

Lower Limb Lengthening Using Wagner Technique

Waleed Abdul Majeed Jasim FIBMS

Muhammed Jafer Humood Alwash FIBMS

Objective: To evaluate the Wagner technique as a method for bone lengthening of the lower extremity.

Methods: Twenty three patients underwent lengthening of the lower extremity between July 2000 and December 2002 in Al-Wasity hospital. 17 femora & 6 tibiae were lengthened in 16 females & 7 males, the ages of them were between 4.5 - 35 years & the length discrepancy was between 3.5 - 16 cm. The mean gain in length was (5.2cm). The mean percentage of femoral lengthening was (13.1%) of the original bone length, while that of tibial lengthening was (10.2%) of the original bone length. The percentage of true complications was 21.3%, in spite of complications, the ultimate goal of equalization of limb length did not significantly affected. we recommend Wagner technique as a method for bone lengthening in the lower limbs.

Results: The mean gain in length was (5.2cm). The mean percentage of femoral lengthening was (13.1%) of the original bone length, while that of tibial lengthening was (10.2%) of the original bone length. The percentage of true complications was 21.3%, in spite of complications, the ultimate goal of equalization of limb length did not significantly affected. we recommend Wagner technique as a method for bone lengthening in the lower limbs.

Conclusion: The Wagner technique is a safe and effective method for bone lengthening of the lower extremity.

Abstract:

The objective of this study is to evaluate Wagner technique as a method for bone lengthening. By using this technique, twenty three patients underwent lengthening of the lower extremity between July 2000 and December 2002 in Al-Wasity hospital. 17 femora & 6 tibiae were lengthened in 16 females & 7 males, the ages of them were between 4.5 - 35 years & the length discrepancy was between 3.5 - 16 cm. The mean gain in length was (5.2cm). The mean percentage of femoral lengthening was (13.1%) of the original bone length, while that of tibial lengthening was (10.2%) of the original bone length. The percentage of true complications was 21.3%, in spite of complications, the ultimate goal of equalization of limb length did not significantly affected. we recommend Wagner technique as a method for bone lengthening in the lower limbs.

Introduction:

Limb lengthening by means of osteotomy & callus distraction was first described in 1904-1905 by A. Codivilla.^(1,2) In 1913 Ombredanne performed gradual femoral lengthening by fixing one pin above & one pin below the osteotomy with an apparatus fitted to the side of the thigh. In 1921 V. Putti adopted the ideas of Codivilla &

Ombredanne by application of gradual distraction to 2 pins placed proximal & distal to the osteotomy.^(3,4) In 1936 Compere recommended bone grafting at the lengthening site to lower the incidence of nonunion.⁽⁵⁾ Ilizarov in 1952 developed his modular ring external fixator. In 1971 Wagner described a new unilateral dynamizable fixator for leg lengthening which gives an effective stability of the osteotomy.^(6,7)

Materials and Methods:

Wagner technique was used in 23 patients between July 2000 - December 2002 in Al-Wasity hospital. 17 femora & 6 tibiae were lengthened in 16 females & 7 males, the ages of them were between 4.5 - 35 years & the length discrepancy was between 3.5 - 16 cm. The causes of leg length discrepancy were poliomyelitis in 11 patients, congenital in 7 patients, trauma in 4 patients & infection in 1 patient. The mean period of follow up was 26 months. We evaluate our results using 3 parameters, first is the gain in length measured by cm., second is the percentage of lengthening amount divided by the bone length before surgery & third is the healing index which is defined as time required to accomplish one cm. of lengthening & consolidation & is calculated by dividing the total overall treatment time (in days) by the total lengthening amount (in cm.).⁽⁸⁾ We evaluate our complications according to the classification system proposed by Paley⁽⁹⁾: There are three types of complications; *problems*, obstacles and true complications.

A problem was defined as potential expected difficulty that arise during the course of treatment & that is fully resolved by non-operative means. An obstacle was defined as a potential expected difficulty that arises during the course of treatment & that's fully resolved by operative means. A true complication was defined as a difficulty that is unresolved at the end of the treatment, or as an early or late post-treatment difficulty. A true complication was further defined as minor or major.

Surgical technique.

The Wagner technique consists of a transverse osteotomy of the femoral or tibial shaft at the proximal part of the diaphysis. Then, the osteotomized bone is fixed with an apparatus, that employs percutaneous Schanz screws anchored proximal & distal to the osteotomy site.

The apparatus consists of two telescoping rods with a gear for distraction.

Before commencement of distraction we wait for 5-10 days; during this period, the patient is taught to do distraction by himself, to take care for the pins & to do static physiotherapy.

After the waiting period, distraction is begun at a rate of 1mm. per a day. After the completion of distraction, the bone is exposed through the same incision, the distraction site (which is filled with soft callus) is bridged with A.O. plate, bone graft obtained from the anterior iliac crest can be applied & the Wagner device is removed.

Results:

Wagner technique was used in 23 patients between July 2000 - December 2002 in Al-Wasity hospital. 17 femora & 6 tibiae were lengthened in 16 females & 7 males, the ages of them were between 4.5 - 35 years & the length discrepancy was between 3.5 - 16 cm. The gain in length in all 23 patients varied from 3.1-9.5cm. (mean gain in length was

5.2cm). The gain in tibial length was between 3.1-5 cm .The gain in femoral length was between 3.5-9.5cm.

The percentage of the lengthenings obtained was between 8.5%-18.5% of the original bone length (mean 12.8%). The percentage of the tibial lengthenings obtained was between 8.5%-13% (mean 10.2%) while that of femoral lengthenings was between 8.9%-18.5%(mean 13.1%) of the original bone.

Total period of treatment was calculated from the day of operation to the beginning of full weight bearing without any external support. The total period of treatment was between 3.5-9 months (mean 5.6 months).

The healing index in our study was ranging from 28-50 days “mean 35 days”. The mean healing index for the patients with poliomyelitis was 40.8 days, while it was 32.3 days in other patients.

Equalization of the leg length was achieved in 15 patients.Seven patients had a slight residual length discrepancy of less than two cm.In one patient with poliomyelitis, the desired length could not be achieved because of the large amount of discrepancy ‘16cm.’.Both femur& tibia were short.

There were 26 complications in 20 lengthenings, 3 patients had no complications. The complications can be classified according to the classification system proposed by PaleyAccording to this classification system, we have 18 problems, 3 obstacles & 5 true complications (tab.1). Tibial fracture occurred in (1) patient& was regarded as major complication treated with open reduction & internal fixation. Two patients (tibial lengthening), required lengthening of the Achilles tendon because of equinus contracture unresponsive to physiotherapy.

Table (1): complications of our study according to Paley classification.

True complication	obstacle	problem	
		7	Pin track infection
		5	Knee stiffness
		3	Delayed union
		1	Implant failure
		2	Uncooperative patient
	1		Knee contracture
	2		malalignment
2			Axial deviation
1			Fracture
2			Equinus contracture

Discussion:

The site of osteotomy in gradual distraction is an important consideration; most authors observe an improved osteogenesis after metaphyseal bone transection compared with diaphyseal transection.^(10,11) The rate of distraction in our study was 1 mm./day; various authors reported that a daily distraction of one mm./day yielded the best results.

Slower distraction often leads to early ossification and premature union. Faster distraction of more than one mm./ day coincides with less new bone formation due to tearing of the endosteal and periosteal vessels.^(10,12,13,14)

During distraction some angulation may develop. The problem of angulation is one of the most undesirable disadvantages of Wagner technique compared with Ilizarov method. In our study, four patients (17.3%) developed angulation at the site of osteotomy, whereas in the study of Aaron A.D. who used Ilizarov method in (21) patients, there was no such problem.^(15,16) ;however, the angulation can be corrected by two means:

1. By readjustment of external fixator (during the distraction phase).
2. When doing internal fixation (after the distraction has been completed).

A major problem in bone lengthening procedures is maintaining stability during the period of consolidation. Wagner approached this problem by changing from external to internal fixation.⁽¹⁷⁾ We apply the plate in place before removing the external fixator to avoid any rotation, malalignment, or collapse of the gap. Changing from external to internal fixation permit early physiotherapy & early weight bearing.

In Wagner technique, removal of the external fixator with it's pins shortly after the distraction has been completed will reduce the rate of complication caused by these pins like pain, loss of knee motion, pin track infection, and interference with the function of muscles.

Breakage of the plate through the holes which were devoid of screws occurred in two patients (8.6%). It is better to bridge the distraction site with a special lengthening plate (which we do not have), that has no holes over the distraction area of bone.

As a group, the skeletally immature children generally developed fewer complications & tended to tolerate the procedure better than the skeletally mature group. Fig.(1)

The mean gain in length in our study was (5.2 cm) which was consistent with the study of Alan-D.A. (5.4 cm.) and the study of Jeffery M.H. (5.5cm.). The average length obtained by Roberto G. in 1990 was(4.5 cm.). In 1978 Wagner reported an average gain in length of (6.8 cm.).^(13,18,19) Fig.(2)

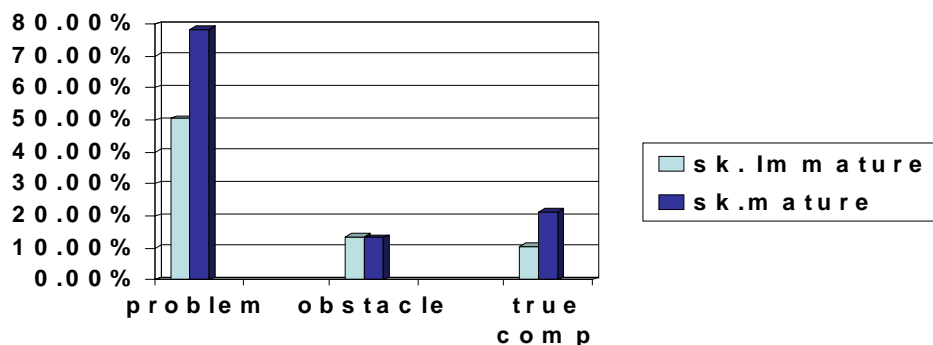


Fig.(1): Complications ((a comparism between skeletally immature patients and skeletally mature patients.))

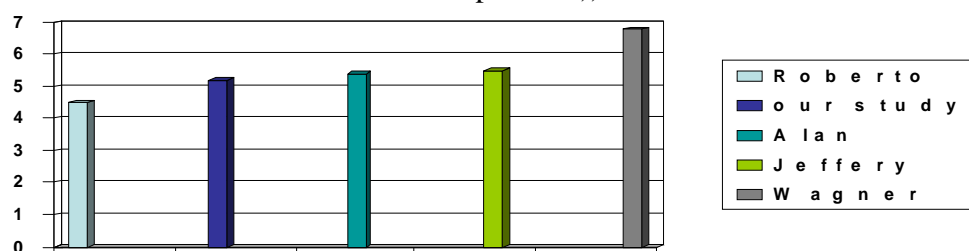


Fig (2): The gain in length(in cm.) in different studies.

The mean healing index in our study was (35 days/cm), while the mean healing index in the study of Fink B. *et al* was(40.4 days/cm)&in the study of Dwyer J.S. *et al* was (52.4 days/cm) & both of them used Ilizarov method.^(13,17)

The mean healing index of the femur (33.8 days/cm)was lower than that of tibia(40.3days/cm); this difference is attributed to the high vascularity & good soft tissue cover of the femur compared with the tibia.^(10,14)

The polio- patients possessed a higher healing index than that of other patients.The loss of muscle tonus & active movement in polio-patients cause diminishing arterial perfusion & stagnation of venous drainage. The impaired circulation is held responsible for retarded new bone formation.^(16,20)

In polio-patients, bone graft application was necessary to stimulate new bone formation, while in other patients, bone graft did not affect the duration of treatment or the quality of new bone.⁽²⁰⁾

Conclusions and recommendation:

1. We recommend Wagner procedure as an effective and fairly safe method for leg lengthening.
2. After the distraction has been completed, changing from external to internal fixation gives an effective stability at osteotomy site, allows early ambulation and decreases the rate of complications.
3. Per-operative application of the plate is best to be done before removing the external fixator to avoid displacement & collapse at the lengthening gap.
4. Bone graft is essential in polio-patient to induce new bone formation (osteogenesis).
5. Skeletally immature patients adapt the procedure well and have fewer complications compared with skeletally mature patients.

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