

Seven Rounds of Corrective Osteotomy

Narrated by Chen Ing-Ho, Honorary Superintendent of Hualien Tzu Chi Hospital

The surgery to treat the 26 years old female patient Chen Tuanzhi's congenital knee hyperextension had two major features:

The strategy to correct the knee joint involves two surgical operations: closed corrective osteotomy, and open corrective osteotomy. In comparison to the documented method of removing a wedge of bone 6.5cm in size, the combination of the two surgical procedures can correct as much as 160 degrees of deformity, while preserving the length of the patient's limb.

The surgical corrections were performed on both knees and both feet. The addition of the latter drastically increases the scope and difficulty of the treatment. All four joints

in the lower limbs must overcome the injury from the surgeries and acquire the joint functions it never had, posing challenges unprecedented in the documented cases.

Besides bone and joint deformities, important preoperative assessment of congenital knee hyperextension, a case I have never seen before, let alone operate on, involves nerves and blood vessels. The angiograph of Tuanzhi revealed her thigh artery to be of a normal size, but it grew thinner as it extended below the knee. Furthermore, we could not feel the pulse of her dorsalis pedis artery during physical examination. These are the signs of poor blood circulation in lower extremities.

According to the preoperative

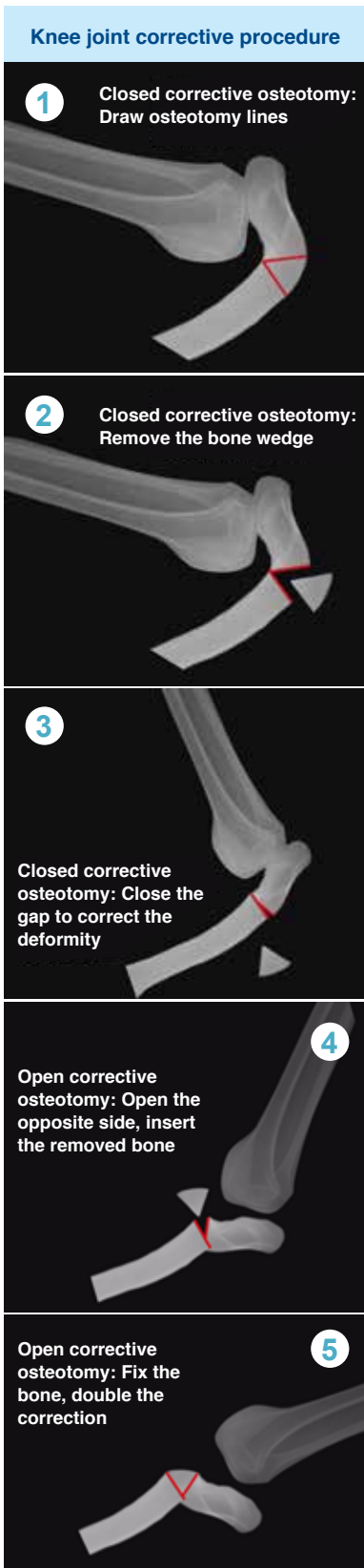


Supt. Chen Ing-Ho drew 1:1 scale operation plan for Tuanzhi so that the medical team could follow the exact details of the operation.

assessment, the functions of her sensory and motor nerves were normal. However, after a surgical correction of 160 degrees, the nerves, by then bent around at a large angle, was at risk. Damage to the nerves could result in paralysis, while damage to the blood vessels could lead to amputation. I explained to Tuanzhi's mother that, despite these risks, surgery was still the recommended option. "The region

at risk of tissue necrosis is at the level of the mid calf," I told her. "In the worst case scenario that Tuanzhi's calf had to be amputated after surgery, her lower limb will still be longer than it is now. And judging from the overall performance of the limbs, Tuanzhi is better off with the surgery than without."

After the first surgery, while Tuanzhi was laying on the surgical table, I



immediately checked the conditions of her blood vessels. Even though she was sedated, I could perform the test by examining the pulse of her dorsalis pedis artery and by pricking her skin with a needle and observe the bleeding. I was under tremendous stress at the time, afraid that her blood circulation might be affected by the surgery. As it turned out, not only could I feel the pulse, it was stronger than before.

I was concerned, aside from vessels and nerves, whether the correction of such large angle was even probable. A correction of 160 degrees was apparently unheard of. Corrective osteotomy is usually performed with an average of 40 degrees of correction or less. Whether bones under quadruple of that amount of correction can grow properly were the question no one could answer beforehand.

Mobile Knee as First Priority, Innovative Osteotomy Technique

When treating an unfamiliar case, like Tuanzhi for example, it is vital to review the past literature.



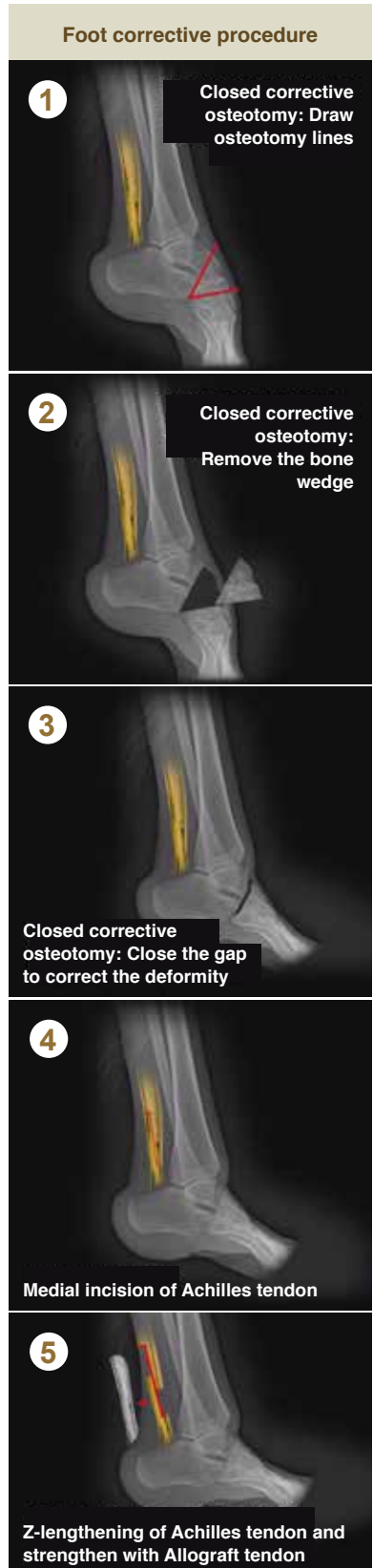
An innovative integration of open and closed corrective osteotomy has achieved a 160-degree correction

Fortunately, there were two papers on the surgical treatment of congenital knee hyperextension. Through its descriptions, I could observe their surgical procedures, pondering its strengths and weaknesses, and grasps what we can learn from it and what we can improve on. It was the literature that made me realized that I was not alone.

The first paper was on arthrodesis. Arthrodesis is a relatively simple procedure where the bones are straightened and nails implanted, irrespective of the relationships among fibula, tibia, and joint. But, there is no joint motion. If I performed arthrodesis on Tuanzhi, all I needed to do was to remove a piece of 30 degrees bone from the femur, realign it and nail it. The problem was that, by performing arthrodesis, the patient would be incapable of moving the joint, and have to walk by moving the entire leg rigidly. Considering the patient's quality of life, I chose corrective osteotomy that preserves the knee joint. Although I chose not to perform arthrodesis, the paper still offered me a backup solution: If the corrective osteotomy is proven too much of a challenge, I can always return to arthrodesis.



Performed closed corrective osteotomy to achieve 90 degrees of correction on the foot, followed by z-lengthening on Achilles tendon, and strengthened with donated Allograft tendon.



2014 Date	Surgical operation	Degrees of Correction
Mar 12	Right knee corrective osteotomy	130 degrees
Mar 22	Left knee corrective osteotomy	130 degrees
Apr 04	Left knee corrective osteotomy (2 nd)	30 degrees
Apr 30	Right foot corrective osteotomy	60 degrees
May 14	Left foot corrective osteotomy	80 degrees
Aug 19	Right knee corrective osteotomy (2 nd)	30 degrees
Sept 03	Right foot corrective osteotomy (2 nd)	30 degrees

【 Total Degrees of Correction 】

Both of Chen Tuanzhi's knee joints were hyperextended at an angle of 160 degrees. The deformity was completely corrected after four surgeries, and now she can straighten her legs like a normal person.

Her right foot received two surgeries and corrected a total of 90 degrees, and her left foot received a correction of 80 degrees. Because her left leg was shorter than her right, the correction on her left foot was reduced by 10 degrees, which allowed her to lower her left footplate slightly and minimize the length discrepancy between both legs.

The second paper documented a case of corrective osteotomy that preserved the patient's joint by removing a wedge of bone from the upper knee joint at an angle greater than 100 degrees. The literature was extremely helpful, as it informed me that a large angle correction, without damaging cardiovascular system, was a feasible option.

Unfortunately, the surgical technique mentioned in the literature had a major flaw. The technique, which removes a wedge of bone 7cm in size to achieve the degree of freedom they needed for the correction, would leave the patient with a shortened limb. Tuanzhi was born already with a shortened limb due to her congenital deformity, hence my priority was to preserve the length of her lower limbs as much as possible. To do that, I would have to innovatively combine closed and open corrective osteotomy. The key was to calculate the precise base length and the angle of the triangular bone that was to be removed, remove it, and realign the bones to complete the closed osteotomy; then take the removed bone, insert it into the original pivot end to complete the open corrective osteotomy. By applying this surgical combination, not a piece of bone is wasted. We could achieve the intended

goal of correcting the deformity, while preserving the maximum length of the limb.

Prepared Every Detail for Surgeries

People who suffer from equinus foot deformity, a disease resulted from imbalanced muscle tension, often have cerebral palsy. However, even in those cases, the deformity rarely reached 90 degrees. To have knee hyperextension coupled with equinus foot deformity of 90 degrees, Tuanzhi was certainly the first.

I have performed surgery on patients with equinus foot in the past, but their symptoms were far milder than that of Tuanzhi. Therefore, I turned to Dr. Huang Shih-Chieh, my mentor in National Taiwan University Hospital, and the current Commissioner of the Department of Health, Taipei City Government. He was an experienced and excelled in the field of pediatric orthopedics. I showed him the information I had on Tuanzhi, and as expected, he concurred with my decision.

To correct Tuanzhi's feet, I have to first deal with her contracted Achilles tendon. I chose z-lengthening, a method that requires division of the tendon. However, in the preoperative

assessment, I realized that her tendon was too thin, and to half it with z-lengthening was way too risky. Even our suture was thicker than her tendon!

Every surgery requires a comprehensive assessment of every possibility. I decided to use allograft tendon to strengthen Tuanzhi's Achilles tendon. By then, Tuanzhi's feet surgery consisted of two major operations: metatarsal osteotomy and z-lengthening. The key challenge of performing two operations consecutively was that the forces applied in each operation were directly opposite of the other. In other words, to achieve the desired effect in metatarsal osteotomy, the footplate would have to be pulled upward, which most likely would damage or even snap the newly surgically attached tendons. The foot skin was another stressor. During the surgery, all segments of the foot are cut open, which already reduces the viability of the skin, and since the foot is pulled downward during the correction, it stretches the skin thin, further reduces its viability. I explained to Tuanzhi's mother that even if I am capable of cutting the bone, lengthening the tendon, and correcting the deformity by 90 degrees, to preserve the viability of the skin, I may have to reduce the correction down to 60 degrees, and slowly adjust

the correction with casting. The stress, honestly speaking, is no less than the knee surgery.

Expect to Lengthen Her Legs in the Future

After seven surgeries, the responsibility to recover had shifted to Tuanzhi. She had to practice walking, using stairs, climbing slopes, and move through various spaces and environments. I believe her limb functions will improve with time, and one day she can let go of her crutches, and walk with her head up high.

The next phase of her treatment probably is the leg-lengthening surgery. It is a surgical operation that I have been mastered in. Surgery like this is a routine. When it comes to Tuanzhi, however, it is a little bit challenging. Her thigh bone is only 20cm, far from the length of a normal person, which leaves very little room for the lengthening procedure. Whether or not there are appropriate apparatuses to operate in such a narrow space remains to be seen.

There is prerequisite for the lengthening surgery, Tuanzhi's walking function must be better than better. The reason being that, once the surgery begins, her walking function will certainly decline. We have to be



certain that she can walk properly even with reduced capability.

Leg lengthening surgery does not only entail the lengthening of the limb, it also improves its overall function. Looking back at the past ten months, Tuanzhi had truly come a long way. She remained optimistic

and cheerful throughout the treatment. Never once did she appear disgruntled. I thank Tuanzhi and her family for placing their trust in me, to permit us a chance to treat her condition. Let us pray for her and wish her a bright future ahead.