Soft tissue balancing plays a key role in the kinematic accuracy, stability, and long-term survival of a total knee arthroplasty (TKA).\(^1\)\(^2\)\(^3\) Currently, assessment of balance remains an art that is largely dependent on surgeon experience and technique—highly subjective factors that limit translatability and repeatability.

To standardize this aspect, a new device for intraoperative assessment of ligament tension has been developed. The eLIBRA Dynamic Knee Balancing System (Synvasive Technology, Inc, Reno, Nevada) provides an objective measurement of the forces across the medial and lateral compartments while allowing dynamic, controlled adjustment of the rotational position of the femoral component. The surgeon can use the device to define the precise external rotation that balances the compressive forces within the compartments and then position the 4-in-1 guide to make soft tissue–guided anteroposterior bone resection. In addition, the device can be used during trialing to assess ligament tension and aid the surgeon in selecting the correct poly insert thickness.

**Materials and Methods**

Between April 2010 and January 2011, the eLIBRA device was used during the implantation of 100 TKAs in 60 patients at the authors’ institution. All surgeries were performed by 2 senior surgeons (F.D., P.C.) using the same surgical technique, which consisted of a medial parapatellar approach and a posterior-stabilized implant.

At the time of surgery, average patient age was 69.55 years (range, 47-85 years). The study group comprised 19 men and 41 women. Thirty-eight patients had a varus knee, 15 had a physiological valgus knee (3°-5°), and 7 had a mild valgus knee. All patients were assessed clinically using the Knee Society Score pre- and postoperatively.\(^4\)

**Surgical Technique**

All surgeries were performed using a tourniquet. The joint was exposed by a medial parapatellar approach and the patella was externally dislocated.\(^5\) The first step was to create the extension space by making the distal femoral cut and the proximal tibial resection (Figure 1). It is recommended to remove all medial and lateral osteophytes from the border of the femur to avoid ligament tenting (Figure 2).

The device is designed to be implant specific, consisting of 2 parts: a contoured femoral component fixed to the resected distal femoral bone with 2 screws (Figure 3) and the activated force sensor coupled with a corresponding poly insert that allows full articulation and rapid change of stack thickness to accommodate a range in joint laxity. The eLIBRA force sensor is a single-use sterile instrument, designed to display the real-time compartmental forces in a digital display positioned directly on the tibial insert, compared with the previous model, where it was an external device (Figure 4).
The soft tissue balancing procedure must be done at 90° of flexion. Using a towel as a sling under the Achilles tendon, the surgeon can flex the knee at 90° while an assistant lifts the femur, being sure not to influence the posterior structure or bias the soft tissue balance in the joint. Following fixation of the eLIBRA femoral component and insertion of the force sensor, the surgeon should assess the medial compartment forces with the thinnest insert. If no or minimal forces are noted, increasingly thicker inserts should be used until ligamentous tension is realized. At this point, if the medial and lateral compartment force values are unbalanced, the surgeon should turn the adjustment screw in the femoral component (Figure 5). This will elevate the lateral condyle, generating external rotation until the medial and lateral forces are balanced (Figure 6). Once balance has been established, the implant-specific anteroposterior femoral location holes can be drilled to provide a reference point to locate the corresponding implant system 4-in-1 cutting guide.

RESULTS

In the 100 cases (60 patients) under review, no lateral releases were performed. None of the patients included in this study reported complications peri- or postoperatively. Clinical evaluation showed an improvement in scoring, from preoperative means of 60.1 and 54.5 points for clinical and...
functional aspects, respectively, to postoperative means of 82.7 and 88.2 points for clinical and functional aspects, respectively. Mean tourniquet time was 71.2 minutes (range, 36-121 minutes). Visual analog scale scores decreased significantly, from a preoperative mean of 7 (range, 2-9) to a postoperative mean of 2 (range, 0-7) \( (P < .001) \). Notching of the anterior cortex was observed postoperatively in 7 cases, although no intra- or postoperative complications were associated (Figure 7).

### DISCUSSION

Traditionally, soft tissue balancing has played a secondary role in the surgical methodology of TKA. Conventional methods and instrumentation have been focused on bony alignment, with adjustments to soft tissue performed empirically when deemed necessary. These adjustments are made based on subjective methods of evaluation, with different surgeons having varying thresholds for intervention in appropriate soft tissue balancing. Many TKA systems today offer various methods to achieve correct bone alignment through intramedullary/extramedullary guides, cutting blocks, computer navigation,\(^6\) and customized cutting guides, but none offer an objective way to measure soft tissue balance.\(^7\)

The eLIBRA Dynamic Knee Balancing System is a new instrument designed to address this gap in current treatment options. It can be integrated into a number of TKA systems and is easy to use. It objectively measures a parameter that has until now been more of an art than a science. The use of this device provides patient-specific rotational orientation of the femoral component. It dictates femoral component rotation based on ligament balance rather than the conventional methods of referencing femoral rotation such as Whiteside’s line,\(^8\) the transepicondylar axis, or 3° of external rotation from the posterior condyles (Figure 8).\(^9,10\)

In using the eLIBRA device, the soft tissue balancing technique can be standardized, resulting in better postoperative stability and reduced complications. In addition, this study found that tissue-guided external rotation and subsequent component placement related to better patellar tracking. The authors never performed a lateral release, even using a parapatellar approach, which influences a higher rate of performing lateral retinacular release.

The authors observed a higher incidence of notching of the anterior cortex related to the
rotation of the femoral component. In fact, an excessive external rotation of the femoral guide to obtain a balancing of medial and lateral forces could cause the notching of the anterior femoral cortex, mainly on the lateral side. This result was assumed to be related to previous use of a prosthesis with a 4° anterior flange; while using a femoral component with a 7° anterior flange, this complication was rare.

**CONCLUSION**

Due to the short follow-up period, only favorable impressions of the simplicity of the instrument and the reproducibility of the ligament balancing can be expressed. However, the authors believe soft tissue management is key to successful outcomes and present the eLIBRA technology as a means to help surgeons objectively quantify ligament balance and perform soft tissue–guided resection.

**REFERENCES**