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CLINICAL ARTICLE

Assessing the impact of obesity on full endoscopic spine surgery: surgical site infections, surgery durations, early complications, and short-term functional outcomes

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OBJECTIVE An increasing number of obese patients undergoing elective spine surgery has been reported. Obesity has been associated with a substantially higher number of surgical site infections and a longer surgery duration. However, there is a lack of research investigating the intersection of obesity and full endoscopic spine surgery (FESS) in terms of functional outcomes and complications. The aim of this study was to evaluate wound site infections and functional outcomes following FESS in obese patients.

METHODS Patients undergoing lumbar FESS at the participating institutions from March 2020 to March 2023 for degenerative pathologies were included in the analysis. Patients were divided into obese (BMI > 30 kg/m^2) and nonobese (BMI 18–30 kg/m^2) groups. Data were collected prospectively using an approved smartphone application for 3 months postsurgery. Parameters included demographics, surgical details, a virtual wound checkup, the visual analog scale for back and leg pain, and the Oswestry Disability Index (ODI) as a functional outcome measure.

RESULTS A total of 118 patients were included in the analysis, with 53 patients in the obese group and 65 in the nonobese group. Group homogeneity was satisfactory regarding patient age (obese vs nonobese: 55.5 ± 14.7 years vs 59.1 ± 17.1 years, p = 0.25) and sex (p = 0.85). No surgical site infection requiring operative revision was reported for either group. No significant differences for blood loss per level (obese vs nonobese: 9.7 ± 16.8 ml vs 8.0 ± 13.3 ml, p = 0.49) or duration of surgery per level (obese vs nonobese: 91.2 ± 57.7 minutes vs 76.8 ± 39.2 minutes, p = 0.44) were reported between groups. Obese patients showed significantly faster improvement regarding ODI (−3.0 ± 9.8 vs 0.7 ± 11.3, p = 0.01) and leg pain (−4.4 ± 3.2 vs −2.9 ± 3.7, p = 0.03) 7 days postsurgery. This effect was no longer significant 90 days postsurgery for either ODI (obese vs nonobese: −11.4 ± 11.4 vs −9.1 ± 9.6, p = 0.24) or leg pain (obese vs nonobese: −4.3 ± 3.9 vs −3.5 ± 3.8, p = 0.28).

CONCLUSIONS The results highlight the effectiveness and safety of lumbar FESS in obese patients. Unlike with open spine surgery, obese patients did not experience significant increases in surgery time or postoperative complications. Interestingly, obese patients demonstrated faster early recovery, as indicated by significantly greater improvements in ODI and leg pain at 7 days after surgery. However, there was no difference in improvement between the groups at 90 days after surgery.

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KEYWORDS full endoscopic spine surgery; obesity; complications; infection; lumbar

ABBREVIATIONS FESS = full endoscopic spine surgery; LE-ULBD = lumbar endoscopic unilateral laminotomy for bilateral decompression; MCID = minimal clinically important difference; MISS = minimally invasive spine surgery; ODI = Oswestry Disability Index; PROM = patient-reported outcome measure; VAS = visual analog scale.

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Obesity has increased in prevalence around the world and is estimated to affect 650 million people.[1] Obese patients are more likely to experience and seek care for low-back and chronic back pain.[2] A variety of mechanisms contribute to this phenomenon, including increased mechanical loading of the spine, loss of muscle mass, impaired vascular supply, and an increased inflammatory state associated with an accumulation of paravertebral fat.[3] Furthermore, an increased BMI in spine patients has been associated with worse baseline functional status as measured by the Oswestry Disability Index (ODI).[4,5]

In addition to being a likely contributing factor in the development of degenerative spine disease, obesity has also been associated with poorer surgical outcomes and higher complication rates after traditional spine surgery. In meta-analyses of spine surgery outcomes, obese patients demonstrated significantly increased surgical site infection, venous thromboembolism, operating time, blood loss, and mortality.[6,7] Obesity may also lead to higher revision rates, as high BMI has been shown to be a risk factor for adjacent-segment disease after lumbar fusion.[3,8] While obese patients report benefits after spine surgery, inferior outcomes have been observed when compared with normal-weight patients as measured by the ODI, EQ-5D, and satisfaction indices.[9]

Interestingly, obese patients appear to reap benefits from minimally invasive spine surgery (MISS) not seen in their nonobese counterparts, as relevant perioperative outcomes such as blood loss and complication rates are mitigated when analyzing obese patients undergoing MISS.[7] Most complications in obese patients are due to wound complications or infection, presenting a plausible explanation for this observation.[6,7] When compared with MISS, full endoscopic spine surgery (FESS) requires even smaller incisions, which reduces tissue damage. FESS also allows for direct visualization and therefore may provide additional benefits compared with open surgery and MISS.[10,11] Most importantly, FESS has been proven to be an effective alternative to MISS, with exceptionally fast recoveries in several clinical trials.[11–14]

Data analyzing the intersection of obesity and FESS are scarce. Regarding the lumbar spine, FESS has been shown to be an effective treatment for disc herniations and spinal canal stenosis, with similar outcomes for discectomies and decompressions for obese and nonobese patients.[15–17] The aim of this study was to further elucidate FESS in obese patients and to characterize potential perioperative challenges and recovery via prospectively collected data.

Methods

Patient Selection and Data Collection

This study was a multicenter analysis of prospectively collected data including patients > 18 years of age undergoing elective FESS for degenerative lumbar pathologies between March 2020 and March 2023. Demographics and surgical details were collected from the electronic medical records. Demographic parameters included sex, age, BMI, and comorbidities represented in the 5-item modified frailty index.[18] Surgical details included the surgical approach as well as the number of operated levels, surgery duration, estimated blood loss, and intraoperative dural tears.

FESS was defined as surgery that uses a uniportal working channel endoscope that incorporates a light source, a camera, and an irrigation channel. The surgeries were performed at six national centers for FESS by experienced surgeons with at least 100 annual FESS cases. Surgical procedures included lumbar discectomies (interlaminar and transforaminal), lumbar endoscopic unilateral laminotomies for bilateral decompression (LE-ULBDs), foraminotomies, and endoscopic transforaminal interbody fusions. Acute pathologies of the spine (e.g., traumatic injuries) and tumor surgeries were excluded, as were procedures using microsurgical techniques in addition to endoscopic instruments.

Data were obtained following the approval of the University of Washington IRB and collected pseudonymously according to national law and in accordance with the 1975 Declaration of Helsinki.

Virtual Follow-Up via Remote Patient Monitoring

For data collection, an IRB-approved, validated smartphone application was used as previously described.[19,20] In brief, informed consent was obtained from all patients, and the application was enabled for asynchronous virtual patient-provider communication, continuous patient monitoring, and virtual follow-ups. Patients are required to have access to a smartphone that supports the app (iOS or Android). The follow-ups include a survey to assess the patient's well-being and progress, as well as a surgical wound site check via patient-captured images. The application enables continuous patient monitoring via virtual patient surveys. Patient-reported outcome measures (PROMs) are collected for the first 7 days postsurgery, as well as at 2 weeks and 3 months. PROMs use the visual analog scale (VAS) for back pain and leg pain, and the ODI as a functional surrogate.[21]

Statistical Analysis

Statistical calculations and data analysis were carried out using Prism (version 9.5.0, GraphPad Software). Continuous variables are depicted as mean ± standard deviation and categorical variables as the number of cases with percentage. Continuous variables were analyzed using the Student t-test or Mann-Whitney U-test for nonnormally distributed variables. The chi-square or Fisher exact test was used for categorical parameters when appropriate. Categorical and continuous variables were compared via ANOVA or a mixed-effects model to account for missing data points. A p value < 0.05 was determined as statistically significant. The minimal clinically important difference (MCID) threshold was 1.2 points for back pain and 1.6 points for leg pain. An improvement of 30% in ODI score was considered an MCID.[17]

Results

A total of 118 patients met the inclusion criteria. Subsequently, patients were divided into two groups: an obese

TABLE 1. Preoperative patient characteristics

	Nonobese, n = 65	Obese, n = 53	p Value
Sex			0.85
Female	26 (40)	23 (43.4)	
Male	39 (60)	30 (56.6)	
Mean age, yrs	59.1 (17.1)	55.5 (14.7)	0.25
Mean BMI	25.9 (2.3)	37.1 (5.7)	**<0.0001**
Comorbidities			
CHF	5 (7.7)	2 (3.8)	0.46
DM	7 (10.8)	8 (15.1)	0.58
COPD	1 (1.5)	1 (1.9)	>0.99
HTN	25 (38.5)	23 (43.4)	0.71
Prior spine surgery	11 (16.9)	11 (20.8)	0.64

CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; HTN = hypertension.
Values are expressed as number of patients (%) unless otherwise indicated.
Boldface type indicates statistical significance.

TABLE 2. Surgical approach and perioperative characteristics

	Nonobese, n = 65	Obese, n = 53	p Value
Procedure			
Discectomy	34 (52.3)	27 (50.9)	>0.99
LE-ULBD	22 (33.8)	20 (37.7)	0.70
Endo-TLIF	3 (4.6)	4 (7.5)	0.70
Foraminotomy	6 (9.2)	2 (3.8)	0.29
No. of operated levels			0.76
1	54 (83.1)	42 (79.2)	
2	9 (13.8)	8 (15.1)	
3	2 (3.1)	3 (5.7)	
Mean blood loss per level, ml	8.0 (13.3)	9.7 (16.8)	0.49
Mean op time per level, mins	76.8 (39.2)	91.2 (57.7)	0.44
Dural tear	2 (3.1)	1 (1.9)	>0.99

Endo-TLIF = endoscopic transforaminal lumbar interbody fusion.
Values are expressed as number of patients (%) unless otherwise indicated.

group (BMI > 30 kg/m^2) and a nonobese group (BMI 18–30 kg/m^2).

The obese group consisted of 53 (44.9%) patients and the nonobese group of 65 (55.1%) patients. No significant differences were found between the groups for age (obese vs nonobese: 55.5 ± 14.7 years vs 59.1 ± 17.1 years, p = 0.25) or sex (p = 0.85). As expected, the BMI was significantly greater in the obese group (37.1 ± 5.7 vs 25.9 ± 2.3, p < 0.0001). Comorbidity comparison showed no significant differences between the groups for congestive heart failure (p = 0.46), diabetes mellitus (p = 0.58), chronic obstructive pulmonary disease (p > 0.99), and hypertension (p = 0.71) (Table 1).

Discectomies were the most common procedures for both groups (obese vs nonobese: 50.9% vs 52.3%, p > 0.999), followed by LE-ULBDs (obese vs nonobese: 37.7% vs 33.8%, p = 0.7). Furthermore, no significant differences were observable between the groups for both surgery time per operated level (obese vs nonobese: 91.2 ± 57.7 minutes vs 76.8 ± 39.2 minutes, p = 0.44) and estimated blood loss per operated level (obese vs nonobese: 9.7 ± 16.8 ml vs 8.0 ± 13.3 ml, p = 0.49). One dural tear was reported for the obese group and two for the nonobese group. No complication necessitating a surgical revision within the observation period was reported (Table 2).

Remote Wound Check at 2 Weeks Postsurgery

Fifty (94.3%) patients in the obese group and 59 (90.8%) in the nonobese group participated in the virtual wound site check after 2 weeks. No surgical site infection was reported from either group. Among minor wound-related issues, night sweats (obese vs nonobese: 10% vs 6.8%, p = 0.73) and wound tenderness (obese vs nonobese: 10% vs 8.5%, p > 0.999) were reported most frequently (Table 3).

Functional Outcomes and Pain Development

Obese patients reported a significant pain alleviation within the 1st week postsurgery as demonstrated by a significant decrease in VAS score for back pain (5.7 ± 2.5 vs 3.2 ± 2.7, p < 0.0001) and leg pain (6.2 ± 2.6 vs 2.1 ± 2.2, p < 0.0001). Surgery translated into a significant functional benefit at the 2-week time point, reflected by a significant ODI reduction (obese vs nonobese: 23.1 ± 8.9 vs 17.9 ± 9.6, p = 0.001). When compared with the preoperative assessment, obese patients reported significant improvements for back pain (2.9 ± 3.0, Δ –2.8 ± 3.4; p < 0.0001), leg pain (1.9 ± 2.8, Δ –4.3 ± 3.9; p < 0.0001), and ODI (11.3 ± 9.9, Δ –11.4 ± 11.4; p < 0.0001) after 3 months. Except for the ODI, no significant improvements were observable between the postoperative time points for the obese group (Tables 4 and 5).

Nonobese patients reported a significant decrease in VAS scores for leg pain (5.1 ± 3.0 vs 2.3 ± 2.5, p < 0.0001) and back pain (5.0 ± 3.0 vs 2.9 ± 2.4, p < 0.0001) within the 1st postoperative week. They also showed significant improvements in ODI at the 3-month time point (17.9 ± 9.1 vs 8.8 ± 8.2, p < 0.0001). Analogous to the obese group, PROM improvements stayed statistically significant for back pain (2.0 ± 2.5, Δ –3.0 ± 3.5; p < 0.0001), leg pain (1.6 ± 2.5, Δ –3.5 ± 3.8; p < 0.0001), and ODI (8.8 ± 8.2, Δ –9.1 ± 9.6; p < 0.0001) after 3 months when compared with baseline (Tables 4 and 5).

TABLE 3. Results from virtual 2-week wound checkup

	Nonobese, n = 59	Obese, n = 50	p Value
SSI	0 (0)	0 (0)	>0.99
Fevers	0 (0)	2 (4.0)	0.21
Night sweats	4 (6.8)	5 (10.0)	0.73
Chills	0 (0)	3 (6.0)	0.09
Wound drainage	1 (1.7)	0 (0)	>0.99
Redness	3 (5.1)	1 (2.0)	0.62
Tenderness	5 (8.5)	5 (10.0)	>0.99

SSI = surgical site infection.

TABLE 4. Comparison of pre- and postoperative patient-reported outcomes

	Nonobese, n = 65	p Value	Obese, n = 53	p Value
Presurgery				
ODI	17.9 (9.1)		23.1 (8.9)	
Back pain	5.0 (3.0)		5.7 (2.5)	
Leg pain	5.1 (3.0)		6.2 (2.6)	
Day 7*				
ODI	18.8 (8.9)	0.97	20.6 (10.1)	0.39
Back pain	2.9 (2.4)	**<0.0001**	3.2 (2.7)	**<0.0001**
Leg pain	2.3 (2.5)	**<0.0001**	2.1 (2.2)	**<0.0001**
Day 14				
ODI	15.6 (7.7)	0.40	17.9 (9.6)	**0.001**
Back pain	2.4 (2.4)	**<0.0001**	2.8 (2.7)	**<0.0001**
Leg pain	2.1 (2.3)	**<0.0001**	2.0 (2.6)	**<0.0001**
Day 90				
ODI	8.8 (8.2)	**<0.0001**	11.3 (9.9)	**<0.0001**
Back pain	2.0 (2.5)	**<0.0001**	2.9 (3.0)	**<0.0001**
Leg pain	1.6 (2.5)	**<0.0001**	1.9 (2.8)	**<0.0001**

Statistical comparison is related to the presurgical assessment of the respective group. Values are expressed as mean (SD) unless otherwise indicated. Boldface type indicates statistical significance.

* Data were available for 63 patients in the nonobese group and 49 patients in the obese group.

TABLE 5. Comparison of pre- and postoperative patient-reported outcomes as well as development relative to the preoperative surgical assessment

	Nonobese, n = 65	Obese, n = 53	p Value
Presurgery			
ODI	17.9 (9.1)	23.1 (8.9)	**0.01**
Back pain	5.0 (3.0)	5.7 (2.5)	0.23
Leg pain	5.1 (3.0)	6.2 (2.6)	0.06
Day 7*			
Δ ODI	0.7 (11.3)	–3.0 (9.8)	**0.01**
MCID (%)	16 (25.4)	15 (30.6)	0.67
Δ Back pain	–2.1 (3.0)	–2.5 (2.8)	0.46
MCID (%)	35 (55.6)	33 (67.3)	0.24
Δ Leg pain	–2.9 (3.7)	–4.4 (3.2)	**0.03**
MCID (%)	36 (57.1)	37 (75.5)	**0.03**
Day 14			
Δ ODI	–2.2 (10.3)	–4.9 (8.8)	0.14
MCID (%)	23 (35.4)	23 (43.4)	0.34
Δ Back pain	–2.5 (3.0)	–2.9 (3.1)	0.55
MCID (%)	43 (66.2)	38 (71.7)	0.55
Δ Leg pain	–3.0 (3.0)	–4.1 (3.6)	0.06
MCID (%)	41 (63.1)	40 (75.5)	0.18
Day 90			
ODI	8.8 (8.2)	11.3 (9.9)	0.14
Δ	–9.1 (9.6)	–11.4 (11.4)	0.24
MCID (%)	45 (69.2)	36 (67.9)	>0.99
Back pain	2.0 (2.5)	2.9 (3.0)	0.08
Δ	–3.0 (3.5)	–2.8 (3.4)	0.73
MCID (%)	44 (67.7)	37 (69.8)	>0.99
Leg pain	1.6 (2.5)	1.9 (2.8)	0.85
Δ	–3.5 (3.8)	–4.3 (3.9)	0.28
MCID (%)	45 (69.2)	39 (73.6)	0.55
Expected surgical outcome, 90 days	54 (83.1)	41 (77.4)	0.35

Statistical comparison is between the groups at the respective time point. Values are expressed as mean (SD) unless otherwise indicated. Boldface type indicates statistical significance.

* Data were available for 63 patients in the nonobese group and 49 patients in the obese group.

Comparing Obese and Nonobese Postoperative PROM Dynamics

Preoperative PROM assessments revealed lower functional capability for the obese group than the nonobese group, expressed by a significant difference in the preoperative ODI (23.1 ± 8.9 vs 17.9 ± 9.1, p = 0.01) without significant differences for reported baseline back pain (5.7 ± 2.5 vs 5.0 ± 3.0, p = 0.23) and leg pain (6.2 ± 2.6 vs 5.1 ± 3.0, p = 0.06). After normalizing the PROMs for the preoperative level, patients of the obese group showed a faster recovery reflected by a significantly greater reduction in leg pain (Δ –4.4 ± 3.2 vs Δ –2.9 ± 3.7, p = 0.025) and greater ODI improvement (Δ –3.0 ± 9.8 vs Δ 0.7 ± 11.3, p = 0.01) 1 week postsurgery. Additionally, patients in the obese group reported MCID improvements significantly more often 1 week after the surgery (75.5% vs 57.1%, p = 0.03). This effect was no longer statistically significant 2 weeks after the surgery for either leg pain or ODI. Interestingly, the preoperative significant difference in ODI favoring the nonobese group was no longer observable 3 months after surgery (obese vs nonobese: 11.3 ± 9.9 vs 8.8 ± 8.2, p = 0.14). Overall, around 80% (p = 0.35) of the patients reported that their postoperative outcome had met their expectations at the 3-month time point (Table 5).

Discussion

The objective of this study was to assess intraoperative complications and functional outcomes in obese and nonobese patients undergoing elective lumbar FESS for degenerative pathologies. Our results highlight the efficacy of FESS for both obese and nonobese patients. Importantly, they also indicate that FESS is a safe option for obese patients, as no differences in complications or wound site infections were observed when compared with nonobese patients.

The prevalence of obesity is increasing globally. Simultaneously, technical advances have broadened the spectrum of indications for spine surgery.[22] Therefore, a substantial increase in obese patients requiring spine surgery must be expected in the future, despite obesity being associated with higher susceptibility to perioperative complications and poorer surgical outcomes.[23–25] To reduce peri- and postoperative complications, as well as to improve functional outcomes, it is essential to determine the optimal surgical approach for obese patients.

MISS has been shown to mitigate some of these complications, especially regarding functional outcomes. Nevertheless, surgery time and intraoperative blood loss remain

significantly higher for obese patients.[26] FESS enables direct and full visualization of the surgical site, granting the surgeon an optimized view of anatomical structures without a loss of sight caused by larger depth in obese patients. Obesity has also been associated with an increased rate of incidental durotomies in open spine surgery.[27]

The groups of the presented study showed satisfactory homogeneity regarding age, sex, and surgical approaches. However, there were no significant differences in obesity-associated comorbidities (e.g., diabetes). This nonsignificance might be due to the limited number of participants, since the relative number of patients with diabetes was higher in the obese group. For our cohort, the only reported peri- and postoperative complications were small dural tears without significant differences between the groups, none of which necessitated revision surgeries. Additionally, no significant differences between the groups were reported for both blood loss and duration of surgery. These findings are in line with a recently published study showcasing the advantages of direct visualization for a reduction of intraoperative complications in obese patients.[17]

Another feared complication following spine surgery is surgical site infection. No infections necessitating surgical interventions were reported for our cohorts. This is corroborated by a recent study that showed an eradication of surgical site infections after FESS when compared with nonendoscopic spine surgery.[28] Furthermore, our results highlight the feasibility and safety of a remote wound check via a smartphone application for patients undergoing FESS. Such an innovation can yield economic benefits by eliminating redundant postoperative in-person clinic visits, improving resource allocation.

Irrespective of their BMI, patients of both groups reported a decrease in back pain and leg pain as well as a functional improvement expressed by an ODI score reduction. Interestingly, most of the pain reduction was observable just 1 week after the surgery, with a diminishing marginal benefit toward the last assessment for both groups. Furthermore, obese patients showed a significantly faster recovery 1 week after the surgery regarding leg pain reduction and ODI improvement when compared with the nonobese patients. This difference might originate from the preoperative difference in low-back disability between the groups. It has been shown that patients with a higher preoperative low-back disability are likely to report a greater ODI reduction after spine surgery.[29] Additionally, the significant difference in reported leg pain between the groups after the 1st postoperative week might have facilitated the faster ODI improvement due to an earlier relief of radicular pain. Lastly, the preoperative significant difference in ODI between the groups was no longer observable at the 3-month follow-up.

The presented results are in agreement with other studies that have compared the complications and outcomes of obese and nonobese patients undergoing FESS regarding improvements of ODI and VAS scores for back pain and leg pain.[15–17] Our patients reported similar short-term improvements irrespective of obesity. This is substantiated by comparable MCID improvements and patient satisfaction regarding the expected postoperative outcome. FESS can therefore mitigate the economic impact of obesity on spine surgery since obesity does not affect operative time and perioperative complications while achieving comparable results for obese and nonobese patients.[30] The presented study adds to the understanding of postoperative recovery following FESS as it is the first of its kind to include solely virtually transmitted, prospectively collected PROMs at uniform time points. It also elucidates the understudied very early postoperative recovery period, which we believe to be of exceptional interest for preoperative patient counseling and postoperative patient satisfaction.

We acknowledge that this study has limitations. Most importantly, the observation period was limited to 3 months, which only allows for an interpretation of short-term outcomes. The small sample size limits the generalizability of our outcomes regarding causality of the reported differences in the very early postoperative period, especially since postoperative functional improvements are multicausal. Despite relative group homogeneity, potential imbalances between groups might further affect the generalizability of the results. Hence, the analysis might have benefited from an initial (propensity score) matching. However, matching would have inevitably reduced the already limited cohort size and therefore might have lowered the statistical power of the results. Also, the complications assessed in our study are rare, necessitating larger cohorts in the future to confirm the presented results. Furthermore, different procedures were included, potentially distorting the results despite there not being a statistically significant difference in procedures between the groups. As we continue to acquire prospective data in our continuously growing database, a more granular analysis of individual procedures as well as long-term outcomes and subgroups (e.g., morbidly obese patients) will be feasible in the future.

Conclusions

FESS presents a surgical approach with the capacity to minimize potential perioperative complications for obese patients. Furthermore, it grants comparable short-term functional outcomes for obese and nonobese patients.

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Conception and design: Leyendecker, Telfeian, Kashlan, Konakondla, Hofstetter, Ogunlade. Acquisition of data: Leyendecker, Telfeian, Derman, Kashlan, Amin, Konakondla, Hofstetter, Ogunlade. Analysis and interpretation of data: Leyendecker, Eysel, Bredow, Kashlan, Hofstetter, Ogunlade. Drafting the article: Leyendecker, Benedict, Gumbs, Eysel, Bredow, Ogunlade. Critically revising the article: all authors. Reviewed submitted version of manuscript: Leyendecker, Benedict, Gumbs, Eysel, Bredow, Derman, Kashlan, Konakondla, Ogunlade. Approved the final version of the manuscript on behalf of all authors: Leyendecker. Statistical analysis: Leyendecker, Bredow. Administrative/technical/material support: Eysel, Telfeian, Hofstetter. Study supervision: Hofstetter, Ogunlade.

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