

STATURE LENGTHENING GUIDE BOOK

Everything you need
to know about
Stature Lengthening

THE MOST
EXPERIENCED
STATURE
LENGTHENING
SURGEONS & CENTER
IN THE WORLD





Dear Prospective Stature Lengthening Patient:

This document is intended to be an honest and practical guide to understanding Cosmetic Stature Lengthening. I continue to add to this comprehensive manual so as to make it a living document. If it has not answered all of your questions feel free to direct your questions to my staff or myself so we can better prepare you for this life changing process. Although this document switches from the first to the third person, it was entirely, written by me. All of the information contained herein is based on my more than 30 years of experience in the field of limb lengthening. I hope you find this useful and I hope to meet you in person should you choose to pursue this journey.

Sincerely,

Dror Paley, MD, FRCS

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STATURE LENGTHENING GUIDE BOOK

*Please read this document carefully as it contains
the answers to most of your questions*

INQUIRIES

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USA

- SAFETY IS OUR #1 PRIORITY
- MOST EXPERIENCED STATURE LENGTHENING SURGEONS & CENTER IN THE WORLD
- HIGHEST REPORTED SUCCESS RATE
- OUR STRICT PROTOCOLS GUARANTEE MAXIMUM RESULTS

雨薇 (Angelique Keller), 是我们佩里医生的国际肢体延长负责人。她可以流利的说和写中文。
雨薇的微信_____是: **DrPaley**。请和她微信联系, 以便为您提供精确信息。

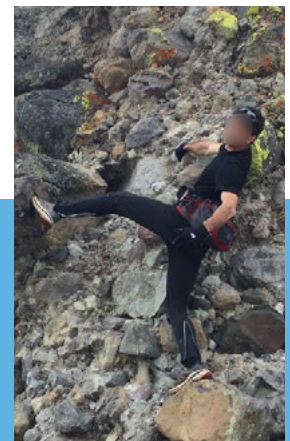
Bilateral Simultaneous Femoral & Tibial Lengthening

Male 5'6" (142cms) height - 52 Year Old - Cardiac Anesthesiologist



Example of a 52-year-old physician who underwent femur and tibia lengthening for a height gain of 4½ inches (11cm). He is standing next to his wife for reference before (left) and after (right) the lengthening surgery.

5cms femurs and 4cms tibias bones united:
back at work and activities



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 the name Dr. Paley gave it: Height Neurosis. Some patients also have Body Dysmorphic Disorder. They usually also need psychological support and medication but may be candidates for this surgery. Psychiatric consultation may be warranted in this group.

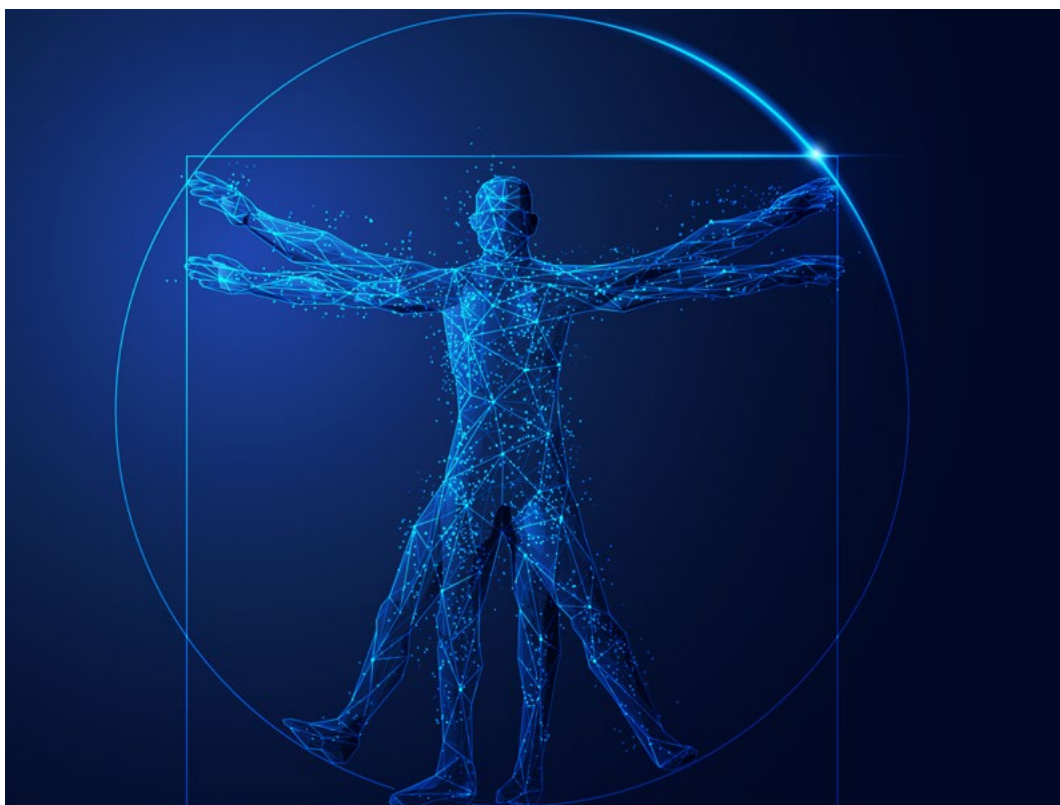
What is the relationship of height to Height Dysphoria?

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" (178cm) is tall in India but short in Holland.

The following anecdote illustrates the point: A man flew all the way from Holland to see me regarding stature lengthening. He was 5'11" (180cm) 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 psychological 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" (147 – 180 cm) for males and 4'6" to 5'8" (137 – 173 cm) 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. We call this body image. Stature Dysphoria is a body image disorder. The patient perceives himself or herself as short irrespective of the actual height and irrespective of how others see them.

**Stature Dysphoria
is a body image disorder.**

Femur: Piriformis Fossa Entry for Antergrade STRYDE Nail Insertion, Skin Incisions, and Lengthening Site

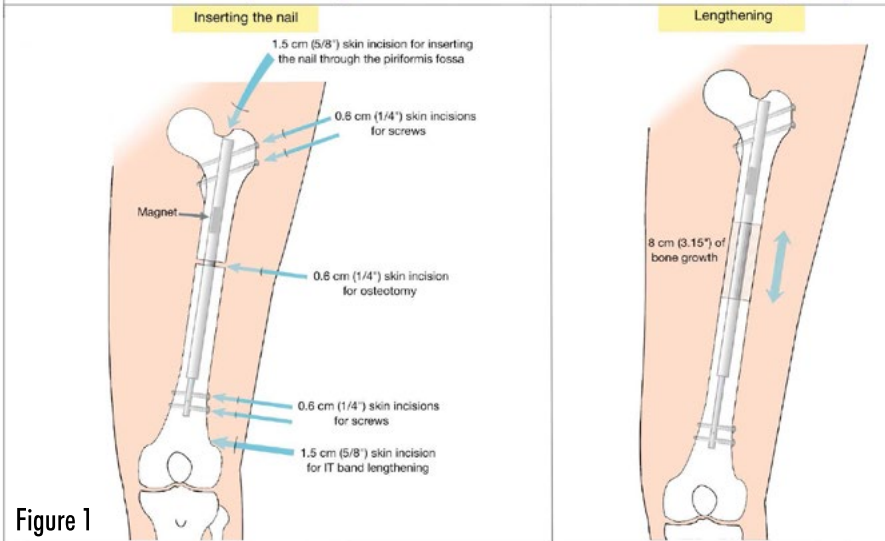


Figure 1

Tibia: STRYDE Nail Insertion, Skin Incisions, and Lengthening Sites

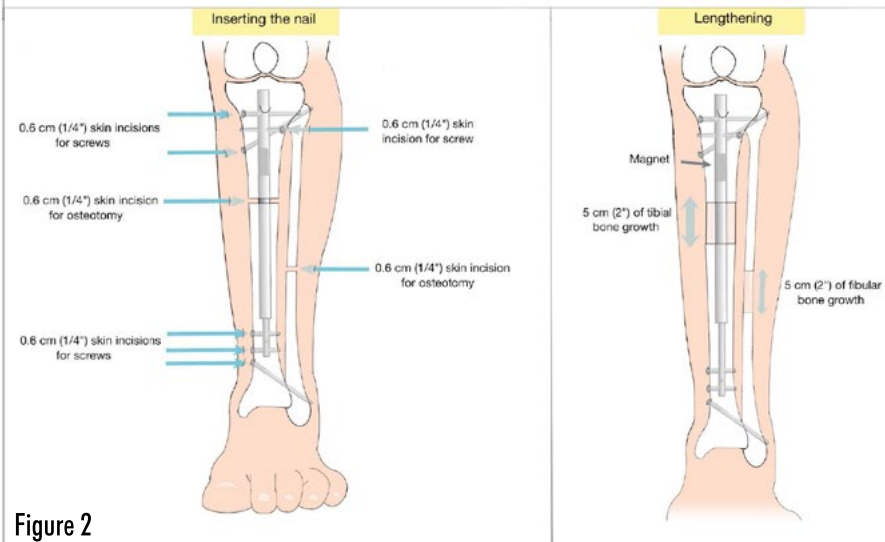


Figure 2

Tibia: STRYDE Nail Insertion, Skin Incisions, and Lengthening Site

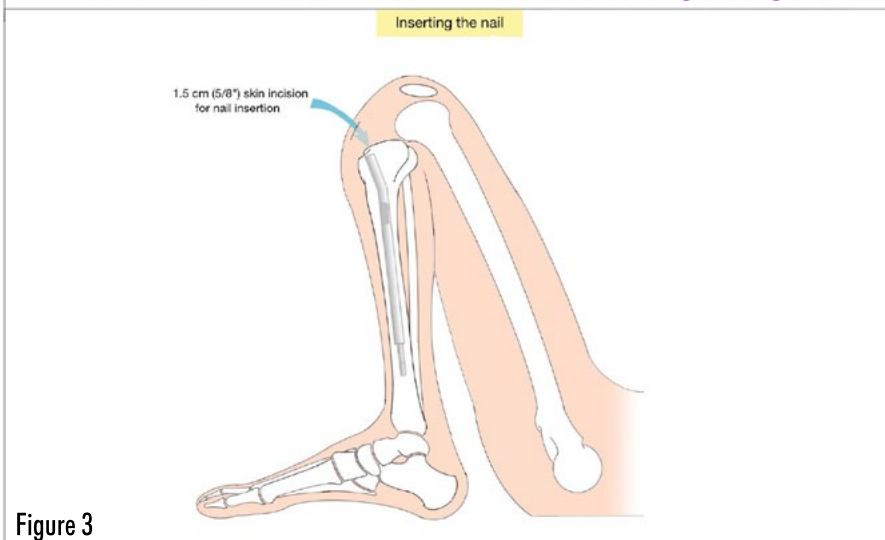


Figure 3

At the
Paley Orthopedic
& Spine Institute
Stature Center,
we use the most
cutting-edge
technology available
in the world today.

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

When assessing the 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).

Percentile	SD	Height Women (in)	Height Women (cm)	Height Men (in)	Height Men (cm)
95	+3	68.5	174	74	188
90	+2	67.5	171	73	185
75	+1	66	167	71.5	181
50	Mean	64.5	163	69.5	176
25	-1	63	160	68	172.5
10	-2	61.5	156	66.5	169
5	-3	60	153	65	166

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?

(see figures 1, 2, & 3 on previous page)

At the Paley Orthopedic & Spine Institute Stature Center, 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 STRYDE nail from Nuvasive Specialized Orthopedics (NSO). The NSO products are currently the only FDA approved lengthening nails in the USA. The mechanism provides excellent rate control and patients claim the lengthening itself is painless. The mechanism can also go reversed. The ability to go reverse is a very important safety feature. We are currently using the latest technology STRYDE (S) for stature lengthening. We have stopped using the Precice 2.2 (P2.2) for stature lengthening because the

recovery with STRYDE is so much better. The differences between these two is the P2.2 is made of titanium, which is more flexible and not as strong as the stainless steel STRYDE nail. The P2.2 requires weight-bearing restrictions and therefore a walker or crutches for a prolonged period of time, while the STRYDE does not require weight bearing restrictions or crutches.



STRYDE

Nail Features

Biodur 108 SST Alloy

- Housing Body
- Anti-Rotation Lug
- Distraction Rod

+5mm increase in magnet length
(18.6% increase in strength)



Screws: new stronger design

SST Partially Threaded Locking Screw (mm)	Fatigue Load (lbs)	Max Length Screw (mm)
4.0	150	75
4.5	200	80
5.0	250	80

* Full body weight loading activities (walking).

Additional 15mm overlap

PRECICE (P2)

Diameter (mm)	Max Pt. Body Weight (lbs)	Actual Weight Applied (lbs)
8.5	125*	25
10.7	250*	50
12.5	250*	50

*Precaution: No more than 20% body weight to be loaded to the treated limb.

PRECICE STRYDE

Diameter (mm)	Max Pt. Body Weight (lbs)	Actual Weight Applied (lbs)
10.0	150	150
11.5	200	200
13.0	250	250

How much height can I gain with the STRYDE?

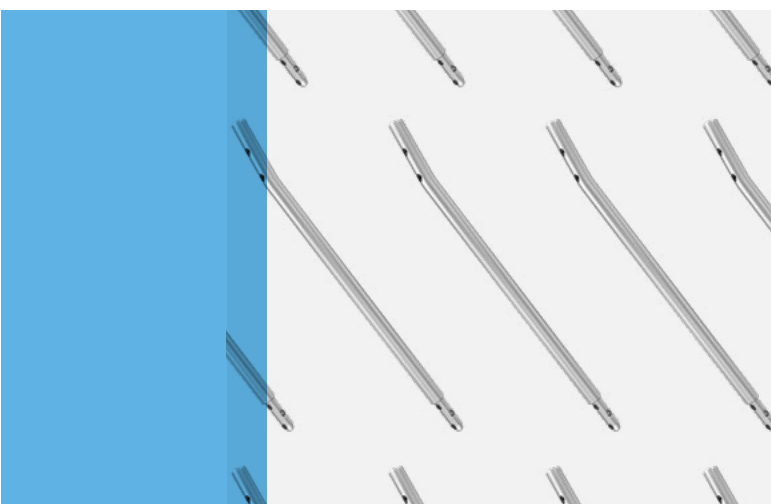
The maximum the STRYDE can lengthen is 8cm which is the same as P2.2. Patients who want more than this should consider a second lengthening of the other bone. The total height gain with two lengthenings is up to 13cm (8cm in the femurs and 5 cm in the tibias). (8cm is not well tolerated in the lower leg (tibia) and exceeding 5cm can lead to more serious complications such as equinus contracture [ballerina foot]). Most patients will not tolerate more than 5cm in the tibias. Of course the cost of two lengthenings is nearly twice that of one lengthening. Although the Precice can lengthen up to 8cm, not every patient can safely achieve this much even in the femurs. We will only allow lengthening to the tolerance of the patient's bone and soft tissues. SAFETY first. We will not risk a loss of function to gain one more cm. To get the full 8cm from both femurs and both tibias requires three lengthening surgeries (see *Lengthening Strategy 5*).

What is the difference between the P2.2 (Precice) and the S(STRYDE) nails?

The difference between the two nails is strength due to material, diameter and the design of the nail. The mechanism for lengthening is the same for both nails. The P2.2 is made of titanium, which is a more flexible and brittle metal. It can therefore bend and break more easily. It is fine for unilateral use but requires significant weight bearing restrictions for bilateral use. The S is made from Stainless Steel (Biodur 108 SST Alloy), which is stiffer and stronger. The mechanical testing of the S show that its bending strength to failure (yield strength) is between 1.2 to 1.5 times higher than that of P2.2. The S fatigue strength is between 2 to 2.5 times higher than P2.2.

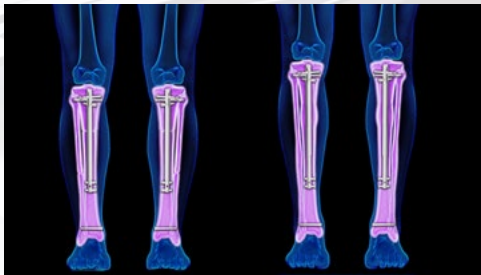
Is everyone a candidate for the STRYDE nail?

The only limitation on using the S nail is length and diameter of the bone. The smallest diameter is 10mm and the shortest length is 265mm. Patients whose bones are too narrow or too short must use the P2.2 instead with its associated weight bearing restrictions of 25lbs (11.4kg) limitation for the 8.5 mm nail. Some smaller boned women are too small for the STRYDE and will still require P2.2 especially for the tibias.

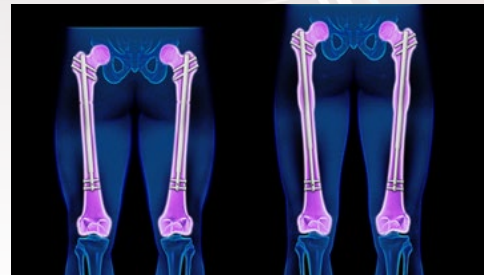


Which lengthening strategy gives what amount of length gain?

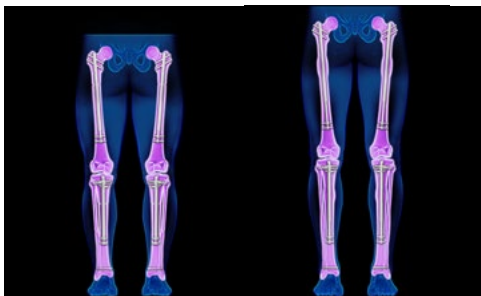
There are several lengthening strategies to get maximum height with each lengthening. Below are these strategies (please note that the cost increases from method 1 to 5):



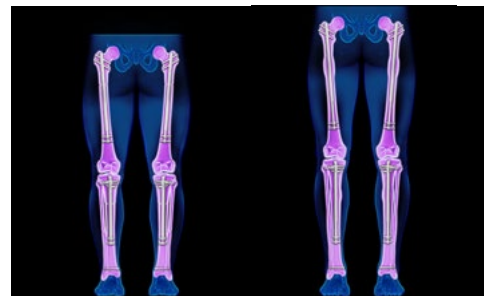
BILATERAL TIBIA LENGTHENING
(up to 5cm; 2in.)



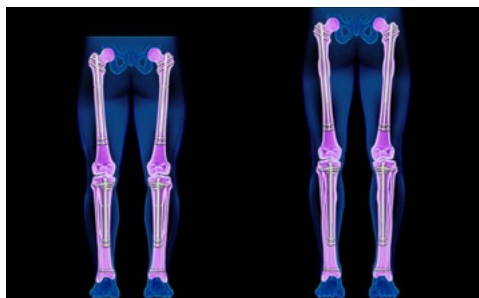
BILATERAL FEMUR LENGTHENING
(up to 8cm; 3.25 in.)



COMBINED TIBIA & FEMUR
(up to 5cm for each)
lengthening three weeks apart
(up to total 10cm; 4 in.)



FEMUR LENGTHENING (up to 8cm)
followed by TIBIAL LENGTHENING
(up to 5cm) **one year later**
(up to 13cm; 5.25in. total)



COMBINED TIBIA & FEMUR
(up to 4cm for each)
lengthening three weeks apart
(up to total 8cm) **followed one or more years later by re-breaking**
femur and tibia with same nail in place and repeating up to 4cm
femur and up to 4cm tibia lengthening one or more years later
(up to 16cm; 6.3 in. total)

What are the costs of each of these procedures?

(all prices are for Precice-STRYDE nails)

CONSULTATION

1. Initial Consultation \$750
2. EOS / Lab work for Vitamin D \$500

SURGERY

1. Bilateral femur lengthening (up to 8cm; 3.1 in.) \$97,500
2. Bilateral tibia lengthening (up to 5cm, 2in.) \$109,000
3. Combined tibia (up to 5cm) and femur (up to 5cm) lengthening three weeks apart (up to total 10cm; 4 in.) \$196,500
4. Femur lengthening (up to 8cm) followed by tibial lengthening (up to 5cm) one year later (up to total 13cm; 5.25in.) \$206,500
5. Combined tibia (up to 4cm) and femur (up to 4cm) lengthening three weeks apart: total 8cm followed by re-breaking femur and tibia with same nail in place and repeating up to 4cm femur and up to 4cm tibia lengthening one year or more later (up to total 16cm; 6.3 in.) \$280,000
6. Bilateral Humeral Lengthening (usually 5cm, 2in.) \$90,000

SURGERY ADD ONS

- A. Rotation correction both femurs during bilateral femur lengthening surgery +\$10,000
- B. Rotation correction both tibias during bilateral tibial lengthening surgery +\$10,000
- C. Bowleg correction both tibias during bilateral tibial lengthening surgery +\$15,000
- D. Bowleg correction both tibias during bilateral femur lengthening surgery +\$50,000

Financing
Available



Femur plus tibia lengthening

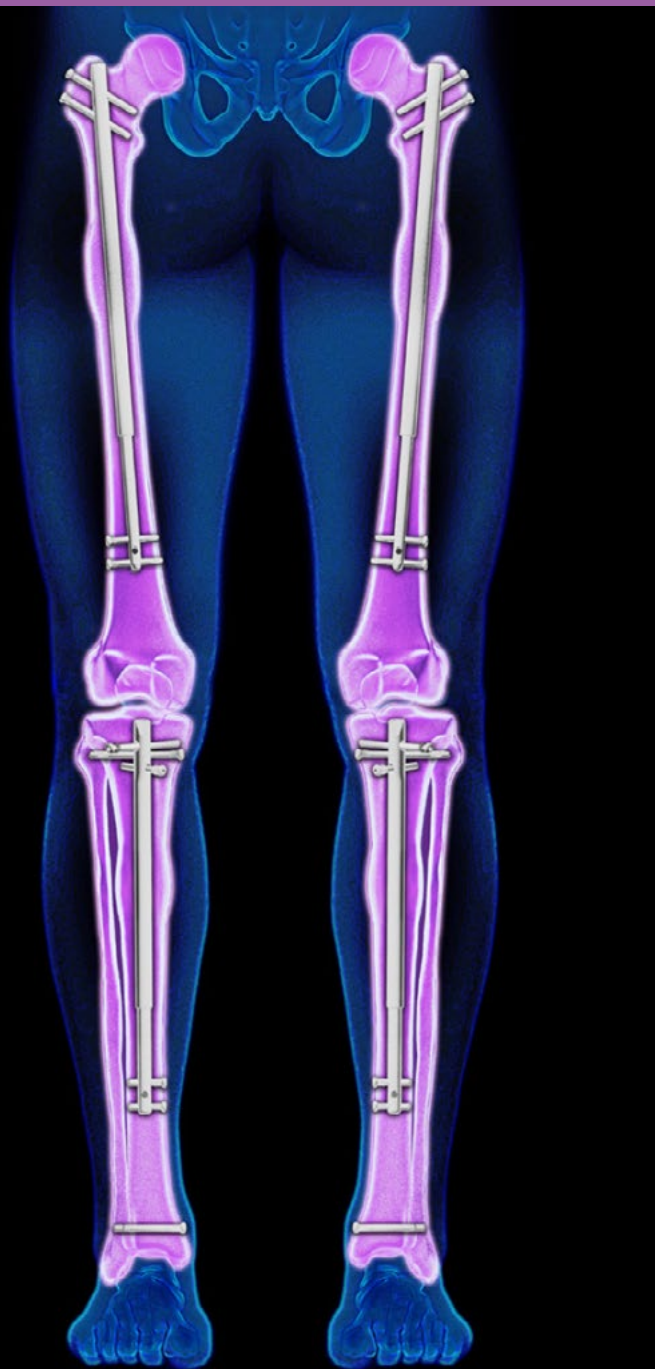
Options 3, 4 and 5 include both tibia and femur lengthening.

Bilateral femur lengthening vs bilateral tibial lengthening

This option is the most popular one chosen since the femur is the easier bone to lengthen than the tibia, it is also the quicker option since you get more length in less time. Femur lengthening goes 1mm per day in most people (exceptions made after age 50 and for osteoporotic bones where the rate is dropped to 0.75mm). Tibia lengthening is done at 0.75mm per day. The femur bone also heals faster than the tibia bone. Therefore the lengthening and healing rate of an 8cm femur lengthening is the same as a 5cm tibial lengthening. Femur lengthening also has fewer risks and complications than tibial lengthening. If a patient wants to achieve between 2-3 inches of height gain then the best option is femur lengthening. The only reason to do tibial lengthening instead of femur is if there is a significant disproportion of the tibia to the femur, meaning the tibia is proportionately shorter than the femur (<0.75). Femur lengthening is combined with surgical lengthening of the iliotibial band and biceps aponeurosis. This is included in the procedure with no additional cost.

Lengthening of the femur and tibia allows for greater height gain and better proportions of the femurs and tibias. Lengthening both bones is much more involved and more expensive than lengthening only one pair of bones. There is also more pain involved if both are done at the same time. We do not insert the femur and tibia rods in the same surgery due to the **theoretical** increased risk of *fat embolism syndrome* 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 in two patients but do not recommend or even offer it as an option since it is less safe.

The lengthening and healing rate of an 8cm femur lengthening is the same as a 5cm tibial lengthening.



To obtain the maximum of 16cm (6.3 in.) we need to lengthen the tibia and femur at the same time staggered three weeks apart, 4cm each bone.

Option 3 reduces treatment time, since femur and tibia are done simultaneously. The tibia surgery is performed first and three weeks later, we do the femur surgery. The reason for this order is two fold: 1) slower healing of the tibia as compared to the femur, and 2) insertion of the tibial nail requires maximum knee flexion. Maximum knee flexion can be reduced during femur lengthening. To reduce pain and to increase the likelihood of reaching the maximum length with femur plus tibia lengthening, we do a peroneal nerve decompression at the time of the tibial lengthening. We do the fibular osteotomy through this same incision. Peroneal nerve decompression is included in combined femur and tibia lengthening with no additional cost.

Option 4 allows maximum femur lengthening since the femur and tibia lengthening are done at different times. No nerve decompression is done since the lengthenings are a year apart.

Option 5 is a rather interesting one, since it allows one to achieve the maximum possible length in the safest possible way. Each Precice nail can lengthen up to 8cm. It is not possible to achieve 8cm in the tibia safely in one lengthening without causing an equinus contracture of the Achilles tendon (ballerina foot). To allow greater tibial lengthening the Achilles tendon can be lengthened. Surgically lengthening the Achilles tendon leads to permanent weakness of push-off strength during gait. We therefore do not lengthen the Achilles tendon to allow greater lengthening. Furthermore we avoid allowing the foot to ever go into equinus (ballerina foot). Therefore we restrict tibial lengthening to 5cm. It is possible, to reach 8cm in the tibia safely if it is done one year apart through two independent tibial lengthenings. Therefore, to obtain the maximum of 16cm (6.3 in.) we need to lengthen the tibia and femur at the same time staggered three weeks apart, 4cm each bone. We then stop and allow the bones to heal. One year later, the femurs and the tibias and fibulas can be cut and the same nail used to restart the lengthening again. The remaining 4cm in each bone is then obtained. Since 4cm is considered a small lengthening, the risks from lengthening are lower. This strategy is therefore very safe and minimizes the time of lengthening for each procedure. The first lengthening takes 11 weeks to complete the femur and tibia 4+4cm lengthening. While the first lengthening requires two surgeries to prevent fat embolism, the second lengthening done a year or more later, requires only one surgery since the lengthening nails are already in place. All the bones (both femurs, both tibias and both fibulas) are cut at one time through very small incisions. Since this strategy requires 3 surgeries and 2 lengthenings it is more expensive than all the other strategies.

Surgery Add Ons to treat associated femur or tibia deformities

The femur and tibia may have associated deformities that can be corrected at the same time as the lengthening. Most of these can be done without too much additional surgery. The easiest deformity to correct is a rotational one, in which the femur or tibia are twisted inwards and outwards. This manifests as intoeing (pigeon toed) or outtoeing (duckfooted). It can also manifest as restriction of hip motion, low back pain, hip , knee, ankle or foot pain. We always assess for this problem. To fix a rotational bone deformity requires an osteotomy (bone cut). Since the femur is cut for femoral lengthening we can easily correct femur rotation deformity at the time of femur lengthening surgery. To do this accurately, requires us to insert two temporary guide pins in the femurs at specific angles measured using a device called an inclinometer. We then dial in the exact amount of rotation correction after breaking the femur bone and inserting the STRYDE nail.

This correction is then locked in place with the screws that go through the STRYDE nail. The two temporary guide pins are removed. For tibial rotation deformities the same is done in the tibia. We cannot correct tibial rotation deformity with femur lengthening surgery or vice versa.

The second deformity that can be corrected at the same time is bowlegs. Many people undergoing stature lengthening also have bowlegs. This deformity called genu varum , can only be corrected with a tibial osteotomy. Therefore when doing a tibial lengthening we can do bowleg correction at the same time without much additional surgery. To do bowleg correction with femur lengthening requires a separate tibial osteotomy with insertion of a metal plate and bone graft to the tibia. Therefore bowleg correction with femur lengthening is a much bigger surgery and therefore more costly.

Bilateral Humeral Lengthening

Most people undergoing lower limb stature lengthening do not choose to also lengthen their arms. For most lengthenings under 4 inches the arms do not look out of proportion. The greater the amount of lower limb lengthening the more proportionately short the arms appear especially when walking and swinging the arms by the sides. Therefore some patients who undergo longer lengthenings also choose to lengthen both humeri (upper arms). The humerus can safely be lengthened between 5-8cm. Most people choose to have 5cm of lengthening. This lengthening can be done with the Precice nail instead of the STRYDE since the arms are not normally used for weightbearing. There are more diameter and size options with the Precice than with the STRYDE.

Forearm lengthening is not an option. The forearm contains two long bones. These two bones have a very delicate anatomic relationship to each other. The radius bone rotates around the ulna bone. This motion is called supination (palm up) and pronation (palm

down). Forearm rotation is a very important function. Lengthening of the forearm causes loss of pronation and supination range. Therefore lengthening of the radius and ulna would cause significant loss of upper extremity function. This tradeoff is not reasonable and therefore should never be done when normal anatomy and motion exists before surgery.

We also do not lengthen the feet, hands, fingers or toes. We do not lengthen the clavicles (collar bones). It is not that these bones cannot be lengthened. It is that lengthening these bones causes serious permanent loss of function which is not an acceptable trade off for making a bone longer.

Some patients who undergo longer lengthenings also choose to lengthen both humeri (upper arms)



How long will I be on crutches with the STRYDE nail?

Dr. Paley is the surgeon inventor of the STRYDE nail. He designed it specifically for stature lengthening patients to allow full weight bearing during the lengthening process. Immediately after surgery there is pain. Therefore most patients use crutches or a walker for two to three weeks after surgery. For longer distances a wheelchair can be used during these first few weeks. We do a weight bearing test in our physical therapy department and once the patient passes this test they can stop using crutches. We still recommend one cane when walking up or down stairs or on/off curbs.

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 increases with increased length. A lot of research on this has been done by Dr. Paley. Up to 5cm is a low risk lengthening. Between 5-8cm is medium risk and over 8cm is high risk. For example to achieve 10cm of lengthening it is much safer to lengthen the femur and tibia each by 5cm than to lengthen either bone by 10cm.

Are there any additional unexpected costs from the initial surgery?

The pricing for the femur and tibia lengthening includes all additional ancillary procedures such as iliotibial band (ITB) release and biceps tendon lengthening for femur lengthening and blocking screws if needed for tibial lengthening, and peroneal nerve decompression for tibia followed by femur lengthening. These additional procedures are done to PREVENT complications and there is not additional fee for them. The only additional costs are the add on procedure listed and explained previously. Dr's. Paley or Robbins will recommend these if they are indicated to correct rotational or bowleg deformities.

Fortunately, complications that require surgery are uncommon. About 1% of patients experience complications that require unplanned surgery to fix. This leads to additional costs of about \$30,000 to fix the complication. We therefore advise to keep about \$30,000 in reserve even though the risk of needing this is quite small.



Will insurance pay for cosmetic stature lengthening surgery?

Cosmetic surgery of any kind is not covered by medical insurance. Cost is 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 since it is related to cosmetic surgery.

The Paley Orthopedic & Spine Institute Stature Center is the SAFEST most RELIABLE place in the world to have this surgery.

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

The Paley Orthopedic & Spine Institute STATURE CENTER is the SAFEST most RELIABLE place in the world to have this surgery.

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 patients that had lengthening done overseas. Since this surgery is paid in cash and not by insurance, it is open to abuse all over the world including in the United States. It is very difficult for the consumer to discern where to go. All limb lengthening surgeons or centers are not the same. Just because a doctor advertises or is on TV does not mean they are experienced or safe.

. Just because it is cheaper, it 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 United States 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 less expensive centers overseas as well as at some US centers. The cost to reconstruct and 'rescue' their limbs was as high or higher than the cost

to undergo the procedure at the Paley Orthopedic & Spine Institute Stature Center 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 STRYDE is the most advanced and safest method for cosmetic lengthening, with less pain and lower complications than other methods. Ask yourself, is reduction in your function worth the cost savings.

How experienced is the Paley Orthopedic & Spine Institute Stature Center at limb lengthening and who are the clinical team?

The Paley Orthopedic & Spine Institute Stature Center is the most experienced place in the world to have this surgery.

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 20,000 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. His protégé, Dr. Craig Robbins, has been working with him on Stature Lengthening for the past five years and helps Dr. Paley with almost every stature surgery and also helps with the follow up office visits. Together they have the largest and safest experience in the world with **STATURE LENGTHENING**.

The rest of the stature lengthening team includes physician assistants, nurse practitioners and one Nurse Coordinator. Our four physician assistants; John Robb, Vera Gray, Allan Loesch and Michelle Hyland are very experienced in helping with the surgery and outpatient management. Our two nurse practitioners Marcia Haines and Osiris Ahuatzin are exceptional with the inpatient management. They are available all day on the inpatient surgical unit where the stature patients stay for three to four nights. Our case manager Emily Ward organizes all the discharge needs of the patients. The entire team approach is coordinated by, Angelique Keller, RN. Angelique who is also a nurse, is present at each stature consultation. She is the central point person who helps with all aspects of care including booking of consultation and surgery, patient housing, etc. Finally Angelique's assistant Sylwia Kaczmarek works behind the scenes to coordinate all of these aspects.

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

SAFETY is number ONE.

EXPERIENCE is number TWO.

RELIABILITY is number THREE

REPRODUCIBILITY is number FOUR

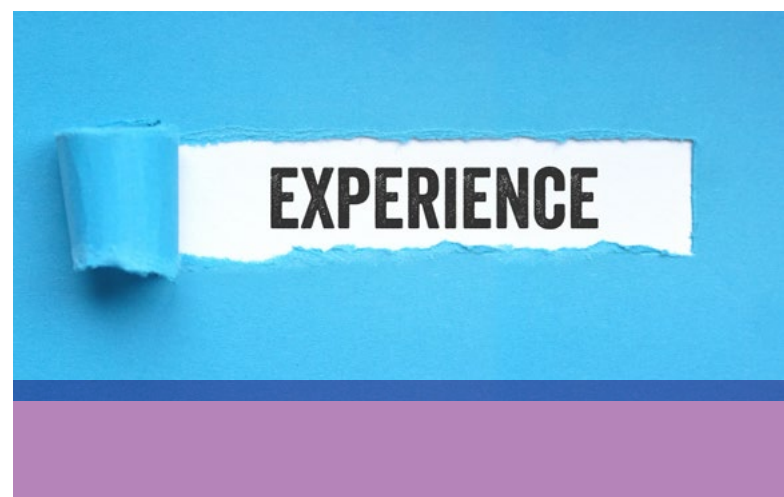
Limb lengthening can lead to many complications. Unlike other cosmetic surgery, limb lengthening can lead to chronic pain and disability. Therefore the most important factor to consider is **NOT COST**, but rather **SAFETY**.

There are many centers around the world offering stature lengthening at cheaper prices than at the Paley Orthopedic & Spine Institute Stature Center. There are no other centers offering limb lengthening as safely as at the Paley Orthopedic & Spine Institute Stature Center. **SAFETY** is the most important consideration when choosing where to go. Safety comes from **EXPERIENCE** and organization. At the Paley Orthopedic & Spine Institute Stature Center, 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, nurse practitioners, physician assistants, nurses, physical and occupational therapists, orthopedic technologists, and patient coordinators, etc. All of which are dedicated to the limb lengthening process makes it safe, secure and as streamlined as possible. The **RELIABILITY** of the

team gives peace of mind knowing that 24 hours a day, 7 days a week, 365 days a year the team is there to provide care for all of our patients from around the world. Finally, we have achieved excellent results in all of our patients, demonstrating the **REPRODUCIBILITY** of the methods we use.

Can I get financing to help pay for the surgery?

We **DO NOT** provide financing. If you need financing, you will need to obtain this privately on your own to be paid in full prior to surgery.





There are no other centers offering limb lengthening as safely as at the Paley Orthopedic & Spine Institute Stature Center.

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: 2 STRYDE lengthening nails.
4. Anesthesiologist fees.
5. Surgeon fees.
6. Surgery assistant fees.
7. Hospitalist fees (internal medicine doctor available during the entire hospital stay).
8. Radiologist fees (includes their reading fee of all the x-rays).
9. All hospital diagnostic tests during the admission are included.
10. All x-rays: up to 12 weeks femurs or tibias; up to 14 weeks femurs plus tibias combined (surcharge after 14 weeks).
11. All office visits: up to 12 weeks femurs; up to 14 weeks femurs plus tibias combined (surcharge after 14 weeks).
12. 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).
13. Wheelchair, walker, crutches and bedside commode as needed for post surgery; provided as part of discharge from hospital.

What is covered in the cost of Physical Therapy?

1. Daily (5 days per week) one hour of physical therapy at the Paley Orthopedic & Spine Institute Stature Center outpatient rehab center (\$225 per day extra cost for PT on weekends); up to 12 weeks femurs and tibias (surcharge after 12 weeks); femur plus tibia overlapped up to 14 (surcharge after 14 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. After discharge Medications and pharmaceuticals (e.g. pain medicine, anticoagulants, supplements e.g. calcium, bone health now, Vitamin D, anti-inflammatory medications).
2. Accommodations in West Palm Beach.
3. Travel to and from West Palm Beach.
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 West Palm Beach.
6. Entertainment or Internet.
7. Home health aids (nurses, homemaker, etc.).
8. Additional PT beyond the one hour a day for 5 days a week. (patients may purchase more PT for a second hour a day or weekend or pool therapy).

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 fifteen (15) business days before surgery or the surgery will be canceled. Payment can be made by wire transfer or certified check. If you want to use a credit card there will be a surcharge of 2.5%. A non-refundable deposit of \$10,000 is due at least two months 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 or representative with less than two months notice, will result in loss of the deposit. The deposit is fully refundable if changes or cancellation of surgery are more than two months before the booked surgery date. The deposit money is part of the total fee and will be credited to the total balance due unless it is forfeited. In the case of late cancellation, rebooking of the surgery will require a new deposit.

How are the scars from surgery?

We use a minimally invasive method to put the lengthening device into the bones. A 1 to 1.5cm incision is made at the hip area, and approximately 5 quarter in. (6mm) incisions are made on the side of the thigh. These scars are so small they are not very noticeable. Most look no bigger than a mosquito bite. For the tibia there is one half in. (12mm) and 8 quarter in. (6mm) incisions. The incision to cut the fibula is about 2-3cm long and the peroneal nerve decompression incision is about 4cm long.

How painful is limb lengthening?

Immediately after surgery, there is post surgery pain. Most patients have epidural anesthesia or PCA (patient controlled analgesia). We often inject a long acting slow release local anesthetic into the wounds (Exparel), which lasts for 96 hours. These methods offer excellent post-operative pain control. Patients are switched to oral pain medication in preparation for discharge

from the hospital. 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. Most patients do not complain of much pain during the daytime. The actual lengthening process is usually painless. Most patients have little to no pain during the majority of the lengthening.

What can I do to prepare for surgery?

- a) Education:
 - (1) Read all printed and online materials we provide.
 - (2) Book a consultation and have your questions answered in person
 - (3) Email us any additional questions
- 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, you can do cross-leg stretches with the hip straight. These stretch the IT band.
 - 2) quadriceps and especially the rectus femoris muscle (bend knee with straightening of hip at the same time. Can be done standing while pulling foot behind butt and leaning back or kneeling with leaning back).
 - 3) Hamstrings: knee straightening while flexing hip.For tibial lengthening: 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 medications, aspirin and fish oil supplements at least one month before surgery.
- e) Notify us if you are a smoker or a vaper and immediately stop smoking or vaping and avoid exposure to second hand smoke. Smoking and vaping both cause lung damage and increase your risk for symptomatic fat embolism syndrome.
- f) 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 the duration of the distraction phase. This will vary according to which type of lengthening strategy you choose. Depending on your profession you may or may not be able to return immediately to work after completing the distraction. 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. Arrange for someone to come with you or be prepared to hire a home health aid 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?

NO

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 on patients with a body dysmorphic psychosis as well as to make sure that patients have realistic expectations and the proper support required to undergo this procedure.

Do I need to book a consultation before surgery?

YES

Although the information we provide via email is very educational, it is preferable to be assessed either in person or have a virtual consultation via Zoom online. This helps you become as prepared as possible for the surgery. We have found

that patients who do not come for a consultation are not as prepared for the surgery and have much more difficulty when they undergo this procedure.

If you insist on having the consultation the week before surgery, please keep in mind you will not be as well prepared. Furthermore, you will have paid your deposit and it will be non-refundable at this stage should you change your mind. There is no problem if you change the strategy of lengthening and we will do everything to accommodate you. You will still need to pay separately for the consultation.

At the first consultation, Dr. Paley performs four muscle length tests (Ober test, Popliteal Angle measurement, and Ely test for femur lengthening and Silverskiold test for tibial lengthening) to determine if the iliotibial band-fascia lata, hamstrings, and rectus femoris muscles (for femur lengthening) and the gastrosoleus muscles (for tibial lengthening) are tight. The greater the amount of lengthening, the more likely the need for such soft tissue releases. For most lengthenings between 5 to 8cm, an iliotibial band release is carried out. For tibial lengthening, if the Achilles tendon is too tight, as determined by the Silverskiold test (physical examination), then a gastro-soleus contracture could result. Gastrosoleus lengthening can be performed but can lead to permanent weakness of push-off strength. We, therefore, avoid this and prefer limiting the amount of tibial lengthening to 5cm maximum.

What is involved in the consultation?

The consultation starts with a specialized standing x-ray called an EOS scan. This is a low radiation dose scan of your entire body from head to foot in a biplanar fashion (front and side at the same time). This may be done the night before the consultation if the consultation is first thing in the morning.

You will meet with one of our physician assistants as well as with Angelique Keller. After that you will see Dr. Paley. Dr. Craig Robbins will also try to meet with you. They will measure and evaluate you and your x-rays, including a physical examination of range of motion, muscle tightness, height, proportion, etc. They will measure your bone proportions from the EOS scan. The normal proportion of the tibia to femur lengths is 0.80 ± 0.02 . If the ratio is greater than 0.82, your tibias are relatively long compared to the femurs and femoral lengthening may be preferable, while if the ratios are less than 0.78 then tibial lengthening may be preferable. This must be tempered by the amount of lengthening desired since up to 8cm can safely be done in the femurs and usually only 5cm in the tibias.

Dr. Paley will then come in. He will discuss your goals and suggest the best lengthening strategy. He will advise the advantages and disadvantages of the various lengthening options. He will help you customize a lengthening strategy for you according to your specific height increase goals, proportions, level of affordability and time availability. Dr. Paley will go into these and other aspects of lengthening in detail and try and answer all your questions.



ANGELIQUE KELLER, RN
International Program Manager
for Stature Lengthening
akeller@paleyinstitute.org

After the consultation with Dr. Paley, Dr. Robbins or the physician assistant will stay to answer any additional questions that may remain. Angelique will then take you over to the physical therapy department for a tour. If possible, we will try and introduce you to other stature lengthening patients if they are around at the time. We cannot guarantee this as these other patients are scheduled for PT independently of our consultation schedule. We must also request permission from them. We respect and guarantee all patient privacy.

Can I take a tour of the Paley Orthopedic & Spine Institute Stature Center in advance of the surgery?

Yes, a tour is part of every consultation.

How do I book a consultation or surgery date?

Please email Angelique Keller (akeller@paleyinstitute.org) who will help you find a date for the consultation or surgery. To secure a surgery date, you will have to make a deposit via wire transfer, check or credit card as explained in a previous section. Angelique can also be reached by WhatsApp at: 561-371-9403 Or scan this barcode for WeChat



How do I protect my privacy regarding my consultation and surgery?

At the Paley Orthopedic & Spine Institute Stature Center we are HIPPA compliant. We cannot and will not release your name or medical information to anyone unless you authorize it. The only exception to this is patients under the age of 18 years old, in which we communicate private information to their parents or legal guardians. If you are over age 18, we cannot even speak to your significant other, parents or children without your permission.



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 can discuss your anesthesia and postoperative pain management in advance of the surgery. You will be given instructions for surgery. You should not eat or drink after midnight before the surgery, and you should come in two hours before your scheduled surgery time, to the preoperative area in the Kimmel building on the campus of St. Mary's Hospital, 901 45th St.

How long is the hospitalization?

The hospitalization is usually 3-4 nights. Up to 4 nights is included in your fee. Hospitalization and surgery is at St. Mary's Medical Center, in a private room of the beautifully renovated surgical care unit in the Waters 3 Pavilion if you are over 18. If you are under 18 years, your private room will be on our newly renovated Pediatric Surgical Floor on the third floor of the Palm Beach Children's Hospital adjacent and connected to St. Mary's Medical Center. One parent or visitor is permitted to stay in the patients room during the day and overnight.

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. You will receive an intravenous iron infusion which helps to replenish blood loss and prevent transfusion. If you have family or friends, our patient liaison will keep them informed during the surgery and then organize for Dr. Paley to speak to the family after the surgery. We will then bring the family or friends into the recovery room (PACU) after the surgery to be beside the patient. You will have an IV and a Foley catheter (bladder catheter). The Foley catheter can be removed one or two days after surgery. While in the hospital, you will start on a blood thinner to prevent blood clots. The nurses will make sure you are comfortable and positioned in such a way as to prevent pressure sores. You will have blood tests to check your blood level. Even if your blood level

is low we rarely need a transfusion (2%). Each day our Nurse Practitioners will come by to check on you. You will also see the rest of the surgical team, as well as Drs. Paley and/or Robbins. 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 the wheelchair and bedside commode, etc. Once you are mobile enough, you will be discharged from the hospital with instructions.

Will I require a blood transfusion?

We rarely transfuse patients after surgery. We do give intravenous Iron to all patients to increase their blood levels faster. Very few patients lose enough blood to require a blood transfusion before surgery. Auto-donation 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 of days. The transfusion, if needed, almost always occurs one or two days after surgery. The risks from this are very minimal. Less than 2% of our patients require a transfusion.

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. Our nurse case manager will organize all of this for you. Our inpatient physical therapists will teach you how to do transfers from bed to chair to toilet. You will start walking with a walker and later transition to crutches as an outpatient. With the STRYDE nail you will be allowed weight bearing as tolerated right away. Due to pain you will likely not put your full weight and will use the walker for about two to three weeks.

What medications will I take after discharge from the hospital?

Blood thinner to prevent blood clots: Since you have the S nail and are allowed full weight bearing as tolerated we only use 81mg aspirin twice a day for prophylaxis. If you are on the birth control pill and do not wish to stop or if you have other known risk factors, then you will be started on Xarelto 10 mg daily (approximately \$313.99 per month).

Pain medicine (as needed): Percocet 5/325 # 90 pills an 7 day supply (approximately \$60); we refill this as needed during the lengthening. Due to the opioid crisis, the new law is that you must make an appointment with our Dr. or NP to have this refilled.

Muscle relaxant.

Vitamin D and anti-inflammatory medications are also part of the regimen.





Where will I stay after discharge from the hospital?

There are several options.

- 1) The most common place to stay is at one of our extended stay hotels on 45th Street. This is a few miles west of the hospital and the Paley Orthopedic & Spine Institute Stature Center, on the same street. The cost of stay at these hotels varies with season and availability. High season is winter and low season is summer. Please book as far in advance as possible, especially for in-season. Always ask for the Paley rate.
(Shuttle service provided to the 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 hotel to the hospital only if you stay at the extended stay hotels listed above. (Available Monday - Friday 8 am to 5 pm)

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 millimeter of planned lengthening. E.g. 80mm = 80 days. We don't start lengthening for 7 days. Therefore 80 days for 80mm plus 7 days = 87 days (12 weeks) for 80mm. Tibia lengthening is $\frac{3}{4}$ mm per day compared to 1mm/day for femur lengthening. For tibia lengthening, the distraction phase for 50mm is 10 weeks plus one week before we start lengthening; total 11 weeks.



Will I need help to look after myself?

Yes, you will need help for the first two to three weeks. You either need to come with someone who can help look after you or else you will need to hire a home health aid for the first two to three weeks. 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, everyone needs help for the first two weeks after discharge from the 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 weight bearing is allowed during lengthening?

With the STRYDE, you will start walking full weight bearing as tolerated with a walker or two crutches right away. This means you can put as much weight as you can tolerate. You will then be tested by our physical therapist with a special single leg standing test. This test has you step onto a scale and stand on one leg. If you can do this it shows that you have your balance back and it also shows peak single leg stance load which is higher than your weight. If the load is still within the fatigue strength limit of your nail diameter you may walk with no crutches. You will need to use a single cane for walking up and down stairs and for stepping

one or off of a curb. If a patient exceeds certain weight limits related to the diameter of the PS nail, then we may ask you to walk with one or two crutches but full weight bearing. . This is quite uncommon.

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. Again we recommend the use of a single cane when getting in and out of a car.

How often will I have physical therapy?

Daily, 5 days a week for the entire distraction phase. (6 days a week may be available for an additional payment of \$225 per session-please inquire regarding this)

During the 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. The additional cost of this is as noted above and can be paid on a weekly basis.

Daily home exercises are required by the patient throughout both distraction and consolidation phases.



Who does the actual lengthening and where?

The patient or their helper at their place of residence does the lengthening during the lengthening phase. The lengthening is done in 0.25mm increments, 4 times a day for the femur and 3 times a day for the tibia. For simultaneous femur plus tibia lengthening, the femurs are lengthened 3 times a day and the tibias 2 times a day. The lengthening is done using a special device called the ERC (External Remote Control) device. Our orthopedic technologist trains each patient to do this until they are comfortable using the ERC device. Each patient receives an ERC to take

There are no other centers offering limb lengthening as safely as at the Paley Orthopedic & Spine Institute Stature Center.

with them. The ERC must be returned at the end of the lengthening to avoid being billed by Nuvasive for the device (\$10,000 cost). As long as it is returned, there is no charge for the ERC device.

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

Every two weeks at the Paley Orthopedic & Spine Institute Stature Center office.

When will I have x-rays done?

Every two weeks, x-rays of each bone being lengthened are taken. Again this is done at the office visit.

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

Immediately.

What is the follow-up after I go home?

Send monthly x-rays to Dr. Paley/Robbins.

There are several options for sending x-rays:

Option 1:

Have your imaging facility place the images on a disc for you so that you can upload them yourself to My Medical Images website www.mymedicalimages.com

When ready to upload the images, please let us know and we will have an email from My Medical Images sent to you with a one time, free upload link. (Please check your spam folder)

Once you receive the email with the link, follow the prompts to upload your images.

(No need to create an account)

Once you have completed the process, we will transfer all imaging from that site to our Paley PACS System and alert your physician.

Troubleshooting & Tips:

The site only supports Google Chrome and Safari, do NOT use other web browsers such as Internet Explorer, Firefox, etc.

You will need a CD drive/reader to upload images.

An account is NOT necessary to use the one time, free upload link.

You may choose to create an account for \$30 per year.

Use code OTHROMD for \$10 off your first year.

We can only provide one free upload link per email address provided.

If you have used a link previously, please provide a new email, or create a paid account with the original email.

If you have any trouble uploading the images please reach out to My Medical Images support line at (855) 800-2851.

Option 2:

(Slower - can take up to 10 days for us to receive the images at the institute)

Mail the disc with the imaging to the following address:

Paley Institute

Attn: Name of Physician

901 45th Street, Kimmel Building

West Palm Beach, FL 33407

Option 3:

Email these to dpaley@paleyinstitute.org or crobbins@paleyinstitute.org.





When can I resume full weight bearing without crutches or a walker?

For the S nail, a couple of weeks after surgery.

When can I return to sports?

For the S nail 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. The doctor individualizes this for each patient. Most patients can start to run one month after being freed to stop using crutches. They can return to other sports after one month after starting to run.

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 Albizzia (1996 to 2000), the ISKD (2001-2010), the Precice1.0 (2011-2013) Precice 2.0 (2013), Precice 2.1 (2014), and Precice 2.2 (2015 to present). I have the world's largest experience with the ISKD (more than 300 cases) and the Precice/STRYDE (more than 1000/300 cases) devices. To date, all of my patients have achieved the goals of treatment and have returned to full activities including sports. Articles of our published results are available upon request but are also posted online. I was the first surgeon to use the STRYDE nail. The first one was implanted in May 2018.

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 metal have moving parts that 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. The nail also has a rare earth magnet inside. This is sealed from the body inside a waterproof chamber. It is possible that after years this seal could leak and the rare earth magnet would be exposed to body fluids. As such, it is preferable to remove this device before this could happen. Finally, MRI is not permitted with the nails in place. Since you never know when you need an MRI it is better to remove these so that this does not become an issue.

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 \$18,000 for bilateral femurs, \$22,500 for bilateral tibias (including tibio-fibular screws and blocking screws) and \$28,000 for simultaneous bilateral femur and tibial removal. If you combine removal with a lengthening in another segment there is some cost savings.

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

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

What are the main risks and 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 occurs in 4% of cases. It results from reaming the medullary (marrow) canal of the bone to make room for the nail. The reaming leads to pressure in the bone which causes the fat in the bone marrow to be pushed into the circulation. When this fat gets filtered by the lungs it is called fat embolism. Small amounts of fat are well tolerated by the lungs and lead to no symptoms. Larger amounts can lead to shortness of breath and lower oxygenation. In the majority of cases this is treated by breathing oxygen through a nasal cannula for a few days. In more severe cases a mask with oxygen is used instead. Finally in the very rare and most severe cases of fat embolism syndrome, (FES) the patient may require transfer to the ICU including intubation and ventilator treatment. Patients can even die from fat embolism. To date we have never had a patient die of FES and only one patient required ICU treatment.

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 (1%). Prevention is key. We use baby aspirin (81mg) twice a day after surgery both in the hospital and as an outpatient until the end of the distraction phase. While we have seen very few cases of DVT, none resulted in pulmonary embolism (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, either aspirin or Xarelto for higher risk patients.

Premature consolidation

In this complication, the patient's bone heals prematurely and prevents further lengthening. Premature consolidation (PC) can occur with any lengthening 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 STRYDE nail, with its rate control, allows the surgeon to do this. If premature consolidation

Dr. Paley has performed over
20,000 limb lengthening
surgeries since 1986.

He has the best track record
of success with all types of
limb lengthening.

does occur, it requires a small outpatient surgery to re-break the bone through a tiny incision. The incidence of this complication is about 1%.

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 Vitamin D level, smoking/vaping including second hand smoke, anti-inflammatory medicine use, anti-convulsant medication use, menopause, and other medication use (e.g. acutane, biologics, steroids). We also recommend supplements to help the bone heal faster (Silical). All patients are placed on Vitamin D to prevent delayed healing.

Since 2011 when we started with the Precice nail, not one patient required surgery to treat delayed or failure of consolidation. All were successfully treated by nonoperative methods including Zoledronic Acid infusion, parathyroid hormone (Forteo), Vitamin D and other supplements and Exogen bone stimulator. 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.

If surgery is necessary we know how to get the bone to heal with surgery. We got this experience when we used the ISKD. Failure of bone healing occurred not infrequently. We therefore got very proficient at using bone and bone marrow grafting to get the bone to heal. While we hope not to ever need this with the Precice or STRYDE nails if we do need this as a fall back we are very experienced on managing this complication as needed.

Nerve injury

Nerve injury can occur with any lengthening surgery but is uncommon if the rate of distraction does not exceed 1 mm 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) occur, a nerve decompression surgery 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 STRYDE due to excellent rate control, nerve injury is very rare. Nerve irritation can also be treated medically using Neurontin or Lyrica.

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 his or her 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 Precice 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 associated expenses. 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. 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 can 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 fix the fibula to the tibia and the method of cutting the fibula bone.

Dr. Paley is the surgeon inventor
of the STRYDE nail.





Axial Deviation

Axial Deviation or deformity secondary to lengthening is not an uncommon problem. It can usually be prevented. Varus deformity is more likely with the use of a trochanteric nail. For this reason I prefer to use a piriformis entry nail. In proximal femur lengthenings if the osteotomy is done where the bone is tight around the nail the likelihood of varus angulation is unlikely. If a more proximal osteotomy of the femur needs to be performed, a medial blocking screw can prevent varus deviation.

Axial deviation is a more common problem in the tibia. The tibia tends to lengthen into valgus and procurvatum. To prevent this the nail should be inserted at the correct starting point, which is very high and as posterior as possible on the tibia on the lateral and centered on the knee in the frontal plane. If the nail has space between it and the lateral cortex above the osteotomy, a blocking screw should be inserted in this space. If the nail has space between it and the posterior cortex then another blocking screw is inserted there. I designed the STRYDE nail to resist axial deviation by also offering a third proximal locking screw (P2.2 only has two). If all these precautions are followed no flexion or valgus deformity develops with lengthening.

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 20,000 limb-lengthening surgeries. This is more than any other surgeon in the US or the entire world. The majority of these surgeries were for LLD. Over 2000 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 and published in 1997. Although his results were excellent, the scars, the pain, the suffering, and the pin site infections were not conducive to a cosmetic procedure.

He sought a fully implantable lengthening solution. When the *Albizzia femoral nail*, developed by Guichet and Grammont, became available, he worked with the French company that made that nail to develop a tibial lengthening Albizzia for stature lengthening. He started using the femoral and tibial Albizzia 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. This device is still being used in Europe under the name Guichet nail and Betz-Bone. While they have modified this nail to a small extent, it is still the original Albizzia nail that Dr. Paley abandoned in the 1990's. There are much better devices now and the use of this older nail should be abandoned.

In 2001, when the *ISKD*, developed by Dr. Dean 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 ISKD either lengthened too quickly or failed 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, Dr. Paley's 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 Albizzia and ISKD have rate control issues and none of these three nails can go reverse

The first second-generation device on the market was the Precice. On December 1, 2011, Dr. Paley implanted the first 3 Precice nails in the United States. By November 2013 when the improved model he helped develop the P2 was released, he had performed over 155 P1 cases. At present, he has implanted more than 1000 Precice nails (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 or its lengthening mechanism that occurred mostly with the P1 and to a much lesser extent with the P2 and P2.1. There has not been any breakage with the P2.2 which was also designed in collaboration of Dr. Paley. Dr. Paley was the first to identify the problems and weaknesses of the P1 and together with Ellipse Technologies, set out to redesign the nail. The first improved device was

the P2, with increased strength of the nail shell by up to 4X and of the mechanism by up to 3X. The P2 was launched in November 2013 and Dr. Paley again was the first to use this improved device. This eliminated the problems with the mechanism failures and reduced the breakages significantly. Dr. Paley then recognized a more minor problem in the P2 with fragmentation of a washer that helps connect the telescopic parts of the nail together. This led to further design changes and the emergence of the P2.1 in December 2014 and P2.2 in May 2015. Since then there have not been any further breakages. Ellipse was acquired by Nuvasive in 2015 and Nuvasive Specialized Orthopedics (NSO) was created to support and develop the Precice nail. NSO took up a project started between Dr. Paley and Ellipse; the creation of a full weight bearing nail to permit Stature Lengthening patients to walk without crutches. This project started by thickening the existing Precice nail. It then followed with development of a Cobalt Chrome Nail which was later abandoned in place of a Stainless Steel nail. After 4 years of work on this, the STRYDE was born and first implanted by Paley in May 2018.

Together, Dr. Paley & Dr. Robbins have the largest and safest experience in the world with Stature Lengthening.



CHOOSING A LEG LENGTHENING SURGEON

Today is the first day after my surgery that I went to work without a cane, crutches, or any walking aids. I can walk at about half my normal speed, and with some hip sway, but my gait is getting better and better every day.

It's been 5 months since my tibias surgery, and 4 months and a week since my femurs surgery. I must confess I haven't done as much physical therapy as I should have, yet I'm recovering quite well, despite being in my late 30s. I would say I owe my good recovery in large part to my surgeon, Dr. Paley, so I wanted to write a post about how I chose him as my leg lengthening doctor.

Once you've decided to have CLL in the first place, the next choice is to pick a hospital and doctor. Cost and safety are usually the top concerns, followed by location.

As with most other services, when it comes to surgery, you generally get what you pay for. The most expensive doctors have the best reputation, often for good reason - great outcomes, excellent safety record, and a large number of patients

treated. The other major factor that plays into the overall cost is the cost of living, with the US, Western Europe and South Korea being up to 2-3x more expensive than Eastern Europe, India or China.

My advice is to think about your safety first, cost second, and location third. You have the rest of your life to cover a difference of, say, USD 60,000; the other side of the coin is that you'll also have the rest of your life to deal with a complication or serious reduction in functionality. Is the risk worth the cost? Also, some surgery methods are cheaper than others, but also take more time to recover. Depending on your situation, time may be money.

As for the location, make it something you care less about by considering it a vacation. Language may pose a problem, but even an American in Russia can still get by.

Once you've decided on the cost tier (lower end or higher end), the next step is to choose the safest doctor. As a general principle of risk reduction in medicine, the centers that perform higher volumes of a given procedure, tend to have lower complication

rates. Safety is highest with surgeons who are very experienced, and very specialized. The ideal surgeon should be specialized in leg lengthening, and have an excellent track record for this surgery over a long period of time, with many patients.

In the US, Dr. Paley fulfills all these criteria. His Wikipedia page shows an impressive list of credentials - practicing orthopedic surgery since 1980, professor of Orthopedics for 14 years, co-founder of limb lengthening centers, author of numerous specialty books and studies (see PubMed, the US National Institutes of Health database of life sciences topics), and the first surgeon to use the latest advances in intramedullary nail from NuVasive (PRECICE, and in 2018, STRYDE).

To be extra safe, I searched limb lengthening forums for actual patient experiences. Few limb lengthening

patients take the time and effort to share their diaries, but among Dr. Paley patients who did, all were happy with their results, and none had significant complications that weren't promptly resolved. Since I was aiming for quadrilateral

leg lengthening, iamready's diary was closest to my case. Again, the patient recovered well and had no complications.

If you can't go to Dr. Paley, there are other reputable LL surgeons who can help you, but make sure to do your research. Outside of the US, safety information may be hard to come by. Limb lengthening forums can help, but take the information with a grain of salt, and double check everything. Unfortunately, some doctors have been known to pay patients to speak positively about them, others have had a surprisingly high complication rate, even though they operate in first-tier economies, and others have had success cases, but also troublesome ones. Yet other doctors play into the patients' desire for height and allow them to lengthen unsafe amounts, or too quickly.

Generally, the less publicly available information there is about a doctor, the more careful you need to be. The same applies to lengthening devices - while PRECICE has plenty of studies on its effectiveness, and is FDA approved, other nails have little to no information about them.

**"Be careful,
do your research,
and put safety first."**



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