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Universal Height Measurement Jig

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ABSTRACT

In the field of prosthetics and orthotics, compensation is very widely used. There are various examples that how the compensation blocks play a vital role to access the shortening of the limb length and pelvic obliquity. Height is an important factor for the prosthetic cosmesis appearance, which provides the patient self-confidence to feel the equality in the society. The objective of the study was to design and develop a universal height measuring jig and find out the compensation required for the specific LLD and to decide the length from MPT to floor after initial socket fitment in case of trans-tibial amputee. To equalize both normal and affected side to prevent pelvic obliquity. In this height measurement jig, mainly a car jack was used for height adjustment. During this process to minimize the stress and for easy adjustment an extended lever with rounded handle was aligned centrally with the car jack. For accurate vertical liner measurement, a steel measurement tape was used. It is a Portable device with minimum mechanical arrangements with less Economic and easy to operate due to long lever arm. This type of universal device resolves the issue raised by the error occur during conventional measurement methods.

Keywords: leg length discrepancy, Height adjustment jig, Car jack, pelvic obliquity.

INTRODUCTION

Leg length discrepancy (LLD) is an orthopedic condition that can appear in childhood or as a result of an injury or illness that causes damage to the growth plate. Most people have some degree of leg length discrepancy, but larger differences can affect well-being and quality of life during activities. LLD can be caused by structural deformities originating from true bony leg length differences.[1] Nevertheless, it can also be due to functional deformity derived from abnormal hip, knee, ankle and foot movements in each of the three planes of motion. [2,3]

Causes of LLD maybe Congenital, Post-traumatic Fractures, traumatic injuries, bone tumors, Idiopathic developmental abnormalities, Proximal femoral focal deficiency, congenitally short femur, Congenital coxa Vara, Destroyed epiphysial growth plate, Poliomyelitis, Septic arthritis, Cerebral palsy, Scoliosis, Fibular deficiencies, Tibial deficiency.

There are Different methods to accessing the leg length discrepancy.

Various imaging techniques have been used to measure true LLD. Radiography is considered the gold standard for measuring LLD, with established techniques including full limb radio-graphs, scanograms, computerized digital radiographs and Computerized tomography (CT). These methods are highly reliable and valid but they are also expensive and expose the subject to radiation, thus impractical to use in the routine clinical setting and not feasible for everyone. However, these measurements do not reveal the influence of dynamic

lower limb malalignment on leg length. [4,5]

The direct clinical method measures the distance (using a tape measure) between two anatomical points while lying in a supine position. Some authors [6,7] have found that direct measurement, by averaging the distance of two tape measurements between the anterior superior iliac spine (ASIS) and the medial malleolus. [8] But error can happen by these tape measurement methods, as Iliac asymmetries may mask or accentuate a limb length inequality or Unilateral deviations in the long axis of the lower limb (e.g., Genu varum/valgum) may mask or accentuate a limb length inequality or asymmetrical position of the umbilicus.

In indirect method measures LLD while standing, with lifts used to level the pelvis, preferably a pelvic leveling device.[10] The height of the lifts needed to level the pelvis is the difference in leg length. This clinical method takes into account functional factors such as foot, knee and hip position. However, one of the disadvantages of this method is that if asymmetrical loading of the legs or inconsistent compensations occur while standing, a false positive result can result.[8] Palpation of bony landmarks, most commonly the iliac crests or anterior superior iliac spines and posterior superior iliac spine, in standing position. These methods detecting if bony landmarks are at (horizontal) level or if limb length inequality is present. Palpation and visual estimation of the iliac crest in combination with the use of blocks of known thickness under the shorter limb to adjust the level of the iliac crests appears to be the best (most accurate and precise) clinical method to access limb inequality. We should keep in mind that asymmetric pelvic rotations in planes other than the frontal plane may be associated with limb length inequality.

The PALM (Palpation Meter): The PALM is a reliable and valid instrument for measuring pelvic height difference (PD). It is convenient, cost-effective and is a good alternative to radiographic measurement. The PALM is placed on the most superior aspect of the iliac crest. The distance between caliper heads is measured to the nearest mm and the angle of inclination to the nearest half degree. The inclinometer ball is designed to move towards the side of the shorter limb. For a trans-tibial amputee, before bench alignment, the distance from MPT to floor is measured on the non-affected side and replicated on the amputated side for equal leg length. The length of the stump affects the alignment of the prosthesis, whether it will be an endo-skeletal or exo-skeletal design. Stump length helps to select specific availability of component for a particular patient. In the field of prosthetics and orthotics, Orthoses are prescribed in many conditions with requisite compensation for LLD and trans-tibial Endoskeletal prostheses are prescribed in trans-tibial amputees having varying range from short to long stump. But there are no such devices exist to measure the required compensation for LLD and to measure the distance from MPT to floor. So, we have designed and developed a height measuring jig to overcome the above problem.

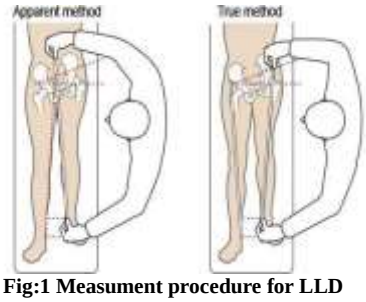

Fig:1 Measument procedure for LLD

MATERIALS & METHODS

Materials required

1. 12mm polypropylene sheet
2. Rubber sole
3. 4mm self -tapping screw
4. Steel measuring tape
5. Aluminium strip
6. Car jack

To fabricate the height measurement jig, mainly a car jack was used for height

adjustment. As the jack has a little base of support and unstable upper supporting plate, so the base was created with 12mm polypropylene sheet for a stable platform. The car jack has a ground clearance for adjustment so as to minimize the distance. The base was created at an initial point of adjustment of car jack. At the initial level of adjustment, a steel measuring tape was installed. The increment of car jack it will show the accurate vertical liner measurement. During this process to minimize the stress and for easy adjustment an extended lever with rounded handle was aligned centrally with the car jack. There was also given provision for complete weight bearing over the car jack. Due to the strength of material and extended lever arm the car jack can withstand the weight of any individual and measure the requisite height.

Fig:2 Car jack

fig:3 Universal height measuring jig

Fig:4,5 Height measuring jig showing maximum adjustment of length

Fig:6,7 Measuring LLD in different conditions of patient (poliomyelitis and limb shorting after surgery

Fig:8 Length from MPT to floor of a left trans-tibial amputee before bench alignment

RESULT AND DISCUSSION

After analyzing all the available direct and indirect methods to measure LLD, this device was tested upon some subjects with LLD and below knee amputation. The results were satisfactory based upon the clinical findings. During the fabrication of the height measuring jig six individuals were selected and length from mid patella tendon (MPT) to floor was measured. Average length was 45.5cm was found. As the device can measure the height up to 23cm, so it is based to measure the length for medium and long below knee stumps, and the subject with LLD. According to Indian standard height from mid patella tendon to floor.

By using this universal adjustable height measuring jig, lower limb residual discrepancy can be measured quickly in patient standing posture. So, during this process one can assure the pelvic obliquity by checking the level of both ASIS and PSIS. Here the pelvic meter has used to check the level pelvis.

After a several articles review, we found no such specific jig exist, for measuring height adjustment. There are only the evidences of using blocks or books for height measurement of required height. There may not be availability of required size of parallel blocks available during the measurement procedure which is again a time-consuming process. During prosthetic and orthotic fitment proper height is an important factor to provide comfort, for cosmesis and to prevent from any secondary deformity after using the device for a long term.

LIMITATIONS

1. 1.This existing design has the limited height adjustment provision i.e., up to 23cm.so it cannot measure the distance above 23cm mainly in case of lower limb amputations like transfemoral, through knee, and hip disarticulation.
2. 2.Cannot measure the height effectively with existing knee flexion and flexed equines deformity and with non-weight bearing condition.

CONCLUSION

Finally, it concludes that this type of universal device resolves the issue raised by the error occur using conventional tape measurement methods. This device overcomes the difficulty in availability of the wooden blocks for measuring the LLD. Based on the results it can be generalized that the accuracy can maintain by use of this device. Further work with system should include studies employing larger population to get better result from this device.

Declaration by Authors

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