

Effect of Hallux Valgus Surgery on Balance and Gait in Middle Aged and Older Adults: A 12 Month Longitudinal Assessment

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Abstract

Background: Hallux valgus deformity is associated with poorer balance and coordination, and has been implicated as a risk factor for falls in older adults. However, it is unknown what effect corrective surgery has on balance and gait in older adults.
Methods: In this prospective study, we followed middle to older aged adults who underwent hallux valgus surgery at our institute longitudinally for 12 months. Thirteen consecutive patients were assessed for gait and balance using non-invasive body worn sensor technology preoperatively and again at 12 months postoperatively, using standardized and validated balance/gait protocols.
Results: While subjects challenged their operative foot, standing in full tandem, center of mass (COM) sway was reduced (improved) by 59% postoperatively at the 12 month follow up ($p < 0.05$, paired t-test). Gait variability, on the other hand, increased on average by 55% ($p = 0.028$, t-test) and medial-lateral sway while walking increased by 43% ($p = 0.08$, t-test) postoperatively.
Conclusion: Hallux valgus surgery appeared to improve balance in our patients, particularly when relying on the operative foot in stance. Patients also seemed to walk with greater variability in stride velocity and with greater medial-lateral sway postoperatively, which suggests perhaps greater confidence after bunion surgery.

Background

- Falls have become the leading cause of injury in older adults as 1 in 3 people over the age of 65 and over experience a fall every year in the US (1).
- Studies have identified that "foot problems" are associated with a 4-fold increased risk of falling (2).
- Hallux valgus, specifically, is associated with a 2-fold increased risk of falling among older adults (3).
- While it is reasonable to expect that hallux valgus surgery will have an effect on balance and gait, it is still unclear how.



Figure 1: Progression of Hallux Valgus Deformity

Purpose

To better understand the effects of hallux valgus surgery on balance and gait in middle aged and older adults.

Methods

- Participants:** 13 consecutive patients aged 45 years or older who were undergoing hallux valgus surgery for medial "bump pain" were recruited from Weil Foot and Ankle Institute. All participants completed pre- and postoperative gait and balance testing using the same testing protocol and portable body-wearable technology (LegSys, BalanceSens).
- Gait:** Patients were asked to walk a distance of at least 40 feet at their habitual speed to a predetermined stopping point. In the second trial, patients were asked to then return to the starting point (4). Patients wore their habitual footwear during these trials. The second trial was used for analysis.
- Balance:** Balance was assessed in two different conditions: double support (Romberg's Test), eyes open and eyes closed, for 30 seconds. Patients were also assessed in those conditions in the semi tandem position for 20 seconds and the full tandem position with eyes opened for 15 seconds.
- Other Outcomes:** Visual Analog Scale (VAS) pain and radiographic alignment were examined preoperatively and 12 months postoperatively.
- Statistical Analysis:** ANOVA and paired t-tests were performed to compare preoperative data and postoperative data within subjects.

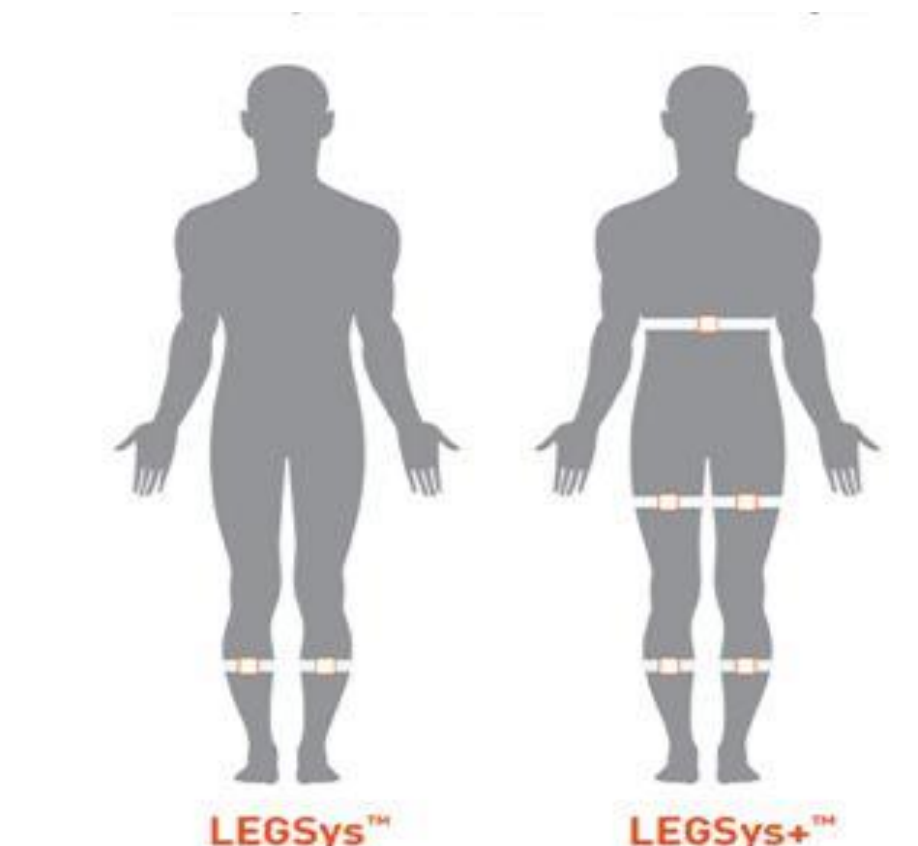


Figure 2: Four small motion sensors are placed on the patient's lower extremities, one each on the front of the lower leg and thigh. The sensors are held in place with elastic Velcro straps, and a lightweight data logger is worn on the patient's belt around their waist. An additional small sensor is then attached to the lumbar region which allows for measuring the range of motion of center of mass (COM).

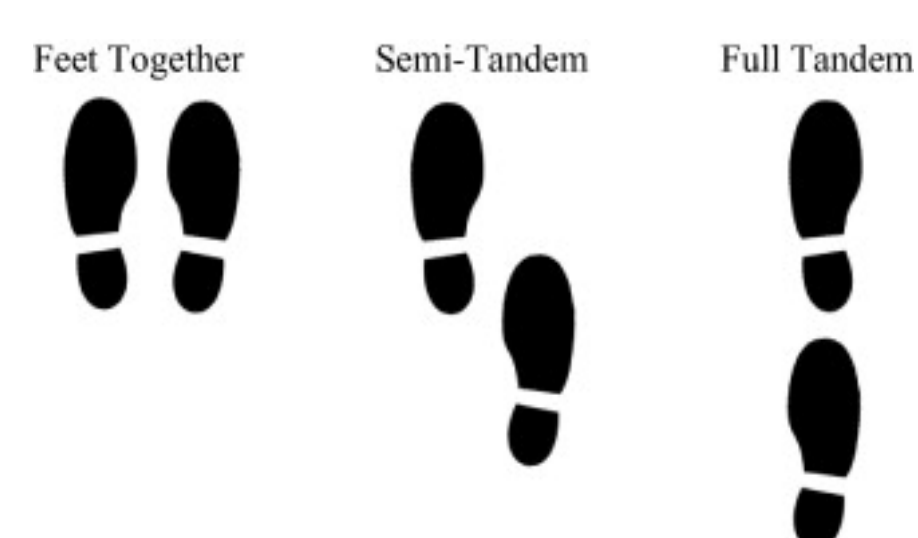


Figure 3: Foot positions of balance testing

Results

Table 1 Mean Characteristics of Patient Population (n=13)

	Age (yrs)	Height (cm)	Weight (Kg)	BMI (Kg/m ²)	VAS Pre Surgery (mm)	VAS Post Surgery (mm)
Mean	54.3	165.30	74.3	27.2	48.2	9.9
Standard Deviation	12.7	8.96	16.3	6.6	31.1	20.8

Age ranged from 47 years to 70 years, while height ranged from 154.9 cm to 188.0 cm, weight ranged from 56.8 kg to 111.4 kg, and BMI spanned from 18.5 to 42.1 Kg/m²



Fig. 4: Austin/Akin Osteotomy Fig. 5: Scarf/Akin Osteotomy
All patients had either successful Austin/Akin (Figure 4), or Scarf/Akin (Figure 5) osteotomies. Successful correction was defined as a congruous 1st MTP joint, and 1st/2nd IM and HA angles restored to within normal limits.

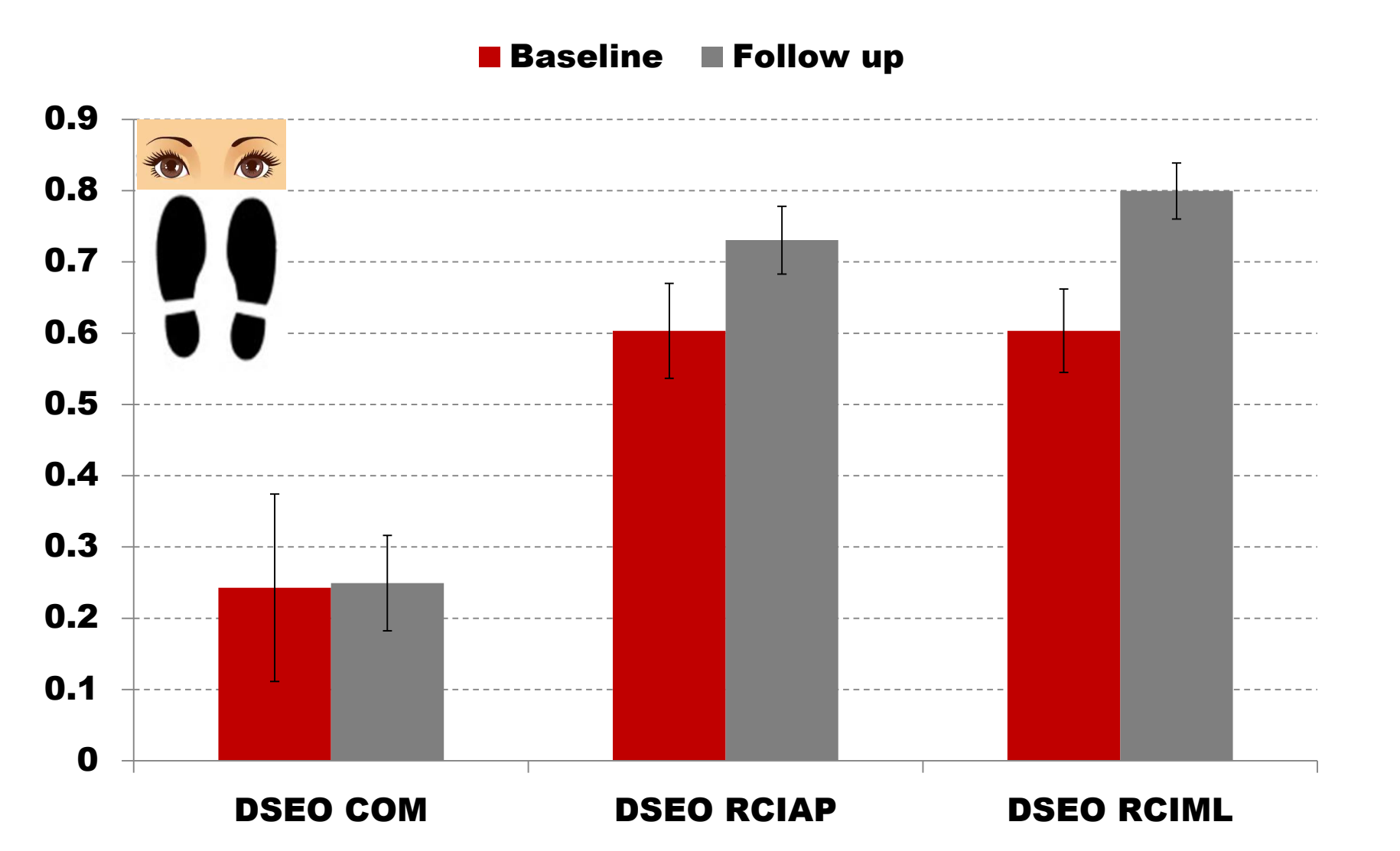


Figure 6: Center of mass sway area (cm²) and reciprocal compensatory index during double support eyes open test comparing baseline and follow up data. (n=13). RCI values closer to 0 are considered better.

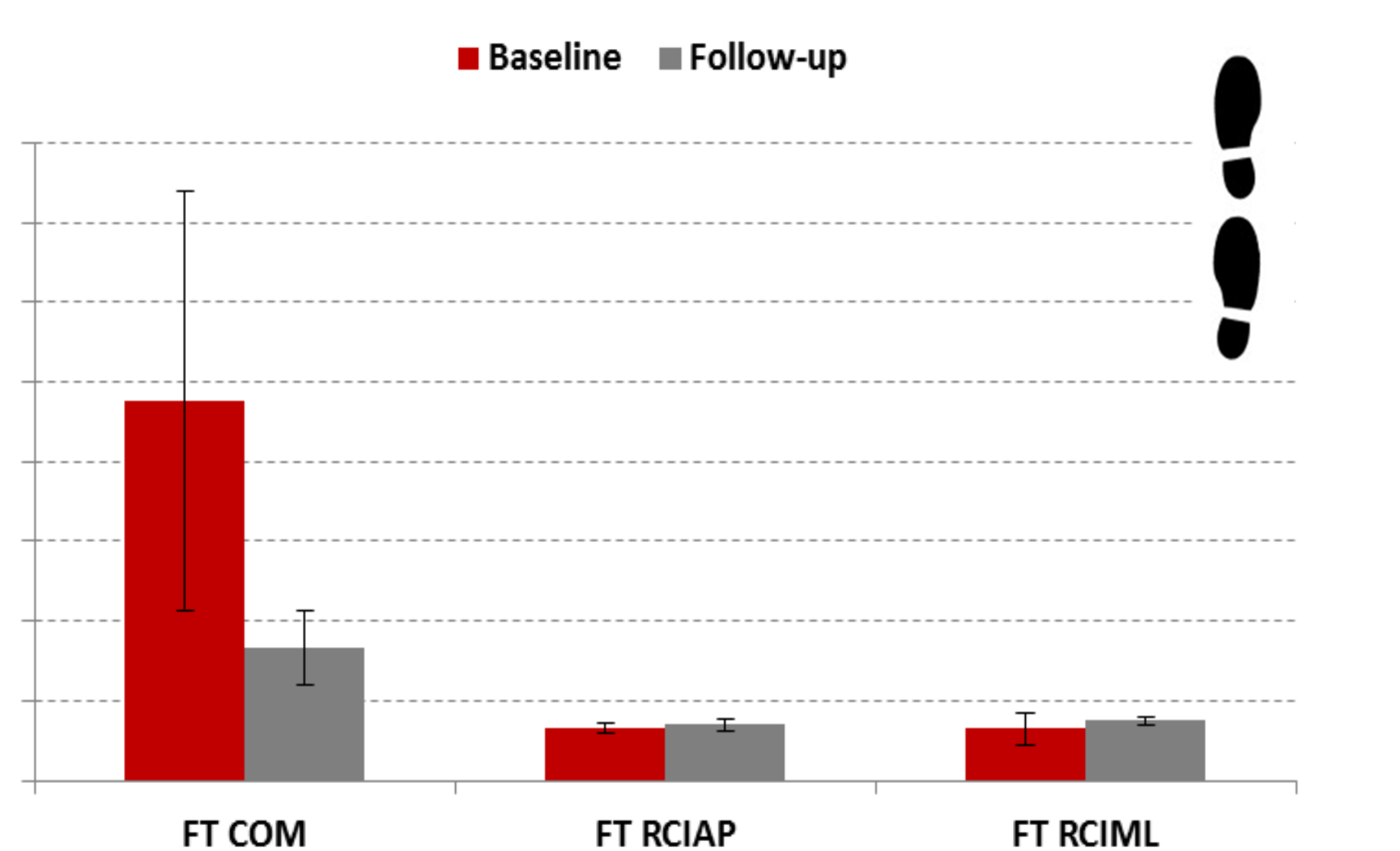


Figure 8: Center of mass sway area (cm²), anterior/posterior and medial/lateral reciprocal compensatory index during full tandem. (n=11). RCI values closer to 0 are considered better.

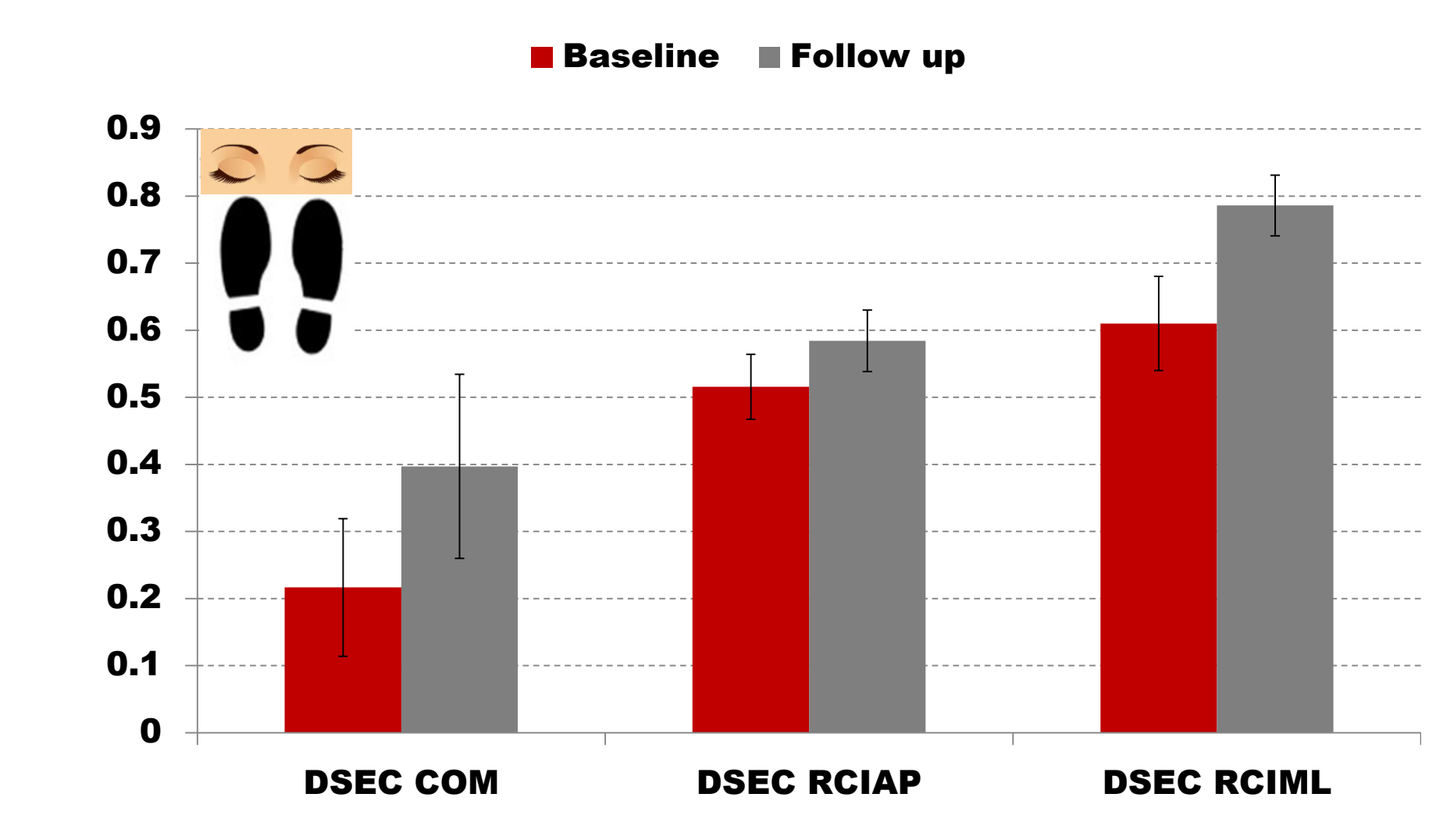


Figure 7: Center of mass sway area (cm²) and reciprocal compensatory index during double support eyes closed test. (n=13)

- No significant differences were found during eyes open (EO) and eyes closed (EC) balance assessments in center of mass sway area while participants were on Double Support (DS) stance. (Figures 6,7)
- Significant 29% ($p < 0.05$, paired t-test) increase in RCI was detected during DS EO.
- Similarly, 33% ($p < 0.05$, paired t-test) significant increase in RCI was observed during DS EC.
- Interestingly, center of mass sway was significantly ($p < 0.05$, paired t-test) decreased by 59% during follow up when performing full tandem test.

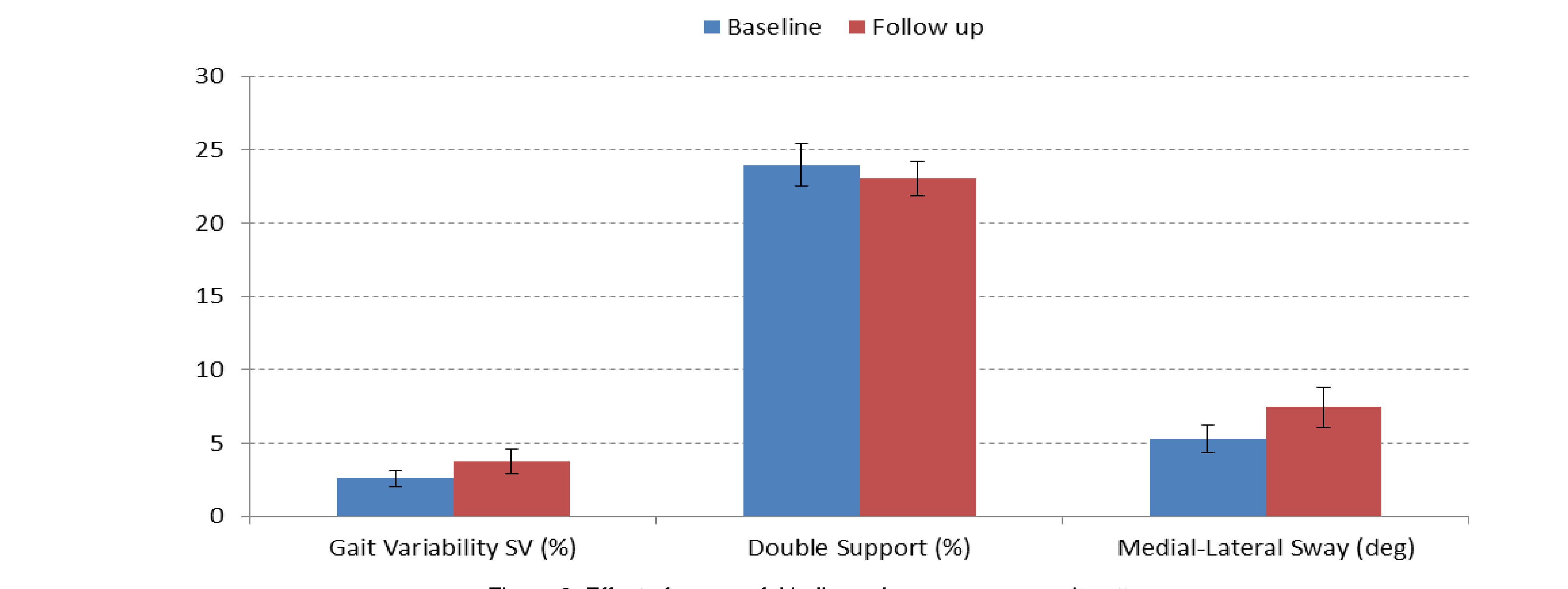


Figure 9: Effect of successful hallux valgus surgery on gait patterns.

Multiple gait parameters were evaluated for differences pre- and postoperatively at 12 months. The gait results were obtained during shod assessments for all patients and failed to reveal any changes in most gait parameters including stride velocity, stride length, and double support time, etc. Gait variability, however, increased significantly ($p = 0.028$, t test), on average by 55%, and medial-lateral sway while walking increased ($p = 0.08$, t test) by 43%, postoperatively.

Discussion

- Balance:**
- While in double support, the modest increase in sway seen at follow-up (especially during eyes closed test condition) with increased RCI (less ankle hip coordination) might be due to potentially greater mobility within the first metatarsophalangeal joint in anterior-posterior (AP) direction after successful hallux valgus surgery. Moreover, during double support, relatively low coordination of ankle and hip was required in the medial-lateral (ML) direction as little correction was required in this direction.
 - During full tandem test which challenges ML coordination within the operative foot (Figure 8), patients observed less center of mass sway area postoperatively, while also maintaining low RCI values in both AP and ML directions.
 - Notable decrease in center of mass sway area and lower RCI values may be due to reduced pain and more linear alignment of the first ray after surgery allowing the patient to distribute weight evenly on the medial aspect of their foot.
- Gait:**
- The significant changes in gait variability suggest that a successful hallux valgus surgery helped the patient change their walking pattern during initiation, steady state, and termination, suggesting to the authors more confidence while walking.

Conclusion

- Participants exhibited better postural control in medial-lateral direction when their operative foot was challenged suggesting improved postural control after successful bunion surgery.
- Participants also displayed greater variability in stride velocity and greater medial-lateral sway while walking postoperatively which may suggest that patients walked with greater confidence after surgery.

Acknowledgements

- This project received funding from the American College of Foot and Ankle Surgeons (ACFAS) Clinical and Scientific Research Grant Program, and from the American Podiatric Medical Students Association (APMSA).
- This project was partially supported also by grant number T35DK074390 from the National Institute of Diabetes and Digestive and Kidney Disease.
- The content is solely the responsibility of the authors and does not represent the official views of the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health, APMSA or ACFAS.

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