sterile sleeve. Mark out the level of the magnet on the skin using fluoroscopy. Apply, the ERC directly over the magnetic spindle, using the image intensifier to mark out the magnet. It takes 7 minutes to lengthen the femur 1mm. Remember to program the ERC for antegrade or retrograde use.

Step 22: Check if the distraction gap is seen radiographically and compare it to the pre-distraction space. If an objective increase in space is seen the procedure is completed. If not do a second millimeter of distraction to confirm. In the rare case where the bone does not separate, the nail must be extracted and tested on the bench and if it does not distract then replaced with another nail. An incomplete osteotomy can cause a failure of distraction and can even lead to failure of the mechanism due to the high force of resistance.

**Dr. Paley's Surgical Technique Tibia:**

Step 1: Mark the proximal and distal end of the nail as before.

Step 2: Mark the level of the osteotomy as before.

Step 3: Make a single drill hole anteriorly at the level of the tibial osteotomy. Avoid getting into the anterior compartment. Additional holes can be made medially and postero-medially under the subcutaneous border.

Step 4: Insert temporary arthrodesis screws just proximal to the distal tibio-fibular joint. Start with a wire from the fibular side and make sure it passes relatively posteriorly into the tibia. This wire should be oriented distal on the fibula and proximal on the tibia. A second wire of equal length can be used to measure the appropriate length of the screw. Bring the wire out the tibial side and then antegrade drill it with a 3.2mm cannulated drill bit. Measure and insert a solid (non-cannulated) 4.5mm screw of the correct length antegrade.

Step 5: Make a 3cms incision posterolateral in the midlevel of the leg. Dissect between the peroneals and gastro-soleus muscles anterior to the intermuscular
septum. Dissect down to the fibula. Incise and elevate the periosteum off of the lateral aspect of the fibula and insert a Hohmann elevator anterior and posterior to the fibula. Make multiple drill holes in the fibula with a 1.8mm wire. Use a narrow osteotome to break the fibula. Confirm that the osteotomy is complete by displacing the osteotomy.

Step 6: Insert a Steinmann pin into the proximal tibia at the level of the joint in line with the medial tibial spine, medial to the patellar tendon. Start as high and posterior as possible. Use an ACL reamer to open the starting point.

Step 7: Ream the tibia in one mm increments until there is chatter and then in half mm increments until 12.5 mms for the 10.7mms nail and 14.5mms for the 12.5mms nail.

Step 8: Osteotomize the tibia with a sharp osteotome.

Step 9: Insert the Precice tibial nail down the tibia.

Step 10: Orient the upper end of the nail so that the upper medial locking screw is oriented towards the tibio-fibular joint. Drill this screw into the head of the fibula. Insert this screw to fix the tibia and fibula. Lock the second proximal locking screw from the lateral side. If the first drill hole and screw misses the fibula, then lock the fibula separately with another 4.5mm screw in a retrograde fashion using a wire and cannulated drill first.

Step 11: Free hand lock two of the three distal screws leaving either the middle or distal one empty.

Step 12: Perform a distraction test of one mm using the ERC.