



Incidence of Complications for Different Approaches in Gynecomastia Correction: A Systematic Review of the Literature



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Abstract

Background Gynecomastia is nowadays a very common disease, affecting a large cohort of patients with different ages. The aim of this literature review is to assess the incidence of complications with all proposed techniques and for combined procedures versus single approach procedures in gynecomastia correction.

Materials and Methods A systematic review of the literature was performed to identify all reported techniques for gynecomastia correction covering a period from January 1, 1987 to November 1, 2020. For all selected papers, demographic data, proposed technique, and complications' incidence have been recorded.

Results A total number of 3970 results was obtained from database analysis. A final total number of 94 articles was obtained for 7294 patients analyzed. Patients have been divided into three groups: aspiration techniques, consisting in 874 patients (11,98%), surgical excision techniques, consisting in 2764 patients (37,90%), and combined techniques, consisting in 3656 patients (50,12%). Complications have been recorded for all groups, for a total number of 1407, of which 130 among “Aspiration techniques” group (14,87%), 847 among “Surgical excision techniques” group (30,64%), and 430 in “Combined techniques” group (11,76%).

Conclusions Several techniques have been proposed in the literature to address gynecomastia, with the potential to

greatly improve self-confidence and overall appearance of affected patients. The combined use of surgical excision and aspiration techniques seems to reduce the rate of complications compared to surgical excision alone, but the lack of unique classification and the presence of several surgical techniques still represents a bias in the literature review.

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Keywords Gynecomastia · Gynecomastia review · Surgical gland excision · Liposuction · Literature analysis

Introduction

Gynecomastia is defined as a benign enlargement of the mammary glands, commonly diffused among men. The prevalence of gynecomastia ranges from 38 to 64 percent in the male population [1].

Prevalence figures vary highly between age groups. Among male neonates, 60–90% have some amount of palpable breast tissue. The next chronological peak occurs during puberty with reported prevalence figures of 4–69% that decrease again by age 17 to approximately 10%. The third and last peak occurs in elderly men [2].

The etiology of gynecomastia is heterogeneous. More than 80% can be classified as idiopathic, since a well-established cause is not determined. Medical drugs, addictional drugs, and anabolic substance abuse, mostly among bodybuilders, have been identified as secondary causes for gynecomastia. The gynecomastia

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pathophysiology is due to a hormonal imbalance with decreased testosterone production, increased estrogen production, mainly from the peripheral conversion of androgens, and increased availability of estrogen precursors. In men, estrogen production results through aromatase activity to estradiol and estrone. In patients affected by gynecomastia, an increased local tissue sensitivity to estrogen metabolites is present [3].

Gynecomastia can affect normal self-esteem and sexual identity and often patients feel ashamed of their bodies during normal social activities.

Being a very popular item in the present literature, several surgical techniques have been proposed for gynecomastia correction. The aim of this systematic review is to assess the rate of reported complications with all proposed techniques and the evaluation of the complications' rate in combined procedures versus single procedures.

Material and Methods

Literature Search

The searched databases included Medline, EMBASE, Cochrane and PubMed, covering a period from January 1, 1987 to November 1, 2020.

A detailed search was performed starting from the general topics to avoid overlooking the studies in the databases. Based on this, the keywords used for detailed investigation were “gynecomastia,” “gynecomastia surgery,” “gynecomastia correction,” “gynecomastia surgical correction”.

Inclusion and Exclusion Criteria

Our predefined inclusion criteria included articles that included any age patients' cohort, including pediatric population; included surgical techniques for the correction of gynecomastia (defined as any enlargement of the breast tissue); were English-language articles; were published between 1987 and 2020. Exclusion criteria were as follows: article considering non-surgical or therapeutic treatment for gynecomastia; articles about pseudogynecomastia; non-comparative studies, systematic reviews, case reports, expert opinions, conference and abstracts, review, letters to editors, and non-English articles.

Data Extraction and Quality Assessment

Two authors independently reviewed the titles and abstracts to assess eligibility for potential inclusion. The full-text papers were reviewed by two authors and

inclusion was made on a consensus basis. Disagreement was resolved through a discussion between the reviewers. Literature analysis is reported in Fig. 1.

All articles have been separately analyzed for the following data:

1. Number of patients
2. Age range or, when the range was not indicated, mean age value
3. Proposed technique(s)
4. Complications

Since not all articles included patients' satisfaction and gynecomastia's grades, the authors decided not to collect those data to avoid bias.

The accurate analysis of all selected papers was conducted by both authors simultaneously. Proposed techniques have been categorized into three major groups according to their characteristics:

1. Aspiration, including techniques involving suction device(s), consisting in
 2. Traditional liposuction
 3. Ultrasound-assisted liposuction (UAL)
 4. Suction-assisted liposuction (SAL)
 5. Power-assisted liposuction (PAL)
6. Laser Lipolysis
7. Sharp cutting Liposuction
8. Mixed techniques
9. Surgical excision, including techniques with glandular removal, consisting in
 10. Open excision
 11. Endoscopically assisted surgical excision
 12. Transaxillary excision
 13. Microdebrider
 14. Vacuum-assisted/Mammotome
 15. Combined techniques, consisting in the combination of surgical excision and aspiration, including
 16. Open excision and Liposuction/UAL/PAL
 17. Pull-trough and Liposuction
 18. Fragmentation and Liposuction
 19. Cartilage shaver and Liposuction
 20. Endoscopic adenectomy and Liposuction
 21. Suction-Assisted excision and Liposuction

Complications have been statistically analyzed for all selected papers. In particular, the following complications have been recorded for each paper and grouped according to the proposed technique: hematoma, seroma, over-resection, under-resection, hypo- or hyperesthesia, wound dehiscence, infection, pathological scar, asymmetries, irregularities/redundant skin, NAC necrosis (partial or total)/abrasion and revision/recurrence.

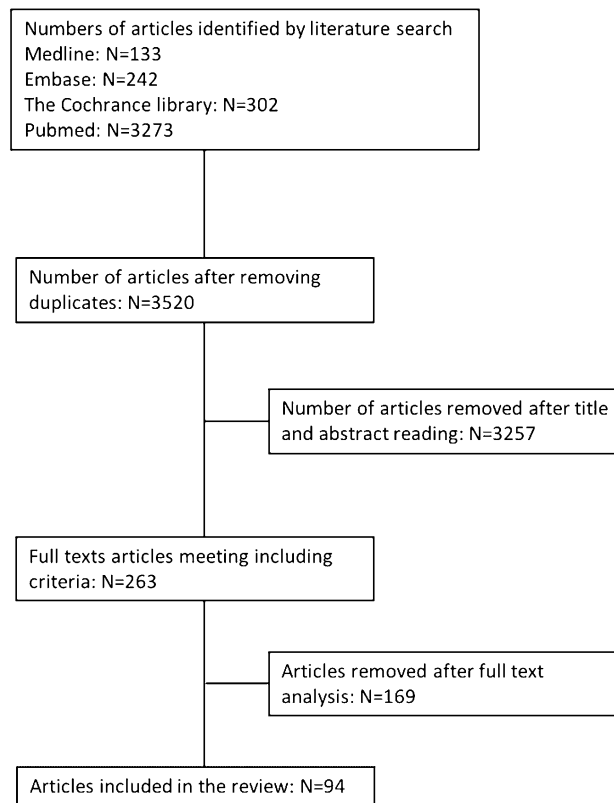


Fig. 1. Flow chart for literature search

Statistical Analysis

For each study, the overall complication rate and the rate of each complication type was calculated. The complication rate across all studies, grouped according to the technique, was then calculated. Chi-square tests were used to compare complication rates between the groups. Data are shown in Table 1.

Results

A total number of 3970 results was obtained from database analysis. A final total number of 94 articles was obtained, according to predefined inclusion and exclusion criteria, for a total number of 7294 patients analyzed [4–97].

Patients, according to previously mentioned criteria, have been divided into three groups:

- Aspiration techniques, consisting in 874 patients (11,98%)
- Surgical excision techniques, consisting in 2764 patients (37,90%)
- Combined techniques, consisting in 3656 patients (50,12%)

Among patients belonging to “Aspiration techniques” group, a further division into subgroups has been reported. Of these, 241 patients underwent traditional liposuction, 31 ultrasound-assisted liposuction, 21 suction-assisted liposuction, 71 laser lipolysis, 57 sharp cutting liposuction and 453 mixed techniques.

Among the 2764 patients belonging to “Surgical excision techniques” group, 2560 underwent traditional open excision, 138 endoscopically assisted adenectomy, 5 transaxillary excision, 8 microdebrider excision, and 73 vacuum-assisted/mammotome excision.

Of the 3656 patients belonging to “Combined techniques” group, 2396 underwent open excision and liposuction (either tradition, ultrasound-assisted or power-assisted), 713 pull-trough and liposuction, 301 excision by fragmentation and liposuction, 186 excision by cartilage shaver and liposuction, 24 endoscopic adenectomy and liposuction, and 36 suction-assisted excision and liposuction.

Complications have been recorded for all groups, for a total number of 1407, of which 130 among “Aspiration techniques” group (14,87%), 847 among “Surgical excision techniques” group (30,64%) and 430 in “Combined techniques” group (11,76%). Complications rate for each group is reported in Table 2. Most common complication

Table 1 Review of the literature for a single article, focusing on demographic parameters and complications rate

Authors	Patients	Age	Surgical technique	Complications												Total
				HE	SE	OR	UR	HH	WD	IN	PS	AS	IS	NN	RR	
Courtiss et al. [4]	101	16-61	SURGICAL EXCISION (hemiperiareolar)	31	18	36	42	21	0	0	36	0	0	0	0	184
	20		LIPOSUCTION	0	2	0	3	5	0	0	0	0	0	0	0	10
	38		SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	4	5	0	2	0	0	0	9	0	0	0	0	20
Aiache et al. [5]	38	NR	SURGICAL EXCISION (hemiperiareolar)	4	0	0	0	0	0	0	0	0	0	0	0	4
Ward et al. [6]	6	NR	SURGICAL EXCISION (horizontal ellipse with vertical pedicle)	1	0	0	0	0	0	0	0	0	0	0	0	1
Varma et al. [7]	20	23.5	SURGICAL EXCISION (hemiperiareolar)	2	1	0	0	0	0	0	0	0	0	0	0	3
Aposos et al. [8]	4	NR	LIPOSUCTION	0	0	0	1	0	0	0	0	0	0	0	0	1
	2		SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
Stark et al. [9]	14	16-34	LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
	9		SURGICAL EXCISION + LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
Brenner et al. [10]	44	NR	SURGICAL EXCISION (37 hemiperiareolar and 7 transverse)	0	0	0	0	2	0	0	4	0	0	0	0	6
Abramo et al. [11]	10	NR	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
Samdal et al. [12]	3	16-69	SURGICAL EXCISION (hemiperiareolar)	1	0	0	0	0	0	0	0	0	0	0	0	1
	33		SURGICAL EXCISION (hemiperi- or circumareolar)+ LIPOSUCTION	2	0	2	1	0	0	0	0	0	0	0	0	5
	31		LIPOSUCTION	0	0	0	5	0	0	0	0	0	0	0	2	7
Morselli et al. [13]	11	NR	SURGICAL EXCISION (pull-trough) + LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
Aiache et al. [14]	18	24-46	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
Peters et al. [15]	11	13-18	SURGICAL EXCISION (bipedicled flap)	0	1	0	0	1	0	0	2	0	0	0	0	4
Hamas et al. [16]	31	12-67	SURGICAL EXCISION (hemiperiareolar)+ sharp cutting LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
	57		Sharp cutting LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	4	4
Smoot 3rd et al. [17]	20	NR	Purse-string SURGICAL EXCISION	0	0	0	0	0	0	0	0	0	0	0	2	2
Colombo-Benkman et al. [18]	81	15-78	SURGICAL EXCISION (73 hemiperiareolar, 4 circumareolar, 4 submammary)	15	0	0	0	17	0	0	60	0	8	0	9	109

Table 1 continued

Authors	Patients	Age	Surgical technique	Complications												
				HE	SE	OR	UR	HH	WD	IN	PS	AS	IS	NN	RR	Total
Gasperoni et al. [19]	64	16-62	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	1	0	0	3	0	0	0	0	0	0	0	0	4
Javaid et al. [20]	4	NR	SURGICAL EXCISION (transareolar)	0	0	0	0	0	0	0	1	0	0	0	0	1
Babigian et al. [21]	2	NR	SURGICAL EXCISION (hemiperiareolar)	0	0	0	0	0	0	0	0	0	0	0	0	0
	18		SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	2	1	0	3	0	0	0	0	0	0	0	0	6
Persichetti et al. [22]	28	16-33	SURGICAL EXCISION (circumareolar)	0	1	0	0	0	2	0	0	0	0	0	0	3
Coskun et al. [23]	32	20-36	SURGICAL EXCISION (hemiperiareolar, in 10 cases extended)	7	0	0	0	1	0	0	9	0	3	1	0	21
Rohrich et al. [24]	61	NR	UAL or LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	12	12
Boljanovic et al. [25]	3	NR	LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
	25		SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	1	0	0	0	0	0	0	0	0	0	0	1	2
Fruhstorfer et al. [26]	31	13-57	31 UAL, SAL or LIPOSUCTION	0	0	0	3	1	0	0	0	0	0	2	1	7
	16		SURGICAL EXCISION + LIPOSUCTION	0	0	0	0	0	0	0	1	0	0	0	0	1
	1		SURGICAL EXCISION	0	0	0	0	0	0	0	0	0	0	0	0	0
Hammond et al. [27]	15	12-69	SURGICAL EXCISION (pull-through)+ LIPOSUCTION	0	1	0	0	1	0	0	1	0	0	0	0	3
Iwuagwu et al. [28]	5	16-88	SURGICAL EXCISION (mammotome)	0	0	0	0	0	0	0	0	0	0	0	0	0
Tashkandi et al. [29]	24	NR	SURGICAL EXCISION (purse-string)	0	0	0	0	0	0	0	0	0	0	0	0	0
Walden et al. [30]	12	25	LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
	6		SURGICAL EXCISION (hemiperiareolar)	1	0	0	0	0	0	0	0	0	0	0	0	1
	16		SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	0	0	0	0	2	0	0	0	0	0	0	0	2
Gabra et al. [31]	39	9.5-17	SURGICAL EXCISION (circumareolar)	3	1	0	1	0	0	1	0	3	1	0	1	11
Bracaglia et al. [32]	45	21-65	SURGICAL EXCISION (pull-through) + LIPOSUCTION	2	0	0	1	0	0	0	0	0	0	0	1	4
Celebioglu et al. [33]	9	15-21	SURGICAL EXCISION (circumareolar with subareolar glandular pedicle)	0	0	0	0	9	0	0	1	0	0	1	1	12

Table 1 continued

Authors	Patients	Age	Surgical technique	Complications												Total	
				HE	SE	OR	UR	HH	WD	IN	PS	AS	IS	NN	RR		
Aslan et al. [34]	15	NR	SURGICAL EXCISION (periareolar–transareolar)	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Prado et al. [35]	25	17–38	CARTILAGE SHAVER + LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hodgson et al. [36]	31	16–57	UAL	0	0	0	0	0	0	0	0	0	0	1	0	1	2
Ramon et al. [37]	17	17–39	SURGICAL EXCISION (endoscopic pull-through) + LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boni et al. [38]	38	23–64	LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yavuz et al. [39]	5	18–24	Transaxillary SURGICAL EXCISION (Lighted Retractor-Assisted)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haddad Filho et al. [40]	12	15–26	SURGICAL EXCISION (circumareolar)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mentz et al. [41]	200	13–78	SURGICAL EXCISION (single puncture) + LIPOSUCTION	2	0	0	2	0	0	0	0	0	0	1	0	0	5
Esme et al. [42]	28	17–80	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lista et al. [43]	96	17–46	SURGICAL EXCISION (pull-through) + LIPOSUCTION	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Zhu et al. [44]	2	24–25	Endoscopically assisted SURGICAL EXCISION	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gheita et al. [45]	8	NR	SURGICAL EXCISION (Horizontal excision ellipse and superior pedicle flap)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lanitis et al. [46]	102	11–82	SURGICAL EXCISION (56 circumareolar, 20 Inframammary fold, 10 concentric circumareolar, 12 inverted ‘‘T’’ reduction mastopexy, 4 extended circumareolar incision)	9	31	0	0	0	2	1	0	0	0	0	0	0	43
Cannistra et al. [47]	58	NR	SURGICAL EXCISION (Periareolar Incision and Dermal Double Areolar Pedicle) + SURGICAL EXCISION	0	0	0	0	6	0	0	0	0	0	0	0	0	6
Goh et al. [48]	8	NR	SURGICAL EXCISION (microdebrider)	0	0	0	0	0	0	0	1	0	0	1	0	0	2
Tu et al. [49]	22	13–63	SURGICAL EXCISION (periareolar zig-zag incision) + SURGICAL EXCISION	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Scuderi et al. [50]	23	16–39	SURGICAL EXCISION (transareolar) + Power-assisted LIPOSUCTION	1	2	0	0	0	0	0	1	0	0	0	0	0	4
Fan et al. [51]	65	14–28	Endoscopically assisted SURGICAL EXCISION	0	1	0	0	0	0	0	0	0	0	2	0	0	3

Table 1 continued

Authors	Patients	Age	Surgical technique	Complications												Total
				HE	SE	OR	UR	HH	WD	IN	PS	AS	IS	NN	RR	
Benito-Ruiz et al. [52]	40	19-57	CARTILAGE SHAVER + LIPOSUCTION	3	0	0	0	0	0	0	2	0	0	0	3	8
Rho et al. [53]	5	30-33	LASER LIPOLYSIS	0	0	0	0	0	0	0	0	0	0	0	0	0
Laituri et al. [54]	20	14-18	SURGICAL EXCISION (circumareolar or inferior pedicle reduction)	0	1	0	0	0	0	0	0	0	0	0	0	1
Petty et al. [55]	45	11-77	SURGICAL EXCISION	0	1	0	0	0	0	1	0	0	0	1	3	6
	56		SURGICAL EXCISION + LIPOSUCTION	2	6	0	0	0	0	0	0	0	0	1	3	12
	50		LIPOSUCTION	1	1	0	0	0	0	0	0	0	0	0	4	6
	76		CARTILAGE SHAVER + LIPOSUCTION	1	2	1	0	0	0	0	1	0	0	0	4	9
El Noamani et al. [56]	15	22-30	SURGICAL EXCISION (inferior pedicle without vertical scar)	0	0	0	0	0	1	0	3	0	0	1	0	5
Qutob et al. [57]	36	16-88	SURGICAL EXCISION (mammotome) + LIPOSUCTION	3	0	0	0	0	0	0	0	0	0	1	0	4
Cigna et al. [58]	37	18-43	SURGICAL EXCISION (hemiperiareolar) + Power-assisted LIPOSUCTION	1	0	0	0	0	0	0	0	0	0	0	0	1
He et al. [59]	20	18-47	SURGICAL EXCISION (mammotome)	1	0	0	0	0	0	0	0	0	0	0	0	1
Jarrar et al. [60]	1	18-44	Endoscopically assisted SURGICAL EXCISION	0	0	0	0	0	0	0	0	0	0	0	0	0
	7		Endoscopically assisted SURGICAL EXCISION + LIPOSUCTION	0	1	0	0	0	0	1	0	0	0	0	0	2
	4		LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
Morselli et al. [61]	260	10-59	SURGICAL EXCISION (pull-through) + LIPOSUCTION	8	0	0	0	0	0	0	13	0	12	0	24	57
Trelles et al. [62]	28	24-56	LASER LIPOLYSIS	0	0	0	0	0	0	0	0	0	0	0	0	0
Zampieri et al. [63]	5	NR	SURGICAL EXCISION (circumareolar)	0	2	0	0	0	0	0	0	0	0	0	0	2
Lee et al. [64]	15	13-55	CARTILAGE SHAVER + LIPOSUCTION	1	0	0	0	0	0	0	0	3	0	0	0	4
Cao et al. [65]	58	17-52	Endoscopically assisted SURGICAL EXCISION	0	0	0	0	0	0	0	0	0	0	3	0	3
Hosnuter et al. [66]	23	15-42	SURGICAL EXCISION (superior periareolar) + LIPOSUCTION	0	0	0	0	0	1	0	0	0	0	0	0	1
Kasielska et al. [67]	113	17-54	SURGICAL EXCISION (94 circumareolar; 9 skin excision mastectomy; 6 inverted-T reduction mastopexy with NAC transposition; 4 inframammary fold approach with NAC graft)	8	4	0	0	11	0	1	0	0	0	1	0	25

Table 1 continued

Authors	Patients	Age	Surgical technique	Complications												Total
				HE	SE	OR	UR	HH	WD	IN	PS	AS	IS	NN	RR	
Song et al. [68]	402	17-82	215 Periareolar incision, 97 complete concentric periareolar, 45 Inframammary fold incision, 26 Inverted-T incision, 53 Mammotome excision	7	10	0	0	2	0	0	10	0	0	9	6	44
	331	15-73	145 LIPOSUCTION, 241 UAL	4	7	0	0	26	0	0	0	0	0	0	2	39
Blau et al. [69]	1073	18-51	SURGICAL EXCISION (hemiperiareolar)	64	128	0	0	0	0	0	0	0	0	0	0	192
Yoo et al. [70]	13	20-28	1,444-nm Nd:YAG LAL	0	0	0	0	0	0	0	0	0	0	0	0	0
Schroder et al. [71]	53	13-66	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	2	0	0	0	0	0	0	0	0	0	0	2	4
Ibrahiem et al. [72]	27	18-53	SURGICAL EXCISION (circumareolar with superior pedicle) + UAL	1	0	0	0	0	1	0	5	0	0	1	0	8
El-Sabbagh et al. [73]	18	13-33	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	0	0	0	0	0	0	1	0	0	0	2	0	3
Shirol et al. [74]	20	16-36	SURGICAL EXCISION (orange pell hemiperiareolar)+ LIPOSUCTION	1	0	0	0	0	0	0	0	0	0	0	0	1
Bailey et al. [75]	75	NR	SURGICAL EXCISION (pull-through) + Power-assisted LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	1	1
Kim et al. [76]	16	18-30	LIPOSUCTION	0	0	0	1	0	0	0	0	0	0	0	0	1
	48		SURGICAL EXCISION (hemi- or circumareolar)+ LIPOSUCTION	0	0	1	1	0	0	0	1	0	0	0	0	3
Innocenti et al. [77]	312	18-52	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	4	6	0	0	0	0	0	0	0	47	0	3	60
Taheri et al. [78]	27	17-36	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	0	0	0	0	9	0	0	1	1	0	4	0	15
Khalil et al. [79]	52	26.9	SURGICAL EXCISION (pull-through) + LIPOSUCTION	0	0	0	0	10	0	0	0	0	0	0	1	11
Sönmez Ergün et al. [80]	25	18-33	980 nm LASER LIPOLYSIS	0	2	0	0	0	0	0	0	4	0	0	0	6
Thienot et al. [81]	9	19-67	SURGICAL EXCISION (Postero-Inferior Pedicle) + LIPOSUCTION	1	0	0	0	0	1	0	1	0	0	0	0	3
Choi et al. [82]	71	16-18	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	2	3	0	0	4	0	0	2	0	0	0	0	11

Table 1 continued

Authors	Patients	Age	Surgical technique	Complications												Total
				HE	SE	OR	UR	HH	WD	IN	PS	AS	IS	NN	RR	
Ozalp et al. [83]	21	19-34	SAL	3	2	4	0	8	0	0	0	0	0	1	0	18
Lee et al. [84]	30	13-56	Cutting edge tip cannula + Power-assisted LIPOSUCTION	0	1	0	0	0	0	0	0	0	0	0	0	1
	10		SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
Wyrick et al. [85]	52	23-73	SURGICAL EXCISION (hemi- or circumareolar)+ LIPOSUCTION	2	4	0	0	0	0	0	0	0	0	0	0	6
Abdelrahman et al. [86]	18	28-34	LIPOSUCTION	0	0	0	2	0	0	1	0	0	0	0	0	3
Tarallo et al. [87]	15	18-28	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
Yao et al. [88]	22	15-45	SURGICAL EXCISION (Vacuum-assisted)	1	0	0	0	1	0	0	0	0	1	0	0	3
Mohamad Hasan et al. [89]	150	NR	SURGICAL EXCISION (hemiperiareolar or Benelli)	40	29	0	0	24	8	0	2	0	0	15	0	118
Sim et al. [90]	101	26	SURGICAL EXCISION (microdebrider) + LIPOSUCTION	7	0	0	18	0	0	0	3	0	0	0	0	28
	31	27	LIPOSUCTION	3	0	0	10	0	0	0	0	0	0	0	0	13
	21	30	SURGICAL EXCISION (circumareolar)	4	0	0	6	0	0	0	1	0	0	0	0	11
	18	25	SURGICAL EXCISION (circumareolar) + LIPOSUCTION	4	0	0	4	0	0	0	1	0	0	0	0	9
Murugesan et al. [91]	149	19-57	SURGICAL EXCISION (pull-through) + LIPOSUCTION	2	0	0	0	0	0	0	0	0	0	0	0	2
Akhtar et al. [92]	30	17-38	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	2	0	0	0	0	0	0	0	8	2	0	0	12
	30		SURGICAL EXCISION (arthroscopic shaver) + LIPOSUCTION	3	0	0	0	0	0	0	0	10	2	2	0	17
Tripathy et al. [93]	10	21-30	SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	2	0	0	0	0	0	0	0	0	0	0	0	2
	10		SURGICAL EXCISION (pull-through) + LIPOSUCTION	0	0	0	0	0	0	0	0	0	0	0	0	0
Harinatha et al. [94]	1159	NR	SURGICAL EXCISION (superior pedicle) + LIPOSUCTION	27	0	0	0	0	32	0	0	7	0	0	0	66
Jian et al. [95]	12	19-40	Endoscopically assisted SURGICAL EXCISION	0	0	0	0	1	0	0	0	0	0	0	0	1
Qu et al. [96]	56	NR	SURGICAL EXCISION (periareolar or inframammary fold)	1	0	0	0	5	0	0	0	0	0	0	0	6
	26		Vacuum-assisted SURGICAL EXCISION	3	0	0	0	2	0	0	0	0	0	0	0	5

Table 1 continued

Authors	Patients	Age	Surgical technique	Complications												
				HE	SE	OR	UR	HH	WD	IN	PS	AS	IS	NN	RR	Total
Pfeiler et al. [97]	34	NR	SURGICAL EXCISION (hemiperiareolar)	8	1	0	0	0	0	2	0	0	0	0	0	11
	21		SURGICAL EXCISION (hemiperiareolar)+ LIPOSUCTION	3	1	0	0	0	0	1	0	0	0	0	0	5

HE hematoma(s); *SE* seroma; *OR* over-resection; *UR* under-resection; *HH* hypo- or hyperesthesia; *WD* wound dehiscence; *IN* infection; *PS* pathological scar; *AS* asymmetries; *IS* irregularities or redundant skin; *NN* NAC necrosis (partial or total) or abrasion; *RR* revision or recurrences

recorded was hematoma (322 cases, 22,88%), mainly present in “surgical excision” techniques. This element could be addressed to the use of surgical excision alone in more severe forms, with a higher incidence of possible complications. For the same reasons, seroma rate is higher in “surgical excision” group.

From statistical descriptive analysis, we observe that using different techniques we obtain different percentages of patients with no complications and with the considered complications (Figs. 2 and 3).

Follow a statistical inference approach, we test, using Pearson’s Chi-squared test, the null hypothesis of independence between technique and outcome; we observe a value of 760,49 for the test statistic with 24 degrees of freedom, with a very small *p*-value (*p*-value < 2.2e−16). This suggests us to reject the null hypothesis, confirming that different techniques give different outcomes.

Discussion

Several techniques have been described throughout the years for treating gynecomastia. Aspiration techniques, including liposuction and its modern variations, base their principles on removing through a minimal access to the redundant fatty and breast tissues by fragmentation and suction. Since gynecomastia in most cases is defined as mixed, aspiration of the gland cannot permit histopathological analysis and skin redistribution is limited. Moreover, these techniques do not permit a direct hemostasis [98–101].

Aspiration techniques vary according to the modality used for fat and glandular tissue removal. In suction-assisted liposuction, after tumescent solution infiltration, localized areas of unwanted fat are removed through the combination of a high-vacuum blunt-tipped cannula and longitudinal motion. In ultrasound-assisted liposuction, ultrasound frequencies produced by specific cannulas primarily affect tissues with the lowest density, such as fat tissues, whose density is further reduced by previous

wetting with tumescent solution. Interactions between adipose tissue and ultrasound waves lead to adipocyte fragmentation through cavitation and, therefore, this technique has a high degree of selectivity for fat cells resulting in a high degree of selectivity for fat cells, and thus reducing blood loss, postoperative edema, and ecchymosis and avoiding contour irregularities. In power-assisted liposuction, oscillating rotational and translational movements of cannula tip are produced, mimicking the motion of the operator’s arm with lower amplitude and allowing an easier penetration of fibrous fat and glandular tissue, while generating no thermal energy and therefore reducing the risk of cutaneous burns. Laser lipolysis utilizes the principles of selective photothermolysis to preferentially lyse adipocytes while leaving surrounding structures unaffected. Different laser wavelengths may vary in their relative effectiveness in targeting substances present in the subcutaneous environment. Thus, lasers achieve their desired effect via photolysis of adipose cells, photocoagulation of small vessels, liberation of adipocyte lipases, and contraction of dermal collagen.

More challenging cases, such as male tuberous breast, can hardly be corrected only with aspiration techniques since an open excision is required to manage the deformity [102–105].

Open excision techniques base their principle on a direct view and management of the gland, through several types of surgical accesses according to the surgeon’s preference and entity of the defect [106, 107]. The main advantage of open excision is the direct control of the hemostasis and redundant skin control, with the main disadvantage of permanent scars, whose quality cannot be predicted. Furthermore, gland excision can permit histopathological analysis since male breast carcinoma, even if rare, can occur only in patients affected by gynecomastia [108].

Combined techniques are usually composed of an open excision phase followed by an aspiration phase: the combination of these techniques can permit a limited scar extension since, after open excision, the wide undermining

Table 2 Complications rate for each group according to the inclusion criteria.

Technique	No. Complications											Total			
	Hematoma	Seroma	Over-resection	Under-resection	Hypo- or Hyperesthesia	Wound dehiscence	Infection	Pathological scar	Asymmetries	Irregularities or redundant skin	NAC necrosis (partial or total)/abrasion		Revision/recurrence		
Aspiration	874	11	15	4	25	40	0	1	0	3	4	0	1	26	130
Traditional Liposuction	241	4	3	0	22	5	0	1	0	0	0	0	0	6	41
Ultrasound-Assisted Liposuction	31	0	0	0	0	0	0	0	0	1	0	0	0	1	2
Suction-Assisted Liposuction	21	3	2	4	0	8	0	0	0	0	0	0	1	0	18
Laser Lipolysis	71	0	2	0	0	0	0	0	0	0	4	0	0	0	6
Sharp cutting Liposuction	57	0	0	0	0	0	0	0	0	0	0	0	0	4	4
Mixed techniques	453	4	8	0	3	27	0	0	0	2	0	0	0	15	59
Surgical Excision	2764	213	230	36	49	97	13	6	130	13	3	13	35	22	847
Open excision	2540	208	229	36	49	93	13	6	129	12	3	12	29	22	829
Endoscopically assisted	138	0	1	0	0	1	0	0	0	0	0	0	5	0	7
Transaxillary excision	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microdebrider	8	0	0	0	0	0	0	0	1	0	0	0	1	0	2
Vacuum-assisted/mammotome	73	5	0	0	0	3	0	0	0	1	0	0	0	0	9
Combined techniques	3656	98	34	4	35	32	35	3	42	64	29	64	16	38	430
Open excision and Liposuction/UAL/PAL	2396	66	28	3	14	21	35	2	22	49	16	49	8	9	273
Pull-trough and Liposuction	713	12	3	0	1	11	0	0	14	12	0	12	0	27	80
Fragmentation and Liposuction	301	9	0	0	20	0	0	0	3	1	0	1	0	0	33
Cartilage shaver and Liposuction	186	8	2	1	0	0	0	0	3	2	13	2	7	2	38
Endoscopic adenectomy and Liposuction	24	0	1	0	0	0	0	1	0	0	0	0	0	0	2
Suction-Assisted excision and Liposuction	36	3	0	0	0	0	0	0	0	0	0	0	1	0	4
Total	7294	322	279	44	109	169	48	10	172	80	36	80	52	86	1407
PERCENTAGE															
Aspiration	11,98	3,42	5,38	9,10	22,94	23,67	0,00	10,00	0,00	3,75	11,11	3,75	1,92	30,23	9,24
Surgical Excision	37,90	66,15	82,44	81,81	44,95	57,40	27,08	60,00	75,58	16,25	8,33	16,25	67,31	25,58	60,20
Combined techniques	50,12	30,43	12,18	9,09	32,11	18,93	72,92	30,00	24,42	80,00	80,56	80,00	30,77	44,19	30,56

UAL, ultrasound-assisted liposuction; PAL, power-assisted liposuction.

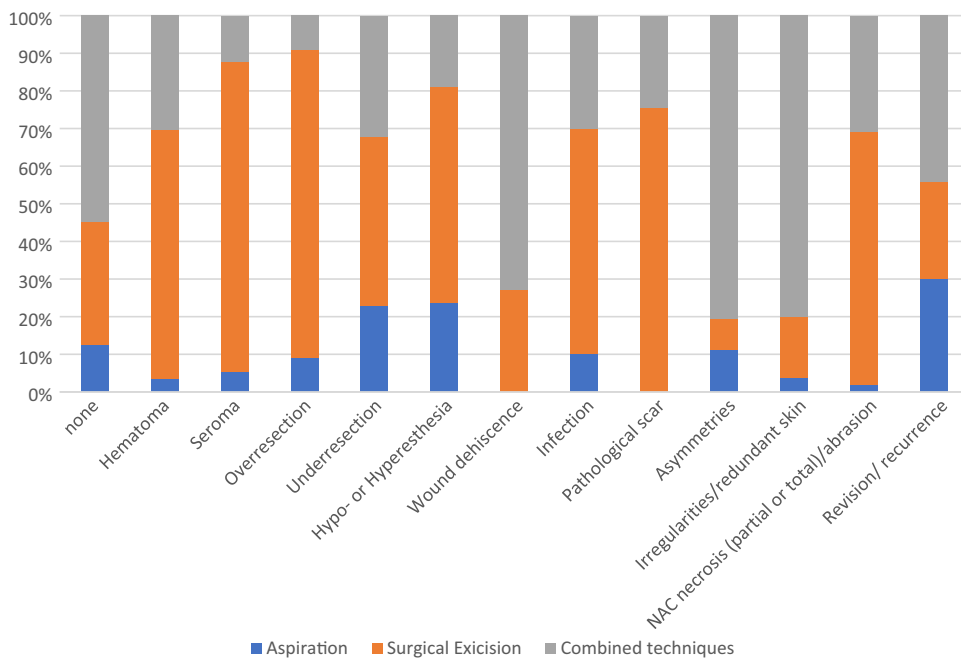


Fig. 2. Percentages distribution of patients subjected to a technique for each outcome

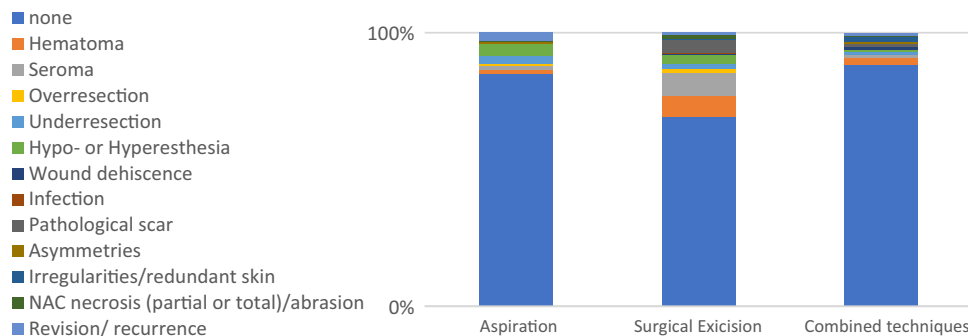


Fig. 3. Graphic representation of percentages distribution of patient's outcome for each technique

of the skin flap onto a larger area can often permit a sufficient skin redistribution [109–112].

Since gynecomastia represents a disease commonly diffused worldwide, an updated systematic review that focuses not only on the different types of proposed treatment but also on complications rate, is a useful tool for plastic surgeons [113]. Several biases can be found, mostly related to the high variations in proposed treatments and clinical classifications. In fact, several articles proposed specific treatments for graded gynecomastia patients, but the large variations of gynecomastia classifications cannot guarantee a statistical comparison and therefore only the type of surgical approach, despite the grade of the disease, have been considered [114–116]. Moreover, no comparison

of patients' postoperative satisfaction has been performed because of the absence of evaluation in some papers and for the different used methods for evaluation [117–121]. Besides those biases, that are strictly relative to the large discussion on this topic in literature, this review, as previously stated, confirms that the combined approach with traditional surgical excision of glandular tissue combined with liposuction provides the lowest rate of complications, compared to aspiration techniques alone and surgical excision techniques alone [4–97]. As an adjunctive element for discussion, authors retain that, despite its rare incidence, breast cancer in male affected by gynecomastia can occur, and therefore, histopathological analysis is mandatory and can be performed only with surgical excision

rather than with aspiration techniques [122, 123]. Since psychological assessments have been largely discussed in literature, this aspect, even if fundamental, have not been included in this review. Focusing on surgical treatment, articles including medical treatment for gynecomastia have been excluded from this review. This review evidences the need for a single classification method, including also minor forms, and for a validated and universal method for the evaluation of satisfaction [124]. In this review, the male tuberous breast has not been included. Even if it presents peculiar clinical hallmarks, it is still poorly investigated in literature and often misdiagnosed with other forms of gynecomastia [125]. A general consensus on this condition, and its inclusion in gynecomastia classification, will help plastic surgeons in the diagnosis and management of this condition. To avoid bias, also pseudogynecomastia, due to massive weight loss, has not been included since its treatment and rate of complications differ from gynecomastia surgery [126, 127]. We personally retain that the higher incidence of complications among patients who underwent surgical excision is strictly related to the high number of patients and to the fact that these techniques are often used to treat the most severe forms, compared to aspiration techniques and combined techniques [128]. Moreover, surgical excision techniques have been early described in the literature, and the evolution of techniques has reduced the complications rate.

Conclusion

Several techniques have been proposed in the literature to address gynecomastia, with the potential to greatly improve the self-confidence and overall appearance of affected patients. The combined use of surgical excision and aspiration techniques seems to reduce the rate of complications compared to surgical excision alone, but lack of unique classification and the presence of several surgical techniques still represents a bias in the literature review.

Declaration

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

Statement of human and animal rights, or ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study, informed consent is not required.

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