



Circumferential Abdominoplasty after Massive Weight Loss Following Bariatric Surgery: Indications, Operative Techniques, and Outcomes, A Systematic Review and Meta-Analysis

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Abstract: The number of patients demanding plastic surgery correction of contour abnormalities has increased with the advancement in weight loss procedures. Massive weight-loss patients often present a circumferential truncal skin and subcutaneous tissue redundancy, which cannot be optimally corrected by common abdominoplasty techniques. Circumferential abdominoplasty, belt lipectomy, 360° abdominoplasty, and lower body lift are all synonyms of a body contouring procedure with the aim of sculpting the torso, modifying abdominal contour, loins and lower back contours. Despite growing number of published literature that supports the efficacy of circumferential abdominoplasty for post-bariatric body contouring, there is, still, a scarcity in high-level evidence that assesses the safety and efficacy of circumferential abdominoplasty. Thus, we conducted the present systematic review and meta-analysis in order to summarize surgical indications, operative techniques, outcomes, complications of circumferential abdominoplasty procedures following bariatric surgery. In the present study, we searched Medline via PubMed, SCOPUS, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL) from their inception till February 2019. The search retrieved 512 unique records. We then retained 89 potentially eligible records for full-texts screening. Finally, 26 studies (Total No. of patients =1234) were included in the present systematic review and meta-analysis. The present systematic review and meta-analysis showed that the average age of the patients within the included studies ranged from 28-45.2 years old; while the majority of those patients were females. In the present systematic review and meta-analysis, the majority of the included studies (No = 14 studies) utilized lower body lift technique; while six studies utilized belt lipectomy. In the present systematic review and meta-analysis, we utilized patients' satisfaction as the primary outcome for abdominoplasty effectiveness. Over all, eight studies reported the satisfaction rates after circumferential abdominoplasty, the overall effect estimates showed that the circumferential abdominoplasty achieved a satisfaction rate of 98% (95% CI [0.95.5 – 0.99.7]). The overall effect showed that the average operative time of circumferential abdominoplasty was 278 minutes (95% CI 241 - 315). Similarly, overall effect showed that the hospital stay after circumferential abdominoplasty was 5.5 days (95% CI 1.45 - 9.52). In terms of complications, sixteen studies reported the rates of complications after circumferential abdominoplasty. The overall effect estimates showed that the rates of complications after circumferential abdominoplasty was 35% (95% CI 26 – 44%). In conclusion, circumferential abdominoplasty is safe and effective body-contouring procedure for post-bariatric patients. This procedure can be ethically proposed to patients with body-contour deformities following bariatric surgery, giving excellent results with minor morbidity. The present systematic review and meta-analysis showed that circumferential abdominoplasty achieved a satisfaction rate of 98% and lower hospital stay than classic abdominoplasty. In addition, the rate of serious postoperative complications was very low. However, special attention should be paid for postoperative seroma and wound dehiscence.

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1. Introduction

The number of individuals that can be classified as obese, class I or higher is increasing. The latest figures from the USA show that 36.7% of the adult population is obese. (*NCHS Data Brief. 2012*)

Class I obesity is defined as a body mass index (BMI) of 30-34.9 kgm. (*National Obesity Observatory, 2012*)

Some of the obese are able to lose weight by dietary changes and exercise, while others have to resort to surgery. Bariatric surgery is a way to achieve

lasting weight loss in the obese and to reduce the prevalence of risk factors such as diabetes, hypertriglyceridemia, hyperuricemia and not least, total mortality. (Sjöström *et al.*, 2007; Sjöström *et al.*, 2004; Pontiroli, Morabito, 2011)

With bariatric surgery, the mean weight loss is 47.5% of the total body weight when performed as adjustable gastric banding, 61.6% when performed as gastric bypass, 68.2% when performed as gastropasty and 70.1% when performed as duodenal switch or biliopancreatic diversion. (Buchwald *et al.*, 2004)

Most patients are content with the achieved weight loss, but it usually includes undesirable elements in the shape of loose skin, especially corresponding to the abdomen, upper arms, thighs, chest, back, laterally on the back, silverside, proximal to the knee as well as on the cheek. This loose skin causes discomfort, such as infections with fungi and itching, physical discomfort, and hampers physical activity, which patients may experience as psychologically and socially inhibiting. (Bioörserud *et al.*, 2011; Kirzl *et al.*, 2003).

Body contouring surgery seeks to alleviate some of the discomfort caused by the excessive loose skin with the following procedures: abdominoplasty, lower body lift, upper body lift, brachoplasty or thigh lift. (Shermak, 2012)

Long-term follow-ups show that the quality of life is significantly improved by body contouring surgery and that this improvement appears to be permanent. (van der Beek *et al.*, 2012).

The post-massive-weight-loss body contouring surgery is not free of risks. It is often necessary with long incisions in the skin, which is not of the best quality, and the patients typically have other comorbidities. The most frequent observed complications are: haematoma, infection, seroma, wound dehiscence, necrosis, asymmetry, lymphoedema, unsightly scarring, influenced sensibility/ neuropathy and deep venous thrombosis (DVT). (Michaels *et al.*, 2011).

Aim of the work

The aim of this study is to summarize surgical indications, operative techniques, outcomes, complications of circumferential abdominoplasty procedures following bariatric surgery.

2. Materials and Method

We performed this systematic review and meta-analysis in accordance to the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and (Meta-analyses Of Observational Studies in Epidemiology (MOOSE) statement. PRISMA and MOOSE are a reporting checklist for Authors, Editors, and Reviewers of Meta-analyses of interventional and observational studies.

According to International committee of medical journal association (ICJME), reviewers must report their findings according to each of the items listed in those checklists (Moher and Liberati, 2009).

Study Selection and Eligibility Criteria:

The present review included studies that fulfilled the following criteria:

(1) Studies that included adult patients (≥ 18 years old) who have had circumferential abdominoplasty following any type of bariatric surgical treatment including but not confined to - Roux-en-Y gastric bypass (RYGB), adjustable gastric banding (AGB), sleeve gastrectomy (SG), or biliopancreatic diversion (BPD), and the BPD with duodenal switch (BPD-DS) for obesity with and/or without other comorbid psychological or medical conditions;

(2) Studies that assessed the efficacy and safety of circumferential abdominoplasty, as single-step surgery, for massive weight loss following bariatric surgery;

(3) Studies that compared the circumferential abdominoplasty with none or other techniques;

(4) Studies that reported any of the following outcomes: indications, operative techniques, outcomes, complications of circumferential abdominoplasty procedures following bariatric surgery.

(5) Studies that were either prospective or retrospective original reports.

We excluded studies with two-step surgery, circumferential contouring of the upper trunk, isolated abdominoplasty or buttock lift, and circumferential liposuction without skin resection. We also excluded all studies lacking original data and studies in any language other than English.

3. Results

Characteristics of the included studies

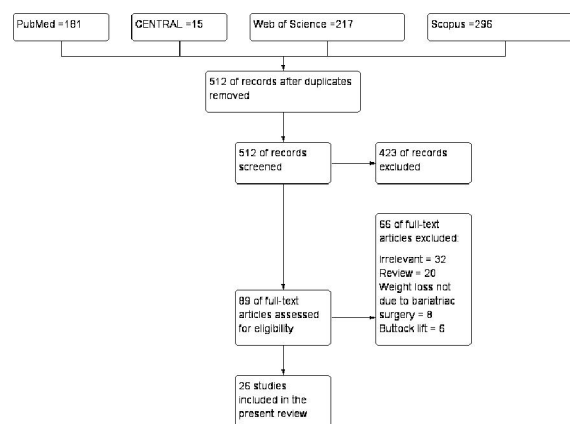


Figure 1: PRISMA flow-chart

In the present study, we searched Medline via PubMed, SCOPUS, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL) from their inception till February 2019. The search retrieved 512 unique records. We then retained 89

potentially eligible records for full-texts screening. Finally, 26 studies (Total No. of patients =1234) were included in the present systematic review and meta-analysis (**Figure 1**)

Characteristics of The included studies

Table 1: Summary Characteristics of the included studies

Study	Country	Study Design	Number of Patients	Technique	Auto-augmentation with flap	Mean Age	Female, No. (%)	Mean weight loss (Kg)	Mean resection weight (Kg)	Mean Operative time (min)	Operative blood loss (mL)	Hospital Stay (days)
<i>Lockwood, 1993</i>	United States	Case series	10	Lower body lift with medial thigh lift	Y							
<i>Van Geertruyden et al, 1999</i>	Belgium	Retrospective cohort	30	Belt lipectomy	Y	39.5 (23 - 59)	27 (90%)	43.5	4.3	210	635	12
<i>Hamra, 1999</i>	United States	Retrospective cohort	40	Belt lipectomy	Y		38 (95%)					
<i>Heiddens, 2001</i>	United States	Retrospective cohort	32		Y							
<i>Modolin et al, 2003</i>	Brazil	Retrospective cohort	12	Belt lipectomy	Y	39.5	10 (83.3%)					
<i>Aly et al, 2003</i>	United States	Retrospective cohort	32		Y		27 (84.5%)	80	4.5	345	495	
<i>Rohde et al, 2005</i>	United States	Retrospective cohort	62		Y							
<i>Van Huizum et al, 2005</i>	Netherlands	Retrospective cohort	21	Belt lipectomy	Y	28(25-49)	21 (100%)	44	3.6	132	980	8
<i>Sozer et al, 2005</i>	United States	Retrospective cohort	20	Lower body lift	Y	(31-61)	20 (100%)		5.7	314	250	1.7
<i>Centeno, 2006</i>	United States	Retrospective cohort	21		Y							
<i>Nemerofsky et al, 2006</i>	United States	Retrospective cohort	200	Lower body lift	Y		166 (83%)			2.95		
<i>Rohrich et al, 2006</i>	United States	Retrospective cohort	151	Belt lipectomy	Y	(24-68)	127 (84%)			204		2.1
<i>Strauch et al, 2006</i>	United States	Retrospective cohort	75	Lower body lift	Y	(22-66)	75 (100%)					
<i>Cobwell et al, 2007</i>	United States	Retrospective cohort	18	Lower body lift	Y	41 (24 - 56)	18 (100%)					
<i>Davison et al, 2007</i>	United States	Case series	3	Belt lipectomy	Y	(30-45)	3 (100%)					
<i>Jones et al, 2008</i>	United Kingdom	Retrospective cohort	16	Lower body lift	Y		14 (87.5%)	252			3.5	
<i>Dini et al, 2008</i>	Italy	Retrospective cohort	41	Lower body lift	N	43.6 (28-63)	28 (68%)	38	3.4	220		3.8
<i>Kolker et al, 2009</i>	United States	Retrospective cohort	24		Y		24 (100%)					
<i>Vico et al, 2010</i>	Belgium	Retrospective cohort	80	Lower body lift	Y	37.7 ±10.6	78 (97.5%)	37	4.6	306	664	8.8
<i>Koller et al, 2012</i>	Austria	Retrospective cohort	50	Lower body lift	Y	40 (22 - 63)	41 (82%)	54	2.3		230	
<i>Kitzinger et al, 2013</i>	Austria	Prospective cohort	50	Lower body lift with medial thigh lift	Y							
<i>Buchanan et al, 2013</i>	United States	Retrospective cohort	35		Y							
<i>Baca et al, 2014</i>	United States	Retrospective cohort	59	Lower body lift	Y							
<i>De Runz et al, 2015</i>	France	Retrospective cohort	55	Lower body lift	N							
<i>Srivastava et al, 2015</i>	United States	Retrospective cohort	97	Lower body lift	N							
<i>Sozer et al, 2018</i>	United States	Retrospective cohort	1000	Lower body lift	N	45.2 (25 -71)	984 (98%)			154		

Table 2: Rates of complications of the included studies

Study	Overall complications	Overall revision	Wound Dehiscence	Skin necrosis	Seroma	Hematoma	Infection	Late
<i>Lockwood, 1993</i>	5							
<i>Van Geertruyden et al, 1999</i>	5		2		2			
<i>Hamra, 1999</i>	4			0	0		0	
<i>Modolin et al, 2003</i>			2		4		1	4
<i>Aly et al, 2003</i>			1		12			
<i>Rohde et al, 2005</i>			5	1	4	0		
<i>Van Huizum et al, 2005</i>	8		6		2		3	
<i>Sozer et al, 2005</i>	7		2		1			
<i>Centeno, 2006</i>								
<i>Nemerofsky et al, 2006</i>	100		64	19	32		7	
<i>Rohrich et al, 2006</i>	43	8	2		22		1	
<i>Strauch et al, 2006</i>		2		5	1			
<i>Cobwell et al, 2007</i>		1			4			
<i>Davison et al, 2007</i>	0							
<i>Jones et al, 2008</i>	7							
<i>Dini et al, 2008</i>	19		7		11			26
<i>Kolker et al, 2009</i>		2			4	1		
<i>Vico et al, 2010</i>	26		18	1	3	1	3	
<i>Koller et al, 2012</i>	13		8		4			
<i>Kitzinger et al, 2013</i>	35							
<i>Baca et al, 2014</i>	30							
<i>De Runz et al, 2015</i>	22							
<i>Srivastava et al, 2015</i>	13							
<i>Sozer et al, 2018</i>		61			190	4		

Overall Estimates Regardless of Type of Vein

A. Satisfaction rate and Operative Characteristics

Satisfaction rate

Over all, eight studies reported the satisfaction rates after circumferential abdominoplasty, the overall effect estimates showed that the circumferential abdominoplasty achieved a satisfaction rate of 98%

(95% CI [0.95.5 – 0.99.7]). The pooled studies showed no significant heterogeneity ($p = 0.43$; $I^2 = 0\%$).

Figure. 2 shows the forest plot of the satisfaction rates.

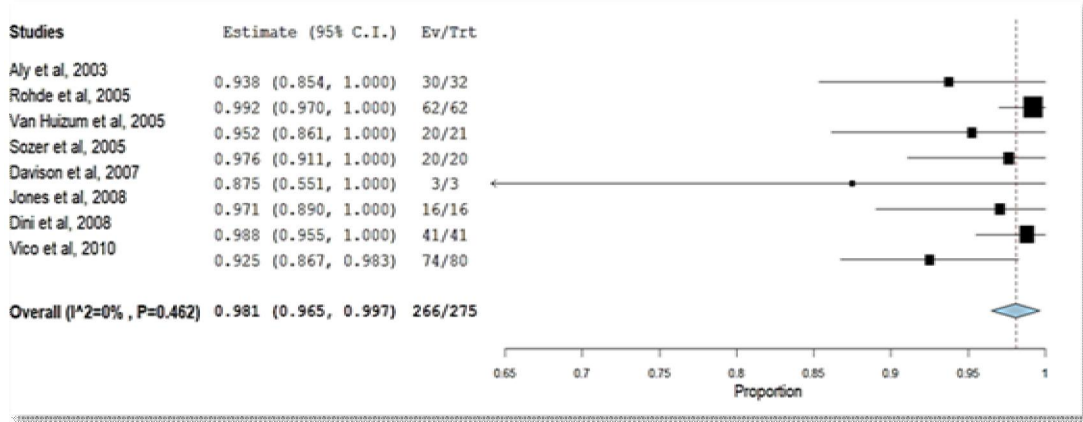


Figure 2: Forest Plot of Satisfaction rate

Operative time

Over all, six studies reported the operative time of circumferential abdominoplasty. The overall effect showed that the average operative time of

circumferential abdominoplasty was 278 minutes (95% CI 241 - 315). **Figure. 3** shows the forest plot of operative time.

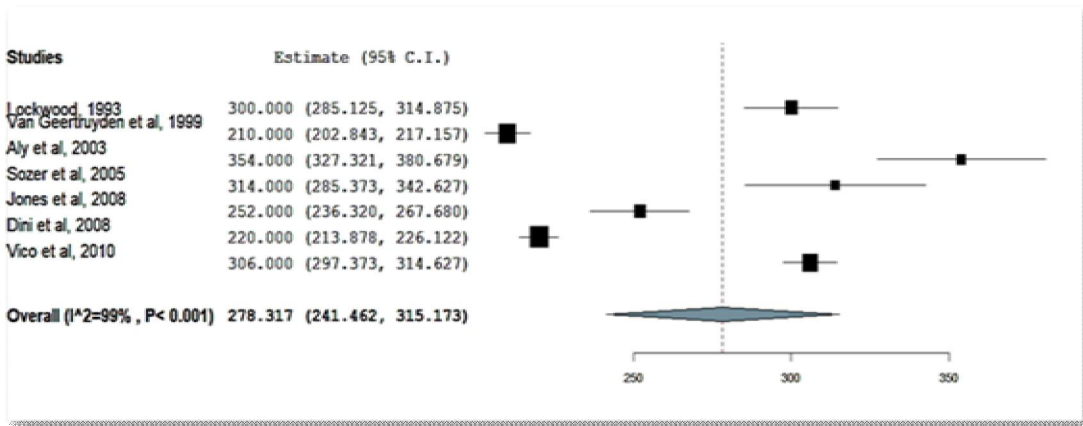


Figure 3: Forest Plot of Operative time

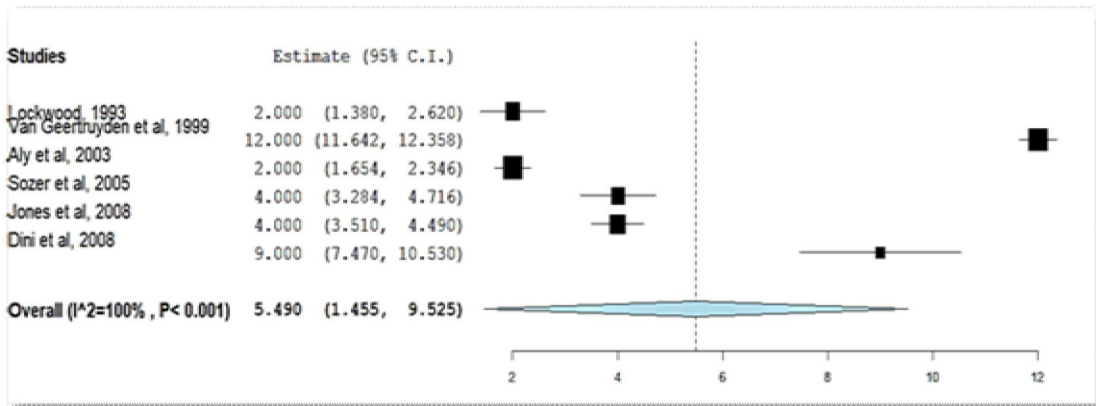


Figure 4: Forest Plot of hospital Stay

Hospital Stay

Over all, six studies reported the hospital stay after circumferential abdominoplasty. The overall effect showed that the hospital stay after circumferential abdominoplasty was 5.5 days (95% CI 1.45 - 9.52]; the pooled studies showed significant heterogeneity ($p < 0.001$; $I^2 = 100\%$). **Figure. 4** shows the forest plot of complete hospital stay.

B. Complications

Overall rate of complications

Over all, sixteen studies reported the rates of complications after circumferential abdominoplasty. The overall effect estimates showed that the rates of complications after circumferential abdominoplasty was 35% (95% CI 26 – 44%); the pooled studies showed significant heterogeneity ($p < 0.001$; $I^2 = 89$). **Figure. 5** shows the forest plot of overall rates of complications.

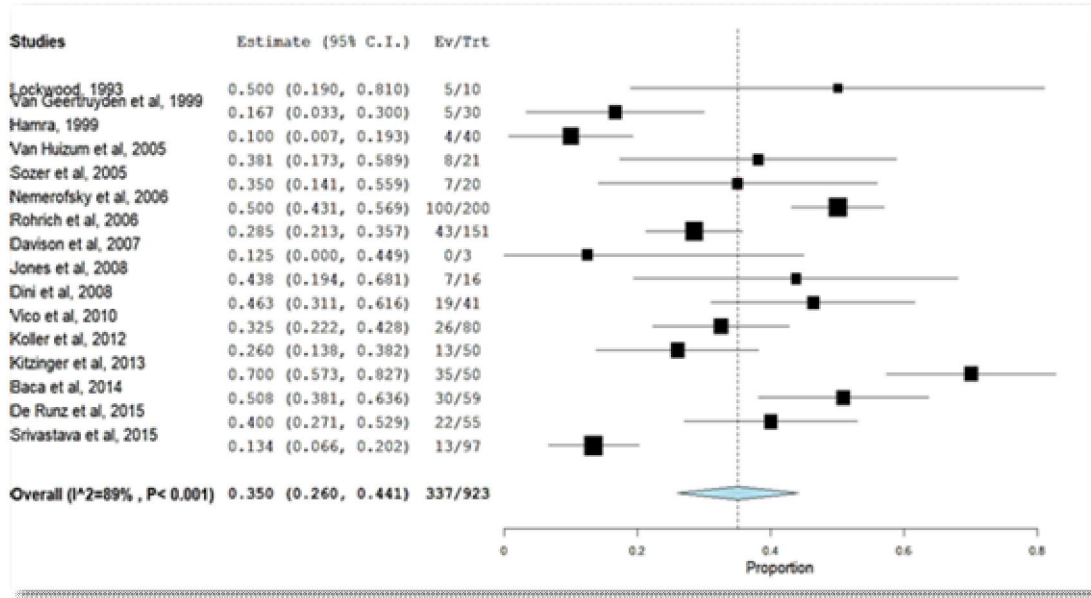


Figure 5: Forest Plot of overall rate of complications

Seroma

Fifteen studies reported the rates of seroma after circumferential abdominoplasty. The overall effect estimates showed that the rates of seroma after

circumferential abdominoplasty was 10.7% (95% CI 6.5 – 14%); the pooled studies showed significant heterogeneity ($p < 0.001$; $I^2 = 82$). **Figure. 6** shows the forest plot of overall rates of seroma.

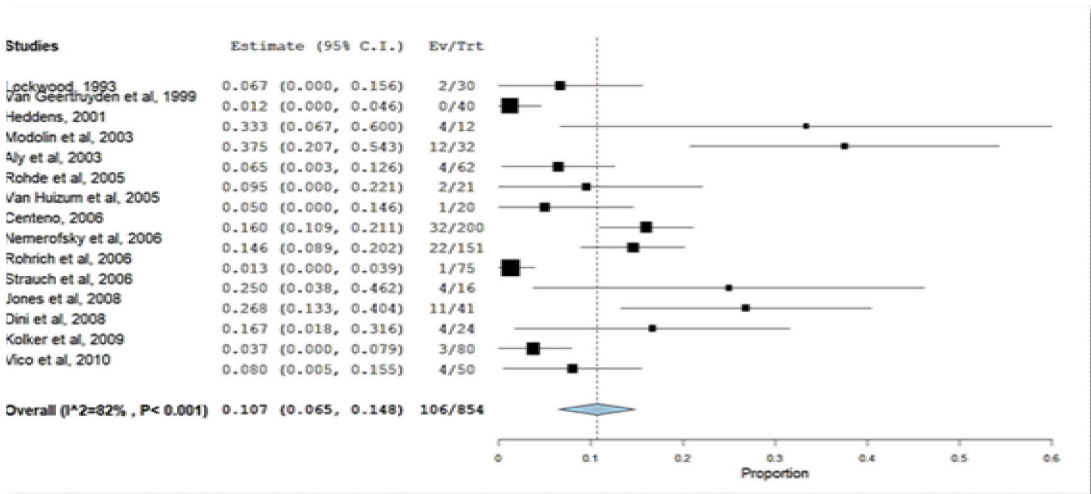


Figure 6: Forest Plot of seroma

Wound Dehiscence

Eleven studies reported the rates of wound dehiscence after circumferential abdominoplasty. The overall effect estimates showed that the rates of wound dehiscence after circumferential abdominoplasty was

14% (95% CI 6.6 – 21.5%); the pooled studies showed significant heterogeneity ($p < 0.001$; $I^2 = 91$). **Figure.7** shows the forest plot of overall rates of wound dehiscence.

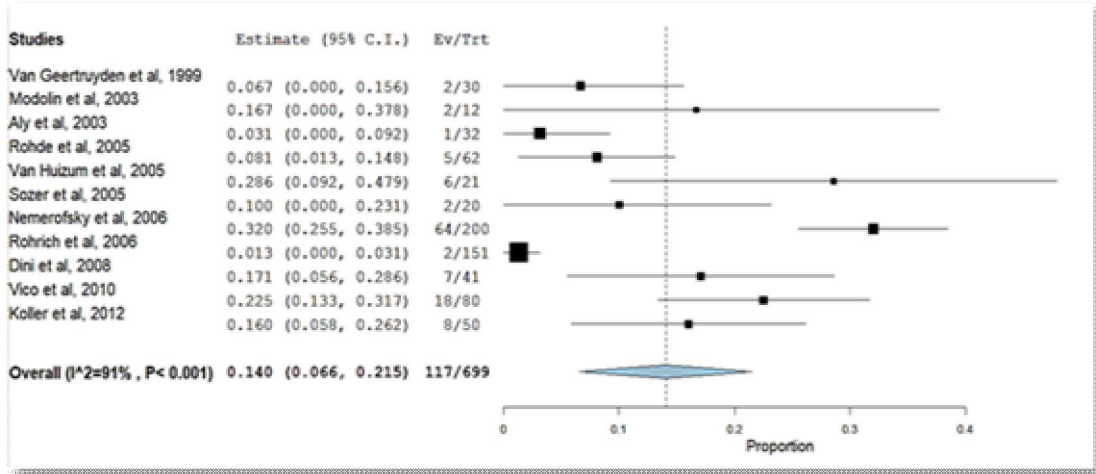


Figure 7: Forest Plot of wound dehiscence

Infection

Six studies reported the rates of infection after circumferential abdominoplasty. The overall effect estimates showed that the rates of infection after

circumferential abdominoplasty was 2.3% (95% CI 0.4 – 4.2%); the pooled studies showed no significant heterogeneity ($p = 0.12$; $I^2 = 42$). **Figure. 8** shows the forest plot of overall rates of infection.

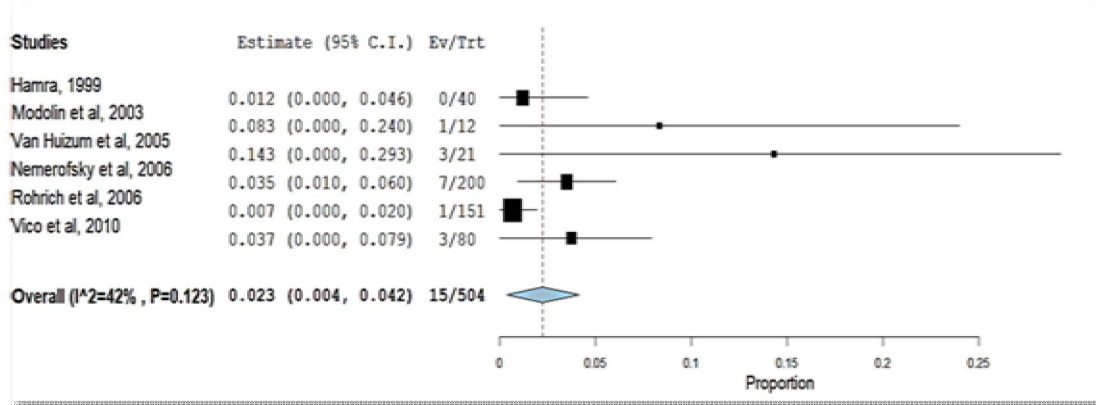


Figure 8: Forest Plot of Infection

Other complications

Table 4: Other Complications Rates

	Studies (n)	Number of Patients (n)	Mean (%)	95%-CI	Model	I2 (%)	P-value (Q)
Overall revision rate	21	964	5	[3-8]	Random effects	51.8	.0026
Skin necrosis	22	1370	4	[3-5]	Random effects	6.7	.3633
Hematoma	22	1370	3	[2-4]	Random effects	0	.915
Scar irregularities	12	523	12	[7-21]	Random effects	74.5	<.0001
Thromboembolism	26	1370	3	[2-5]	Random effects	0	.5487

4. Discussion

In the last years, the prevalence of obesity has increased in most industrialized countries. The rise on obesity prevalence has taken a concomitant increase in bariatric surgery procedures. Moreover, bariatric surgery has demonstrated to improve or even to eradicate significant obesity-related comorbidities including diabetes mellitus, hypertension, dyslipidemia, and obstructive sleep apnea (*O'Brien et al., 2019*).

Despite the large number of benefits conferred by bariatric surgery, the massive weight loss causes a persistence of a large amount of inelastic skin and subcutaneous tissue, which can lead to skin irritations, mycotic infections and secondary self-imaging problems (potentially a worsened overall patient body-image). Skin redundancy following massive weight loss is both an aesthetic and functional problem (*Bocchiotti et al., 2017*).

The number of patients demanding plastic surgery correction of contour abnormalities has increased with the advancement in weight loss procedures. Massive weight-loss patients often present a circumferential truncal skin and subcutaneous tissue redundancy, which cannot be optimally corrected by common abdominoplasty techniques. Circumferential abdominoplasty, belt lipectomy, 360° abdominoplasty, and lower body lift are all synonyms of a body contouring procedure with the aim of sculpting the torso, modifying abdominal contour, loins and lower back contours. Apart from buttock lifting and affecting lateral thighs, these procedures tremendously affect patients' waist size and body image (*EIKafrawy & Wasief, 2016*).

Despite growing number of published literature that supports the efficacy of circumferential abdominoplasty for post-bariatric body contouring, there is, still, a scarcity in high-level evidence that assesses the safety and efficacy of circumferential abdominoplasty. Thus, we conducted the present systematic review and meta-analysis in order to summarize surgical indications, operative techniques, outcomes, complications of circumferential abdominoplasty procedures following bariatric surgery.

In the present study, we searched Medline via PubMed, SCOPUS, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL) from their inception till February 2019. The search retrieved 512 unique records. We then retained 89 potentially eligible records for full-texts screening. Finally, 26 studies (Total No. of patients =1234) were included in the present systematic review and meta-analysis.

Bariatric surgery is most commonly performed during the middle-age as the use of bariatric surgery as

a primary treatment of obesity among older adults (>65 years old) is still under debate due to the perceived risk of perioperative and postoperative complications, as well as poor postsurgical outcomes (*Gonzalez-Heredia et al., 2015*). On the other hand, reports showed that 80% percent of patients who undergo bariatric surgery are female, despite equal rates of obesity among men and women (*Kochkodan et al., 2018*).

In line with these findings, the present systematic review and meta-analysis showed that the average age of the patients within the included studies ranged from 28-45.2 years old; while the majority of those patients were females.

Similarly, **Semer and colleagues (2008)** prospectively recruited patients who underwent abdominal lipectomy at the Bellflower Medical Center during a 12-month period (September 2004 through September 2005). The mean age of the included patients was 47 years old and the majority of them were females.

As mentioned before many techniques are available for circumferential abdominoplasty including lower body lift, belt lipectomy, and corset body lift. In practice, the terms lower body lift and belt lipectomy are used interchangeably. However, the biggest difference between a lower body lift and a belt lipectomy is where the incisions are made. In a lower body lift the incisions on the side and back are lower than in a belt lipectomy (*Langer et al., 2011*).

In the present systematic review and meta-analysis, the majority of the included studies (No = 14 studies) utilized lower body lift technique; while six studies utilized belt lipectomy.

In agreement with these findings, **Sozer and colleagues (2007)** performed a prospective study on 151 female patients treated for abdominal contour deformities from January 2004 to July 2005. Thirty percent of the patients underwent circumferential abdominoplasty, which was most commonly lower body lift.

Similarly, **Vico and colleagues (2010)** assessed the efficacy of circumferential abdominoplasty on moderately to severely obese patients and on patients with no excess-weight problem but some degree of skin laxity and with no history of bariatric surgery. The authors performed 80 consecutive circumferential abdominoplasties during a 4-year period. The most commonly performed technique was lower body lift.

Though medical literature is rather lacking in terms of patient perspective after abdominoplasty, many authors have published extensively on the psychological factors influencing patient motivation to have plastic surgery and evaluating psychological outcome. The gold standard for measuring the impact of body contouring surgery on massive weight loss

individuals is to use patient-specific, well-constructed, report that assessed the satisfaction rate after the procedure (**Jabir, 2013**).

In the present systematic review and meta-analysis, we utilized patients' satisfaction as the primary outcome for abdominoplasty effectiveness. Over all, eight studies reported the satisfaction rates after circumferential abdominoplasty, the overall effect estimates showed that the circumferential abdominoplasty achieved a satisfaction rate of 98% (95% CI [0.95.5 – 0.99.7]).

To the best of our knowledge, this is the first systematic review and meta-analysis study that assessed the safety and effectiveness circumferential abdominoplasty for post-bariatric massive weight loss. However, previous primary studies reported similar findings to our results. In concordance with our findings, **Koller and colleagues (2013)** investigated the quality of life and psychological outcome after body lift surgery. Twenty-seven patients (25 females and 2 males) who had undergone bariatric surgery were scheduled for circumferential body lifting of the lower trunk. Post-weight loss surgery improves the quality of life and body image. The satisfaction rate was 100%.

Similarly, **Aly and colleagues (2003)** evaluated their series of 32 patients who underwent belt lipectomy at the University of Iowa. The improvements were significant in all groups of patients with satisfaction rate of 96%.

Additionally, **van Huizum and colleagues (2005)** evaluated the perioperative complications and cosmetic outcomes of circumferential belt lipectomy in patients with evident truncal excess. In 21 women, a circumferential belt lipectomy was performed between April 2002 and March 2004. Patients scored cosmetic results on a visual analog scale. The majority of patients judged the cosmetic outcome as good to excellent (15 patients > or =8, 5 patients = 7, 1 patient =6).

More recently, **de Runz and colleagues (2015)** analyzed the benefit/risk ratio and the patients' satisfaction following lower body lift. All patients who underwent this procedure at the Nancy University Hospital over a 3-year period (between January 2010 and 2013) were reviewed. A total of 55 patients were included. The overall satisfaction was rated as excellent by 29 (55.8%) patients and as pleasing by 22 (42.3%). The outcome was judged as excellent or pleasing for the abdomen by 29 (55.8%) and 20 (38.35%) patients, respectively, and for the buttocks by 17 (32.7%) and 29 (55.8%) patients, respectively. The quality of life was rated better after than before the intervention by 49 (94.2%) patients.

Circumferential abdominoplasty is considered as elective surgery, and thus require a careful risk/benefit

evaluation for each patient. Although these operations are associated with an increase in quality of life and high patient satisfaction, a relative high complication rates can affect these positive experiences negatively. The most common complication of bodylift/belt lipectomy, outside of small non-healing areas along the incision line, is seroma (**Poodt et al., 2016**).

In the present systematic review and meta-analysis, we found that the rates of complications after circumferential abdominoplasty was 35% (95% CI 26 – 44%); while the rates of seroma after circumferential abdominoplasty was 10.7% (95% CI 6.5 – 14%).

However, recent literature is highly variable as it comes to formation of seroma with 12.9% up to 37.5%. For example, **Carloni and colleagues (2016)** performed a meta-analysis in order to summarize the complication rates and explore the possibility of predictive risk factors for complications. A systematic review using the PubMed and Cochrane databases to identify published articles on the topic was performed. The analysis included 28 studies and 1380 patients. Circumferential contouring of the lower trunk resulted in 37% [95%-CI 30%; 44%] overall complications and 13% [95%-CI 9%; 18%] seromas.

In contrary, **Kitzinger and colleagues (2013)** aimed to identify the complications and possible risk factors of a lower body lift. A prospective study on 50 consecutive patients who underwent a lower body lift procedure was performed. A total of 35 (70%) patients developed at least one complication. Seroma occurred in 17 patients (34%).

The exact causes of such heterogeneity between our findings and the abovementioned studies are unclear; however, it can be attributed to various methodological factors. For the example, the above some of the studies randomized controlled trials; while our study included a wide range of study designs. Moreover, the sample size of the included studies was notably higher in our meta-analysis than the abovementioned studies. The quality of the included studies may be another factors explaining this heterogeneity.

Circumferential procedures are more prone to dehiscence because of the competing tensions, especially the anterior and posterior closures (**Vico et al., 2010**). In the present systematic review and meta-analysis, we found that the rates of wound dehiscence after circumferential abdominoplasty was 14% (95% CI 6.6 – 21.5%).

Similar to our findings, **Carloni and colleagues (2016)** found that circumferential contouring of the lower trunk resulted in 17% [95%-CI 12%; 24%] wound dehiscence.

However, other reports showed higher rates of wound dehiscence. For example, **Nemerofsky and colleagues (2006)** reviewed their experience of 200 body lifts with massive weight loss individuals. The

charts of 200 consecutive body lift patients were reviewed for complications and other variables. The overall complication rate was 50%. The most frequent complications were skin at 32.5%.

Patients undergoing bodylift/belt lipectomy have multiple factors that increase the risk of DVT/PE (Poody *et al.*, 2016). We found that the rates of DVT/PE was 3 % [95% CI, 2-5%].

In line with these findings, Poody and colleagues (2016) performed a retrospective analysis of 100 patients who underwent a lower body lift procedure. The overall complication rate was 78%, while the rate of thromboembolism was 1%.

Study's Strengths and Limitations

The present systematic review and meta-analysis has some strength points. We performed a comprehensive search of five electronic databases to comprehensively include all eligible studies. In addition, the risk of bias was low among the included studies. However, we acknowledge that the present study has some limitations. Some included studies were retrospective studies with inherent limitations of possible misclassification and ascertainment bias. In addition, most of the studies were a single-center experience and therefore the results cannot be generalized to the general population.

Conclusions

In conclusion, circumferential abdominoplasty is safe and effective body-contouring procedure for post-bariatric patients. This procedure can be ethically proposed to patients with body-contour deformities following bariatric surgery, giving excellent results with minor morbidity. The present systematic review and meta-analysis showed that circumferential abdominoplasty achieved a satisfaction rate of 98% and lower hospital stay than classic abdominoplasty. In addition, the rate of serious postoperative complications was very low. However, special attention should be paid for postoperative seroma and wound dehiscence. These data draw attention to the importance of early identification of patients, at high risk of those complications. Nevertheless, further studies are still needed to confirm our findings and to identify patient factors that significantly increase the rate of satisfaction after circumferential abdominoplasty.

Recommendations

- Circumferential abdominoplasty can be ethically proposed to patients with body-contour deformities following bariatric surgery, giving excellent results with minor morbidity.

- The technique is also safe with low rate of serious postoperative complications. However, special

attention should be paid for postoperative seroma and wound dehiscence.

- Nevertheless, further studies are still needed to confirm our findings and to identify patient factors that significantly increase the rate of satisfaction after circumferential abdominoplasty.

- However, we acknowledge that the present study has some limitations. Some included studies were retrospective studies with inherent limitations of possible misclassification and ascertainment bias.

- In addition, most of the studies were a single-center experience and therefore the results cannot be generalized to the general population.

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