Extremity Trauma Rehabilitation

Distraction Osteogenesis Residual Limb-Lengthening Device for Individuals with a Transfemoral Amputation

Extremely proximal transfemoral amputations pose considerable challenges for prosthesis fit and function. A short lever arm (residual femur) reduces energy transfer to the prosthesis, which makes the device harder to control. In addition, a shorter residual limb compromises socket fit, prosthetic suspension, and energy efficiency of gait.

In limb lengthening by distraction osteogenesis (DO), the bone is cleaved and the two segments are gradually separated by an applied traction force. During this distraction phase, new bone is generated to fill the resulting gap. Once the desired length is achieved, the new bone is allowed to mature, in the consolidation phase. Existing DO treatments for amputees require bulky external devices or fixators that require multiple percutaneous components, which pose a significant infection risk to the surrounding skin and/or bone. These devices must be worn for at least three days per 1 mm of added length (e.g., 100 days to lengthen and mature 3 cm). The long treatment period, high infection risk, and severely limited mobility required to achieve clinically significant increases in bone length may impact both physical and psychological health. The benefits of a longer residual limb are thus largely offset by the excessive treatment burden (*Kuiken et al. 2017*).

Researchers at the Rehabilitation Institute of Chicago (RIC) (Chicago, Illinois), now known as the Shirley Ryan AbilityLab, conducted a project that saw the development of an intramedullary limb-lengthening device. The device will lengthen the residual limb of transfemoral amputees who have a short residual limb (less than 35 percent of femoral length) using DO, while minimizing treatment burden. The limb-lengthening device (1) has only one distal percutaneous component, (2) will allow accurate control of lengthening, and (3) will stabilize the residual bone during consolidation for earlier weight bearing. A patent for the limb lengthener was published on December 4th, 2014 (*Kuiken 2017*; Figure 1).

The limb-lengthening device was tested in cadavers by four orthopedic surgeons, including two Army surgeons. They found the device relatively easy to install and strong enough for its intended use. The device could have significant benefits over current practice. For instance, the device may significantly decrease the treatment burden and risk of infection during DO for transfemoral amputees. Also, individuals may achieve a longer residual limb and have better prosthetic fit and function.

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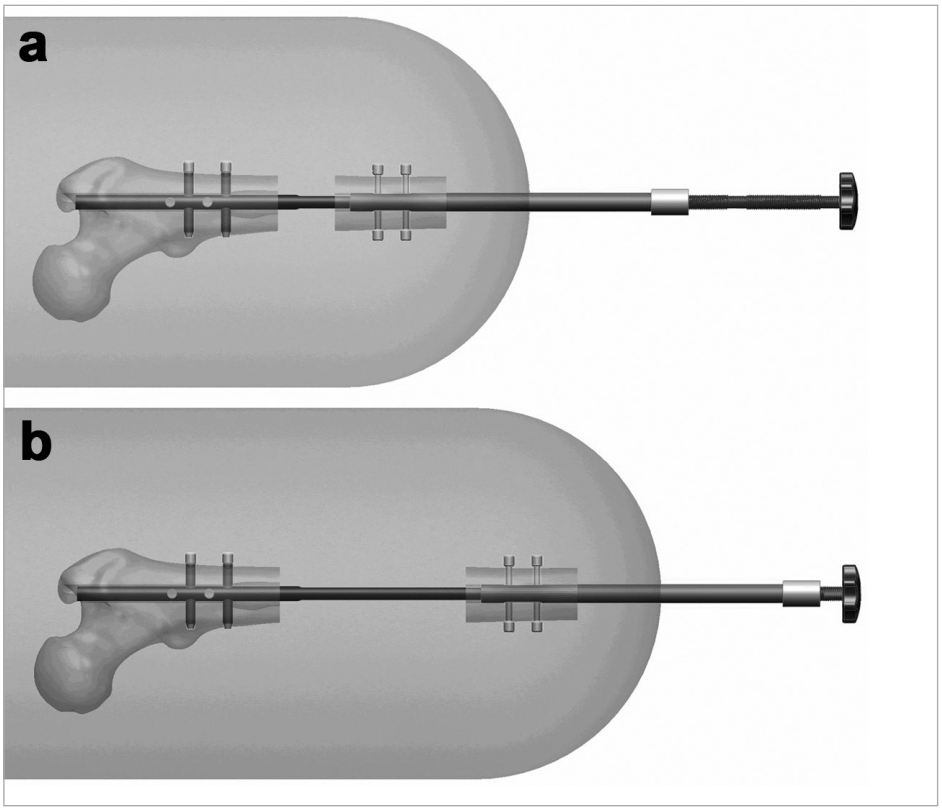

FIGURE 1: Schematic of lengthening of residual limb using lengthening device. (Figure from Kuiken et al. (2017) used with permission from the authors)

REFERENCES:

Kuiken, T. 2017. "Limb Lengthening System for Residual Limb." US. Patent 9,615,864 B2, filed May 31, 2013, and issued April 11, 2017.

Kuiken, T. A., Butler, B. A., Sharkey, T., Ivy, A. D., Li, D., and Peabody, T. D. 2017. "Novel Intramedullary Device for Lengthening Transfemoral Residual Limbs." J Orthop Surg Res 12 (1):53. doi: 10.1186/s13018-017-0553-8.