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ORIGINAL ARTICLE
Breast

A Retrospective Review of Arthroscopic Shaver Utilization in Adolescent Gynecomastia

Caitlyn C. Belza, BS*
Jessica D. Blum, MSc*
Daniel Neubauer, MD†‡
Christopher M. Reid, MD†
Yan T. Ortiz-Pomales, MD‡
Samuel H. Lance, MD†§

Background: This study compares the arthroscopic shaver and liposuction with other established methods for treatment of adolescent gynecomastia.
Methods: Surgical management was via four operative techniques: open excision, open excision/liposuction, arthroscopic shaver/liposuction, or open excision and free nipple graft. Data were collected and compared using independent *t* tests, linear regression models, and one-way analysis of variance.
Results: Patients were stratified by Rohrich grades I -II (low) (N = 47) or III -IV (high) (N = 13). The groups were similar in age ($P = 0.662$) with lower BMI in the low-grade group ($\bar{x} = 25.36 \pm 2.1$) vs. high-grade group ($\bar{x} = 27.62 \pm 4.0$; $P < 0.001$). The low-grade group showed no significant difference in operative time across surgical techniques with decreased mean operative time in the high-grade group using the arthroscopic shaver technique ($\bar{x} = 55.8 \pm 7.56$) compared with open excision ($\bar{x} = 70.83 \pm 11.02$, $P = 0.04$), open excision plus liposuction ($\bar{x} = 89.5 \pm 24.93$, $P = 24.93$), and open excision plus free nipple graft ($\bar{x} = 81.67 \pm 19.11$, $P = 0.05$). There was no significant difference in complication ($P = 0.84$) or reoperation ($P = 0.68$) rates across surgical techniques regardless of grade.
Conclusions: These findings suggest that the arthroscopic shaver is safe and effective for treatment of both low- and high-grade gynecomastia in adolescents. The results yielded a similar incidence of complications and reoperation across surgical techniques, and the arthroscopic shaver approach demonstrated a shorter operative time compared with other techniques for high-grade gynecomastia.
(Plast Reconstr Surg Glob Open 2023; 11:e5336; doi: 10.1097/GOX.0000000000005336; Published online 11 October 2023.)

INTRODUCTION

Gynecomastia is characterized as benign proliferation of glandular breast tissue in men.[1] Although gynecomastia may manifest clinically as an asymptomatic incidental finding, it can also present as a painful, anxiety-inducing, and socially-ostracizing condition. There are three peak ages of incidence across the male lifespan. Asymptomatic gynecomastia has a prevalence of 60%–90% in neonates, 50%–60% in adolescents during puberty, and approximately 70% in men aged 50–69 years.[2] Pubertal gynecomastia begins during male puberty and typically regresses within 1–2 years.[3] If gynecomastia persists longer than 6–12 months, the tissue becomes fibrotic and less responsive to medical therapy.[1] Although the prevalence of persistent and symptomatic gynecomastia occurs in about 8% of adolescents,[4] this condition can cause serious discomfort and negative psychological impact to emotional well-being, mental health, social functioning, and self-esteem.[5]

The pathophysiology of this condition is largely attributable to disruption of the estrogen-to-androgen balance via the hypothalamic-gonadal axis. The hormonal balance between estrogens and androgens can be offset because of estrogen-secreting neoplasms but is more commonly caused by peripheral conversion of

*From the *School of Medicine, University of California San Diego, San Diego, Calif.; †Division of Plastic Surgery, University of California San Diego, La Jolla, Calif.; ‡United States Navy, Naval Medical Center San Diego, San Diego, Calif.; and §Rady Children's Hospital San Diego, San Diego, Calif..*

Received for publication October 6, 2022; accepted August 24, 2023.

This abstract was selected for ePoster presentation at the 2022 annual California Society of Plastic Surgeons meeting in San Diego, California.

DOI: 10.1097/GOX.0000000000005336

Disclosure statements are at the end of this article, following the correspondence information.

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androgens to estrogens by tissue aromatase.[2] Some studies have found body mass index to positively correlate with the presence of gynecomastia and breast diameter in adolescents. In obese individuals, the level of aromatase in breast adipose tissue is thought to be increased in the setting of generalized weight gain, which may increase local estrogen production resulting in stimulation of breast glandular tissue proliferation via paracrine signaling.[6]

Less common etiologies of gynecomastia include primary free testosterone deficiency from gonadal failure (Klinefelter syndrome), secondary testosterone deficiency due to hypothalamic failure (Kallmann syndrome) and androgen resistance syndromes.[7]

While gynecomastia is often a self-limiting condition, the glandular tissue can be painful and cause emotional and psychological distress, prompting the discussion of pharmacologic or surgical management. Medical therapy options such as aromatase inhibitors and dihydrotestosterone have been shown to improve pain and decrease breast size in some cases of gynecomastia; however, there are limitations regarding complete regression and patient satisfaction.[8]

Options for surgical management of gynecomastia have evolved to minimize invasiveness while improving operative efficiency, decreasing reoperation rates, and maximizing aesthetic outcomes. Various techniques have been described in the adult population. Historically, subcutaneous mastectomy was the standard approach; however, application of tools such as the arthroscopic shaver has become more popular due to its effectiveness in breaking up fibroconnective tissue and dense parenchymal tissue.[9] More recently, surgeons have found success in a technique that combines utilization of both ultrasound-assisted liposuction and the arthroscopic shaver to provide a coordinated removal of fatty and fibrous glandular tissue. Compared with traditional techniques, this minimally invasive technique has been found to improve outcomes with less scarring while effectively removing fibrofatty and glandular tissue.[10] This approach has previously been shown in the adult population to yield excellent cosmetic results and high patient satisfaction with a low complication rate.[11,12] Review of published literature highlighted a paucity of data using this minimally invasive technique in the treatment of adolescent gynecomastia.

This study aimed to evaluate the surgical treatment of adolescent gynecomastia using a combination of the arthroscopic shaver and liposuction compared with other established surgical techniques, with operative time as a primary outcome and surgical complications and reoperations as secondary outcomes. The results of this research will provide a comparative analysis of operative approaches, which will contribute to surgical planning and decision-making for management of gynecomastia in the adolescent population.

Takeaways

Question: At a single institution, how do established methods of treatment for gynecomastia in adolescents compare to a surgical technique involving liposuction and the arthroscopic shaver when analyzing demographics, perioperative data, and postoperative data?

Findings: In this retrospective observational study, the arthroscopic shaver technique had a lower incidence of complications and shorter operative time compared with other traditional methods that were assessed.

Meaning: The arthroscopic shaver is a safe and effective surgical technique for treatment of gynecomastia in adolescents, and it can address high-grade gynecomastia with significant ptosis and excess skin.

METHODS AND MATERIALS

This study was designed as a retrospective chart review. Approval for the study was obtained via the institutional review board before initiation of data collection and analysis. All patients having undergone surgical management for gynecomastia between January 2015 and November 2020 at a single center were included in the study. Patients who underwent mastectomy for gender affirmation or neoplasm and patients who were surgically managed with liposuction only were excluded from the study.

After a confirmed clinical diagnosis of gynecomastia, patients underwent one of four different methods for resection: open excision only, open excision plus liposuction, arthroscopic shaver plus liposuction, or open excision plus free nipple graft (FNG). Pre- and postoperative photographs were taken at clinic visits (Fig. 1A–F and Figure 2A–F). All patients compared in this study were assigned a preoperative Rohrich grade[13] to classify the severity of the gynecomastia. The Rohrich grade classification is considered in the treatment algorithm used to guide surgical planning (Fig. 3). While the algorithm serves as a guideline at our center, the arthroscopic shaver technique is currently used by the senior author (S.L.) for most patients, regardless of ptosis grade or amount of excess skin.

Liposuction and Arthroscopic Shaver Operative Technique

A pair of port incisions are introduced: the first, along the junction of the inframammary fold and the anterior axillary line and a second, superolaterally at the lateral margin of the pectoralis fold approximately 5 cm from the axilla. While two access points facilitate the suction lipectomy, the superior incision may be eliminated in patients with mostly glandular tissue and minimal to moderate subcutaneous fat. Standard tumescent solution containing 1 ampule of epinephrine and 30 mL of 1% lidocaine in 1L of Lactated Ringer's solution is then infiltrated about the base of each breast at a ratio of 2:1 tumescent solution to estimated breast parenchyma. After a 10 minute indwell to allow for vasoconstriction, pretunneling is then completed with a liposuction cannula. Suction-assisted lipectomy is then performed, focusing on contouring the lateral and inferior breast until sufficient removal of the fatty parenchyma is noted and the remaining fibrous breast parenchyma is discretely

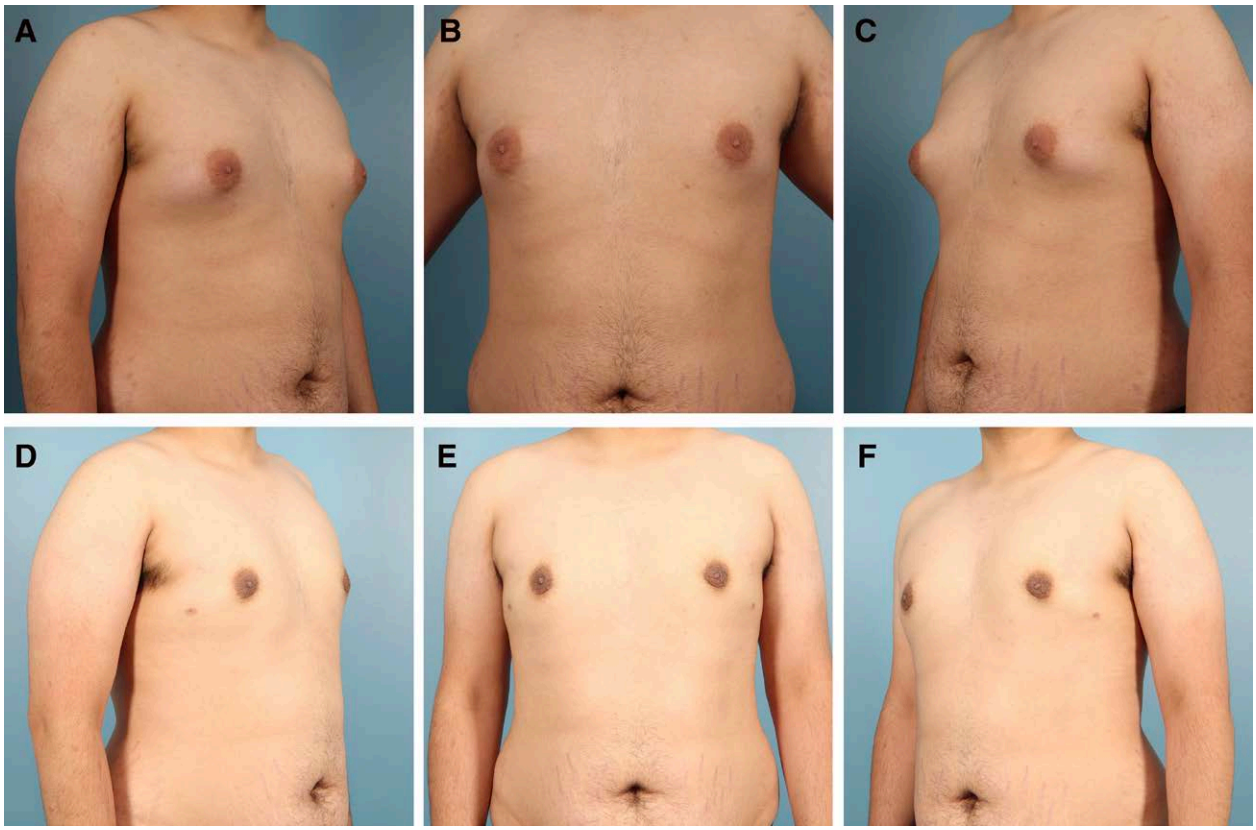

Fig. 1. Patient with low Rohrich grade gynecomastia who underwent treatment with the arthroscopic shaver plus liposuction technique without nipple areolar reduction. A–C, Preoperative photographs; D–F, postoperative photographs.

Fig. 2. Patient with high Rohrich grade gynecomastia who underwent treatment with the arthroscopic shaver plus liposuction technique followed by skin only nipple areolar complex reduction. A–C, Preoperative photographs; D–F, postoperative photographs.

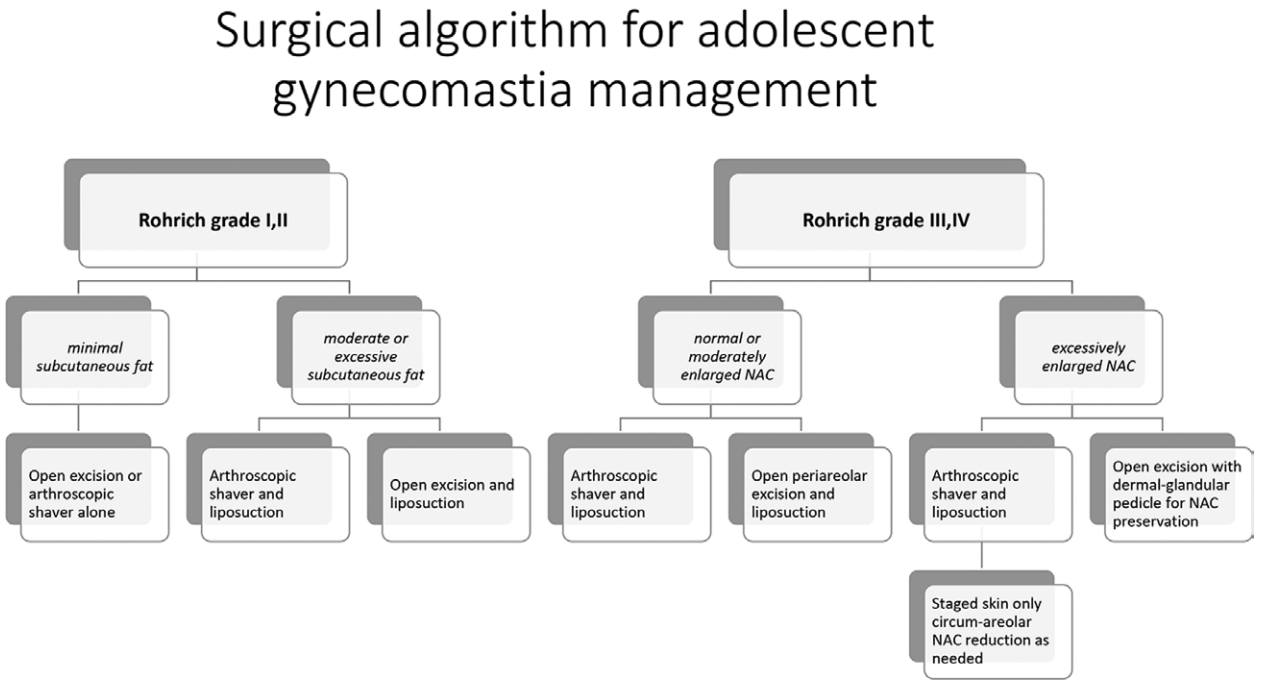

Fig. 3. Treatment algorithm for adolescent gynecomastia.

palpable. Finally, the liposuction cannula is utilized to disrupt the insertions of the inframammary fold to facilitate redraping of the overlying skin. In patients with dense inframammary fold insertions, the shaver can be further utilized to release these insertions.

A 4 mm × 13 mm or 5.5 mm × 13 mm nonserrated blade arthroscopic shaver is then introduced via the same stab incisions used for liposuction. A Lukens trap collection vial is connected in-line with the suction port of the shaver to collect the breast parenchyma for pathologic specimen. The shaver is positioned deep to the parenchymal tissue, and suction is applied. The shaver is operated on in oscillation mode only at a frequency of 750–1500 rpm. The subareolar parenchymal tissue is then excised using a fan-type pattern from both the inferior and superior port, with the cutting surface of the shaver positioned in a cephalad or caudal direction to avoid damage to the overlying skin or underlying pectoralis muscle. This provides excision of the parenchyma and ensures a smooth contour at the margin of the parenchymal tissue and surrounding subcutaneous fat. The pocket is then irrigated with saline solution followed by evacuation of the irrigation to ensure hemostasis before closure. A closed suction drain may then be introduced into the pocket via the inferior port site. **(See Video [online],** which displays the liposuction and arthroscopic shaver operative technique.)

The incisions are then closed with deep dermal sutures. A padded dressing is placed over the chest, followed by a compression garment.

Data Collection and Analysis

The following demographic data were obtained from the electronic medical record for each patient: sex, age at the time of surgery, body mass index at the time of surgery, and Rohrich grade of gynecomastia. Perioperative characteristics investigated included surgical technique, operating time, and length of follow-up. All perioperative complications and any required reoperations were also recorded. These data points were compared across the four groups with different surgical techniques, using IBM SPSS version 28. Independent *t* tests, one-way analysis of variance with post hoc comparisons, and linear regression analyses were performed to assess demographic, perioperative, and postoperative variables.

RESULTS

In total, 60 patients (N) and 105 breasts (n) demonstrated either low-grade gynecomastia [defined as Rohrich grade I or II (N = 47)] or high-grade gynecomastia [defined as Rohrich grade III or IV (N = 13)]. The low-grade group was managed mostly with open excision (N = 28). Relatively fewer patients were treated with the arthroscopic shaver plus liposuction technique (N = 12) and the open excision plus liposuction technique (N = 7). There were no patients who underwent open excision plus free nipple graft within the low-grade group. In the high-grade group, two patients underwent open excision only, three had open excision plus liposuction, five had the arthroscopic shaver plus liposuction, and three had open excision plus FNG (Table 1).

Of these patients, 25% were diagnosed with unilateral gynecomastia and 75% had bilateral gynecomastia. At the time of operation, there was not a significant difference in mean age between the low-grade group

Table 1. Demographic Information for the Study Population Stratified by Rohrich Grade and Surgical Technique

	Participants, n (%)	Breasts	Age (y)	BMI (kg/m²)
Rohrich grades I and II				
Open excision only	28 (59.57%)	44	15.27 ± 1.76	21.71 ± 3.44
Open excision + liposuction	7 (14.89%)	13	15.90 ± 1.22	25.33 ± 4.39
Liposuction + arthroscopic shaver	12 (25.53%)	22	16.29 ± 1.50	25.36 ± 3.85
Open excision + FNG	0	0	—	—
Total sample mean	—	—	15.82 ± 0.51	25.36 ± 2.1
Rohrich grades III and IV				
Open excision only	2 (15.38%)	4	14.39 ± 1.62	21.71 ± 3.44
Open excision + liposuction	3 (23.08%)	6	14.67 ± 0.58	28.66 ± 4.91
Liposuction + arthroscopic shaver	5 (38.46%)	10	17.57 ± 0.85	29.35 ± 3.31
Open excision + FNG	3 (23.08%)	6	16.61 ± 1.54	30.75 ± 0.56
Total sample mean	—	—	15.81 ± 1.53	27.62 ± 4.03
P			0.662	<0.001*

Values are presented as mean ± SD.
*Indicates significance at the 95% level.

($\bar{x}$ = 15.82 years, SD = 0.51) and high-grade group ($\bar{x}$ = 15.2 years, SD = 1.53) (P = 0.662). The low-grade group had a lower average body mass index (kilograms/meters^2; $\bar{x}$ = 25.36, SD = 2.1) compared with the high-grade group ($\bar{x}$ = 27.62, SD=4.03; P < 0.001). The duration of follow-up (Table 1) was also shorter in the low-grade group ($\bar{x}$ = 77.25 days, SD=83.64) compared with the high-grade group ($\bar{x}$ = 169.46 days, SD=138.29; P = 0.004).

When perioperative characteristics were evaluated in the low-grade cohort, there was no significant difference in operative time (minutes per breast) across surgical techniques [one-way ANOVA, F(2, 44) = 1.614, P = 0.211]. Within the high-grade group, a linear regression was fit to model the correlation between operative time and surgical technique. This resulted in a significant difference between groups [F(3,9) = 11.4, P = 0.002]. Pairwise comparisons using t tests with pooled SD found that the mean value of operative time per breast was significantly less in the arthroscopic shaver group compared with the excision only group (P = 0.040), excision plus liposuction group (P = 0.002), and the open excision plus FNG group (P = 0.05). None of the other pairwise comparisons were significantly different. [Table 2 and Table 3]

Table 2. Operating Time per Breast Stratified by Rohrich Grade and Surgical Technique

Surgical Technique	Operating Time (Min per Breast) [SD]	
	Rohrich Grades I and II	Rohrich Grades III and IV
Open excision only	54.61 [23.30]	70.83 [11.02]
Open excision + liposuction	68.86 [16.51]	89.5 [24.93]
Liposuction + arthroscopic shaver	51.50 [18.03]	55.8 [7.56]
Open excision + FNG	*	81.67 [19.11]
P	0.211	0.002†
Total sample [SD]	58.32 [9.26]	74.45 [14.60]

*Indicates no patients stratified to this cohort.
†Indicates significance at the 95% level.

When the low-grade group was stratified by surgical technique, there was not a significant difference in incidence of complications [one-way ANOVA, F(2,44) = 0.94, P = 0.4) or incidence of reoperation [one-way ANOVA, F(2,44) = 0.17, P = 0.84). All patients who developed hematomas presented for assessment of the wound within 24 hours of the initial surgery. Complications that occurred in the open excision group included one aesthetic concern (protuberance of the right nipple, resolved nonoperatively), two hematomas and three seromas. One of these patients was described as having a moderate hematoma that healed without intervention. One patient was taken back to the operating room for evacuation of his hematoma with slow suction. Of the three patients who developed seromas, one required bedside aspiration at the 3-week follow-up appointment. The other two seromas were monitored and resolved by the 2-month or 3-month postoperative office visit. Within the open excision plus liposuction group, one patient had a hematoma and was taken back to the operating room for hematoma evacuation. In the arthroscopic shaver plus liposuction group, one patient had an aesthetic concern not requiring reoperation (hypertrophic scar), but no patients experienced a hematoma or seroma. One patient required an unplanned reoperation to address recurrence of breast tissue (Table 4).

There were no documented postoperative hematomas or seromas in the high-grade group. One patient in the arthroscopic shaver plus liposuction group had an aesthetic concern not requiring reoperation (unilateral inverted nipple). Additionally, one patient in the open excision plus FNG group was reported to have bilateral dog ear deformities. He was satisfied with the aesthetic results and did not undergo reoperation. When stratified by surgical technique, one patient in the open excision cohort and one patient in the open excision plus liposuction cohort required an unplanned reoperation to address recurrence of breast tissue. The total incidence of reoperation (Table 4) was not statistically different across surgical groups in patients with high-grade gynecomastia [one-way ANOVA, F(3,9) = 0.52, P = 0.68].

Table 3. Subgroup Analysis of Mean Operative Time per Breast for the High Rohrich Grade Group with Pairwise Comparisons Using *t* Tests with Holm-adjusted *P* Values

Group Comparisons	Adjusted *P*	95% Confidence Interval [Upper Bound, Lower Bound]
	Significant	
Open excision only versus arthroscopic shaver + liposuction	0.040*	10.9–54.5
Open excision + liposuction versus arthroscopic shaver + liposuction	0.002*	28–66.1
Arthroscopic shaver + liposuction versus open excision plus FNG	0.050*	–44.9 to -6.8
	Nonsignificant	
Open excision only versus open excision + liposuction	0.414	–38.2 to 9.5
Open excision + liposuction versus open excision + FNG	0.154	–0.153 to 42.5
Open excision only versus open excision + FNG	0.533	–17 to 30.7

*Indicates significance at the 95% level.

Table 4. Complications and Unplanned Reoperations Stratified by Rohrich Grade and Surgical Technique

	Hematoma	Seroma		Unplanned Reoperation
Rohrich grades I and II				
Open excision only	2	3	1	Hematoma evacuation
Open excision + liposuction	1	0	1	Hematoma evacuation
Liposuction + arthroscopic shaver	0	0	1	Address recurrence of breast tissue
Open excision + FNG	*	*	*	*
Rohrich grades III and IV				
Open excision only	0	0	1	Address recurrence of breast tissue and nipple areolar complex resizing
Open excision + liposuction	0	0	1	Address recurrence of breast tissue
Liposuction + arthroscopic shaver	0	0	0	—
Open excision + FNG	0	0	0	—
P			0.1	

*Indicates no patients stratified to this cohort.

The presence of redundant tissue anytime in the postoperative period was recorded as a matter of postoperative observation. In the low-grade group, five patients experienced regrowth of breast tissue postoperatively (open excision N = 1, open excision plus liposuction N = 1, arthroscopic shaver N = 3). In the high-grade group, one patient in each cohort stratified by surgical technique was documented to have tissue regrowth. Most patients with tissue redundancy proceeded to contract the soft envelope and did not require reoperation.

Some patients within the study had flat Jackson-Pratt drains placed at the time of initial operation to prevent collection of fluid at the incision site. When patients were stratified by Rohrich grade, 36.2% of patients with low-grade gynecomastia and 92.3% patients with high-grade gynecomastia had drains placed. There was no statistically significant correlation between patients with drain placement and postoperative seromas or hematomas [X2(1, N = 60) = 2, *P* = 0.2].

DISCUSSION

It has been concluded that persistent gynecomastia in adolescents is mostly associated with glandular tissue that cannot effectively be removed by liposuction alone and therefore requires alternative surgical intervention.[14] The American College of Surgeons' National Surgical Quality Improvement Program pediatric database has been used to assess the morbidity profile in adolescents who underwent gynecomastia surgery under Current Procedural Terminology code 19300 to include the use of liposuction. The safety of operative management for gynecomastia was described in a study by Zavlin et al,[15] who found the overall complication rate in the surgical and medical categories to be low (surgical = 3.9%, medical = 0.0%). That being said, this study has been critiqued for the short duration of follow-up (30 days) and failure to consider complications such as tissue recurrence and scarring.[16] The complication rate for our total sample was found to be 10%, and while there was no significant difference in the complication profile across surgical techniques regardless of Rohrich grade, there were no patients with hematomas or seromas in the liposuction plus arthroscopic shaver group.

One additional area of concern is the ultimate aesthetic outcomes of traditional techniques. Inherent challenges of cutaneous scarring over a large subcutaneous defect may commonly result in an aesthetic outcome equally displeasing to the preoperative state, if not worse. To address this, there has been evolution of surgical techniques from open procedures to minimally invasive approaches, which has been well described in the adult population.[11,12,17] Utilization of the arthroscopic-shaver–assisted technique has been shown to provide superior aesthetic outcomes compared with open excision, reduced incidence of hematomas compared with a liposuction plus open excision, and require fewer revision procedures than a liposuction-only technique.[10–12,18,19] Within our population of adolescents, the overall reoperation rate was relatively low and not statistically different between the various operative methods.

Adolescent men with clinically significant gynecomastia often experience pain at the breasts with activity and experience social pressure such as bullying and teasing.[20] These intrinsic and extrinsic symptoms negatively impact their quality of life in multiple domains such as general health, vitality, social-functioning, and emotional well-being.[5] Surgical intervention for gynecomastia can significantly improve physical and psychosocial functioning.[5] Therefore, it is especially important to provide this vulnerable population with treatment options that not only eliminate the redundant breast tissue, but also minimize the stigmata of a mastectomy. In an adult population, the arthroscopic shaver technique has provided improved final outcomes including less scarring, good skin retraction and cosmetic satisfaction,[10] making this method an option worth discussing during surgical planning for all age groups.

When compared with other surgical techniques, this study found the arthroscopic shaver plus liposuction approach to have a similar mean operative time for low-grade gynecomastia and the shortest operative time for patients with high-grade gynecomastia. This is an important consideration given the particularly deleterious neurodevelopmental effects of prolonged exposure to general anesthesia in high-risk young adults.[21] A shorter operating time also provides the means to decrease costs associated with this procedure that normally is not well reimbursed.[22]

This study also demonstrates effective use of the arthroscopic shaver technique in high Rohrich grade gynecomastia patients with significant skin redundancy. This efficacy in the pediatric population, when compared with the adult population, may be a result of higher dermal elasticity in adolescence[23] allowing for significant contraction in the skin envelope following removal of the underlying parenchymal volume. This study demonstrates successful expansion of this technique for use in high Rohrich grade gynecomastia and further highlights the potential for soft tissue retraction following minimally invasive techniques in the adolescent population.

There was not a significant relationship between suction drain placement and postoperative complications, including hematomas or seromas. This finding is similar to current evidence which shows no significant benefit to the utilization of drains after reduction mammoplasty.[24]

One key consideration in surgical decision-making is evidence to support patient satisfaction. Due to the retrospective nature of this study, it was not possible to capture a measurable comparison of preoperative and postoperative body satisfaction. It would be beneficial to integrate a standardized questionnaire into clinical practice to evaluate the impact of differing surgical techniques on body image and health-related quality of life. This additional information can be used to manage patient expectations and inform surgical decision-making while providing insight to best practice.

Although the retrospective design of this study allowed for efficient data collection over a 5-year period, the design is limited, given its inferior level of evidence compared with a prospective study. Additionally, the findings are limited in their generalizability, given the relatively small sample size and considering all patients were treated at a single institution. In future iterations, a larger sample size would be beneficial to increase the power of the statistical analysis. Also, a longer duration of follow-up would support the utility of this technique by demonstrating late results with optimal flat aesthetic breast contour.

CONCLUSIONS

This study shows that use of the arthroscopic shaver for gynecomastia treatment in pediatric patients is safe and effective. There was not a significant difference in the incidence of complications or unplanned reoperations across surgical techniques. For patients with Rohrich grades I and II, the arthroscopic shaver approach demonstrated noninferiority when assessing operative times compared with the techniques evaluated in this study. For patients with Rohrich grade III and IV who had significant ptosis and excess skin, the arthroscopic shaver technique demonstrated an insignificant difference in incidence of reoperation compared with the other techniques, suggesting efficacy in both excision of breast tissue and resolution of skin redundancy. These findings are significant in the pediatric population as it provides additional surgical options potentially reducing the stigmata of traditional open approaches. The authors advocate the use of the arthroscopic shaver technique as a first line surgical treatment of gynecomastia in the pediatric population. Further prospective studies should be pursued to evaluate patient satisfaction and long-term aesthetic outcomes.

Samuel H. Lance, MD
4520 Executive Dr.
San Diego, CA 92121
E-mail address: shlance@ucsd.edu

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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