Preoperative Multi-slice computed tomography for planning abdominal wall plication in abdominoplasty patients with rectus diastasis: A prospective study

Original Article

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ABSTRACT

Background: Safe and effective abdominal wall plication is a crucial step in abdominoplasty for treating Diastasis of Rectus muscles (DR) repair. However, standardized preoperative tools for planning the actual plication amount are lacking, and always measured intraoperatively in a subjective way depending mainly on surgeon experience. So, searching for an objective to standardize the amount of plication preoperative is important.

Objective: This work aims to investigate the reliability of preoperative multi-slice computed tomography (MSCT) in predicting intraoperative plication measurements for DR repair during abdominoplasty.

Patients and Methods: Preoperative MSCT scans measured DR in 13 female patients seeking abdominoplasty at three levels: midway between the xiphoid process and umbilicus, umbilical level, and midway between the umbilicus and pubic symphysis. During surgery, DR plication was performed based on a clinical assessment, and the actual plication amount was measured at the same three anatomical levels. Intra-abdominal pressure and peak airway pressure were monitored to avoid over or under plication. Patients were categorized into two groups: group I, in which MSCT-calculated plication was equivalent to intraoperative plication (±0.5 cm), and group II, in which MSCT-calculated plication was less than intraoperative plication (difference >0.5 cm).

Results: Statistical analysis revealed significant differences between the MSCT-calculated and intraoperative plication measurements in group II (9 cases) ($P<0.05$ at all levels), while no significant differences were observed in group I (4 cases) ($P>0.05$). All intra-abdominal pressure and peak airway pressure measurements remained within safe limits (<12 mm Hg) after plication. Seroma formation was the most common complication (30.77%).

Conclusion: Although MSCT can be a helpful adjunct in preoperative planning, relying solely on MSCT-calculated plication measurements may be insufficient for guiding optimal surgical strategies. Surgeon experience and intraoperative assessment remain crucial for determining the appropriate amount of plication in abdominoplasty with DR repair.

Key Words: Abdominal wall, Intra-abdominal pressure, peak airway pressure, pre-operative planning, tummy tuck.

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INTRODUCTION

Diastasis of rectus muscles (DR) is a condition characterized by the separation of the rectus abdominis muscles along the Linea Alba, resulting in a midline abdominal bulge[1].

Plication, the surgical technique used to repair DR, involves bringing the separated muscles back together and securing them with sutures as a method of abdominoplasty[2].

Determining the optimal plication amount is critical for achieving desired aesthetic and functional outcomes while minimizing complications like abdominal compartment syndrome and respiratory distress[3].

Traditionally, surgeons have relied on intraoperative assessment to determine the appropriate plication amount. However, recent advancements in imaging technology have led to the exploration of preoperative computed tomography (CT) as a potential tool for estimating the required plication.

This prospective study aimed to investigate the reliability of preoperative multi-slice computed tomography (MSCT) in predicting intraoperative plication measurements for DR repair during abdominoplasty.

PATIENTS AND METHODS:

This study included 13 female patient candidates for abdominoplasty with DR. This study was conducted at Ain

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Shams University Hospital, Cairo, Egypt. The study was approved by our institutional ethical committee. Informed consent was obtained from the participants.

Women included in this study were between 25 and 50 years old, with a body mass index ranging from 25 to 29.9 kg/m^2.

Before surgery, each patient was assessed by collecting information, such as age, BMI, and smoking history. Patients who had undergone previous abdominoplasty, other operations, or abdominoplasty-like procedures for breast reconstruction, including transverse rectus abdominis myocutaneous flap or deep inferior epigastric perforator flap, were excluded, as were those who were planning future pregnancies.

DR measures are recorded by preoperative sagittal MSCT at three levels: midway between the xiphoid process and umbilicus, at the umbilical level (UL), and midway between the umbilicus and pubic symphysis. (Figures 1, 2).

During surgery, all surgeons draw the plication that was performed based on our clinical assessment and measure it with a sterilized ruler at the same three levels previously measured by MSCT and recorded as the actual plication amount. (Figures 3, 4).

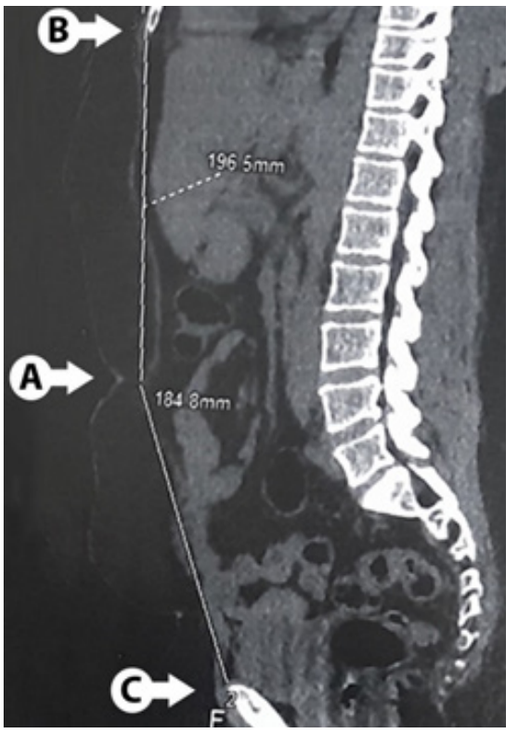

Fig. 1: Preoperative abdominal multi-slice computed tomography A: The sagittal plane in the multi-slice computed tomography was determined at the point opposite the umbilicus (Point to measure diastasis in umbilical level) in the recti muscles. B: xiphoid process point placed. C: pubic symphysis point location.

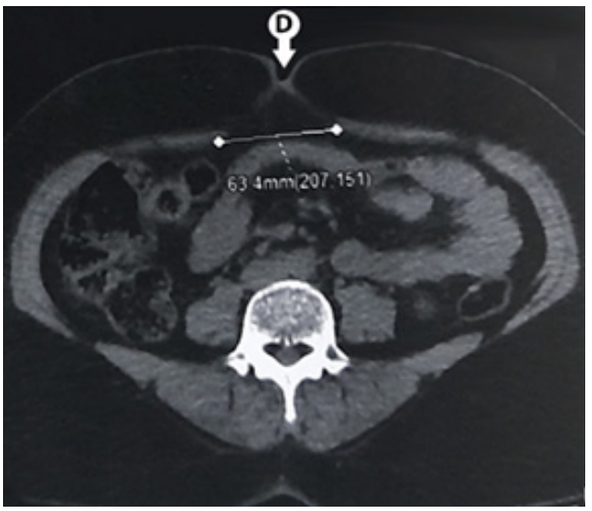

Fig. 2: Preoperative abdominal multi-slice computed tomography D: transverse computed tomography slice cut at the umbilical level that illustrates diastasis at this level.

Intra-abdominal pressure (IAP) was measured pre-plication and postplication throw sterile saline solution was instilled into the bladder via the catheter. Technique mention by Desie *et al*.[4]. Also, the peak airway pressure (PAP) measure is recorded before and after plication through a ventilation device.

Patients are divided into two groups based on the concordance between MSCT-calculated plication and intraoperative plication measurements:

(a) Group (I): MSCT -calculated plication equivalent to intraoperative plication (±0.5 cm).

(b) Group (II): MSCT -calculated plication less than intraoperative plication (>0.5 cm).

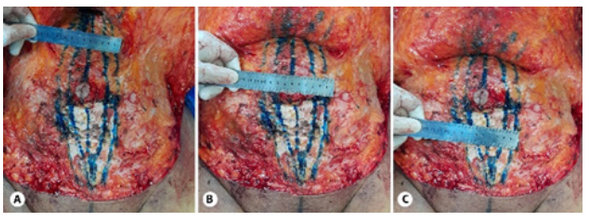

Fig. 3: Illustrate plication measurements of preoperative multi-slice computed tomography estimated and intraoperative will be done by the surgeon at each level. A: Midway between the xiphoid process and umbilicus level. B. Umbilical level level. C. Midway between the umbilicus and pubic symphysis level.

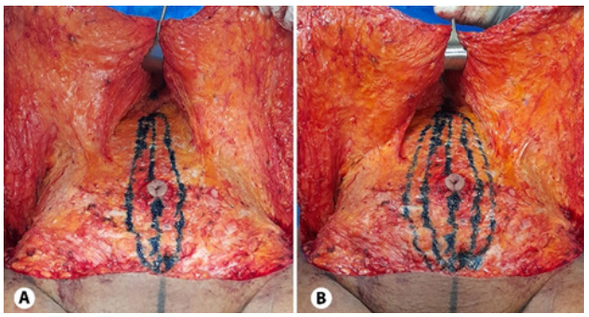

Fig. 4: Illustrate of DR marking A. Marking for estimated plication by preoperative multi-slice computed tomography B. Adding marking for plication intraoperative will be done by the surgeon.

RESULTS:

Of the 13 patients, four (30.77%) were categorized into group (I), where MSCT-calculated plication was equivalent to the actual intraoperative plication (±0.5 cm). The remaining nine (69.23%) patients fell into group II, where MSCT-calculated plication underestimated the amount of plication performed by surgeons (difference >0.5 cm).

In group (I), statistical analysis showed a minor difference between MSCT-calculated and intraoperative plication measurements, with corresponding test values near 0 and p values indicating no significant differences (*P>0.05*). (Table 1) These results suggest that in cases where MSCT-calculated plication measures closely to actual intraoperative plication measurements.

In group (II) Statistical analysis demonstrated substantial differences between MSCT-calculated and intraoperative plication measurements, with notable negative test values and extremely low *P values* (*P<0.05*). (Table 2).

This implies that MSCT-calculated plication tends to underestimate actual intraoperative plication measurements.

In 69.23% of study cases, the preoperative measure by MSCT for DR underestimated intraoperative plication by the surgeon's experience.

Table 1: The comparison regarding diff. between multi-slice computed tomography calculated Plication and intraoperative Plication in group (I)

	MW-XU		UL		MW-US	
Group (I) (*n*=4)	MSCT calculated Plication (cm)	Intraoperative Plication (cm)	MSCT calculated Plication (cm)	Intraoperative Plication (cm)	MSCT calculated Plication (cm)	Intraoperative Plication (cm)
Mean±SD	4.48±1.01	4.75±0.78	5.63±1.38	5.58±1.34	4.88±1.16	5.15±1.18
Range	3.5–5.9	4–6	4–7	4–7	3.8–6.5	4–6.8
Test Value	–0.41234	0.05209	–0.33232			
P value	0.347209	0.480073	0.375476			

**P value* greater than 0.05: Nonsignificant (NS); *P value* less than 0.05: Significant(S); *P value* less than 0.01: highly significant (HS)
*: Paired t-test, •: One-way ANOVA Test.

Table 2: The comparison regarding difference between multi-slice computed tomography calculated Plication and intraoperative Plication in group (II)

	MW-XU		UL		MW-US	
Group (II) (*n*=9)	MSCT calculated Plication (cm)	Intraoperative Plication (cm)	MSCT calculated Plication (cm)	Intraoperative Plication (cm)	MSCT calculated Plication (cm)	Intraoperative Plication (cm)
Mean±SD	4.20±2.54	6.78±1.86	5.52±2.03	7.94±1.98	3.70±2.21	7.83±2.11
Range	0–7.6	3.5–9	1.7–8.3	5–11	0.8–8	3–10
Test Value	–2.45788		–2.5628		–3.07907	
P-value	0.012881		0.010428		0.003594	

**P value* greater than 0.05: nonsignificant (NS); *P value* less than 0.05: Significant(S); *P value* less than 0.01: highly significant (HS)
*: Paired t-test, •: One-Way ANOVA Test.

In study cases, we noted that all IAP measurements are less than 12 mmHg after application. In group (I) the mean±SD and range of change amount of IAP 3.25±0.96 (2–4). While in group (II) the mean±SD and range of change amount of IAP 3.78±1.99 (0–6).

In study cases, we noticed a minimal increase in PAP before plication and after plication. In group (I), the mean, SD, and range of amount of change in PAP were 3.25±0.96 (4–2). In group (II), corresponding values for change in PAP were 3.78±1.99 (6–0).

The complication was reported in 5 cases out of all cases. The most observed complication was seroma, which occurred in four of our patients, representing 30.77% of cases. Wound dehiscence was reported in three patients, representing 23.08%. Umbilical necrosis was reported in two patients, representing 15.38% of cases.

DISCUSSION

DR is an abnormality of the anterior abdominal wall, characterized by a separation of the rectus abdominis muscles along the Linea Alba. This can result in a midline abdominal bulge[5].

Most general surgeons and physicians consider DR a benign process that does not require intervention. However, modern studies are proving what plastic surgeons and physical therapists have known for a while, i.e., that DR, especially when severe, can negatively impact patients beyond their body image[6].

For example, there is growing evidence that DR may also be associated with substantial functional impairment and back pain, core instability, and a negative impact on the woman's quality of life[2,7].

DR a separation of the rectus abdominis muscles, is a common postpartum concern affecting abdominal aesthetics and function. Abdominoplasty with plication aims to correct this separation and restore structural integrity traditionally, surgeons relied solely on intraoperative assessment to determine the appropriate plication amount[8].

Our study aimed to investigate the reliability of preoperative MSCT in predicting intraoperative plication measurements for DR repair during abdominoplasty in 13 female patients.

This research contributes to the ongoing dialogue regarding the role of preoperative MSCT imaging in optimizing surgical outcomes.

Patients were divided into two groups according to the criteria previously mentioned where 4 (30.77%) cases were reported In group (I) and 9 (69.23%) cases were reported in group (II).

In group (I), statistical analysis showed a minor difference between MSCT-calculated and intraoperative plication measurements, with corresponding test values near 0 and *P values* indicating no significant differences ($P>0.05$). These results suggest that in cases where MSCT-calculated plication measures closely to actual intraoperative plication measurements. This implies the preoperative estimates were consistent and accurate.

In group (II) statistical analysis demonstrated substantial differences between MSCT-calculated and intraoperative plication measurements, with notable negative test values and extremely low *P values* ($P<0.05$). This implies that MSCT-calculated plication tends to underestimate actual intraoperative plication measurements, suggesting the potential limitations of relying solely on preoperative MSCT estimates in that group.

Generally, in 69.23% of study cases, the preoperative measure by MSCT for DR underestimated intraoperative plication by the surgeon's experience the results led us to two conclusions: that the MSCT scan is inaccurate in all cases, or the surgeons do over-plication in their experience.

However, MSCT scanning has been identified as the preferred method for evaluating DR due to its ability to detect associated conditions like hernias within a rectus diastasis, which is crucial for surgical planning and determining the appropriate care plan[9].

Love *et al*. have explored the use of MSCT-derived measurements, such as the component separation index and the rectus width to hernia width ratio, to predict the feasibility of achieving tension-free fascial closure with different surgical techniques[10].

Another study by Janes *et al*. reported similar findings, with MSCT demonstrating a high accuracy rate in diagnosing DR[1].

So, based on the published mentioned, MSCT is considered an accurate imaging modality for diagnosing diastasis recti and can provide valuable information for surgical planning and management.

No published paper specifically discusses whether surgeons tend to do more plication than needed to repair diastasis recti.

Therefore, we can put forward another belief, which is that in most cases we tend to do over-Plication than required for DR.

In another point in our study about the safety of over-plication, we used PAP and IAP intraoperative as an indicator of the safety of patients. To avoid the possibility of this occurring abdominal compartment syndrome or affection of respiratory.

In study cases, we note that all IAP measurements are less than 12 mmHg after application. In group (I) the mean±SD and range of change amount of IAP 3.25±0.96 (2–4). While in group (II) the mean±SD and range of change amount of IAP 3.78±1.99 (0–6).

Milanesi R, Caregnato RC (2016) said Intra-abdominal hypertension is defined by IAP elevation above 12 mmHg. IAP may gradually progress to abdominal compartmental syndrome (ACS), with sustained IAP above 20 mmHg and associated organ dysfunction or failure[11].

Maria *et al*.; Gama *et al*. published that there was no significant correlation between recti diastasis plication, increase in IAP, and changes in spirometry values[12,13].

So, this suggests that recti diastasis plication does not directly contribute to an increase in IAP during the postoperative period. And over-plication does not greatly affect IAP if done based on the surgeon's experience.

In both groups of our study noticed a minimal increase in PAP before plication and after plication.

Soto-Hopkins *et al*. publication confirmed the effect of rectus plication on increasing IAP, including Peak Inspiratory Pressure[14].

Rodrigues and colleagues found that the repair of rectus diastasis depends on the protrusion of the abdominal wall and the repositioning of the rectus abdominis muscles. It causes an increase in IAP due to compression. That may cause a decrease in respiratory compliance and a reduction in thoracic compliance, increasing the inspiratory pressure[15].

Al Basti and colleagues published a study that demonstrated an increase in PAP from 13.46±3.13 to 14.24±3.3 cmH_2O (*P=0.005*) after DR plication in patients undergoing abdominoplasty.

So noticed an increase in PAP after plication in both groups was close to what we presented in previously published scientific papers[16].

CONCLUSION

This study highlights the potential benefits and limitations of using preoperative MSCT scans to estimate the plication amount for DR repair in abdominoplasty patients. While MSCT scans offer valuable insights, they should not be considered the sole determinant of intraoperative plication amount. Surgeon experience and clinical judgment during surgery remain essential for achieving optimal outcomes and ensuring patient safety.

Limitations

This study has several limitations, including the small sample size and the focus on female patients within a specific age and BMI range. Future studies should include larger and more diverse populations to ensure the generalizability of the findings.

Recommendations

Further research with larger and more diverse patient populations is needed to validate these findings and refine the role of MSCT scans in preoperative planning for abdominoplasty with DR repair. Additionally, studies investigating the long-term outcomes and functional improvements associated with DR plication are necessary to optimize patient care.

CONFLICT OF INTEREST

There are no conflicts of interest.

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