# RIGHT ANTEROLATERAL THORACOTOMY VERSUS MEDIAN STERNOTOMY IN TRICUSPID VALVE SURGERY

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## ABSTRACT

**Background:** The ideal surgical approach of tricuspid valve surgery is still debatable. The results of tricuspid valve surgery are still controversial although the interest in less-invasive approaches in cardiac surgery is increasing, especially those alternative access routes that decrease the surgical risk and do not affect the quality of surgery.

**Aim and objectives:** To compare the early outcome of isolated tricuspid valve surgery using two different approaches median sternotomy versus right anterolateral thoracotomy.

**Patients and Methods:** This was a prospective, randomized, comparative clinical study during which forty patients underwent isolated tricuspid valve surgery in the period between July 2020 and August 2022 at Kasr Al-Aini hospitals.

**Results:** There was a highly statistically significant difference with p-value <0.05 between study groups as regards operation duration time, Drainage(ml) and length of hospital stay.

**Conclusion:** After assessing all our results, we can say that right antero-lateral thoracotomy for isolated tricuspid valve surgery is a practical and safe technique with less operative time and postoperative bleeding and more importantly, with lower mortality rates, particularly in patients with previous sternotomy.

**Keywords:** Median Sternotomy, Anterolateral Thoracotomy, Tricuspid Valve Surgery.

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## INTRODUCTION

The tricuspid valve (TV) is usually known as the forgotten valve because it has not received as much attention as the aortic valve (AV) or mitral valve (MV) **[1]**.

In addition, there has been far less discussion regarding surgical and percutaneous methods for tricuspid valve repair or replacement **[2]**. Patients are rarely referred for isolated surgical tricuspid valve repair, and most repairs are done in the context of other planned cardiac surgery **[3]**. The minimal invasive right mini-thoracotomy technique can applied to patients that require concomitant tricuspid valve repair or replacement at the time of a mitral valve procedure however this approach is applicable to patients requiring isolated tricuspid valve surgery **[4]**. When compared to a standard median sternotomy approach, the potential benefits of minimally invasive valve surgery include: reduced surgical trauma, blood loss, re-operation for bleeding, and pain; a shorter intensive care unit and hospital length of stay, as well as a more rapid return to functional activity **[5]**. In this prospective study, clinical results of isolated TVR either through a median sternotomy or an antero-lateral thoracotomy. the aim of this study is to compare the early outcome of isolated tricuspid valve surgery using two different approaches median sternotomy versus right anterolateral thoracotomy.

### PATIENTS AND METHODS

this was a prospective, randomized, comparative clinical study during which forty patients underwent isolated tricuspid valve surgery for repair or replacement of tricuspid valve disease primary or secondary using median sternotomy versus right anterolateral thoracotomy, in the period between July 2020 and August 2022 at Kasr Al-Aini hospitals (after obtaining the approval of the local ethical committee).

The forty patients are divided into two groups equally for isolated tricuspid surgery a median sternotomy (1st group) 20 patients and right anterolateral thoracotomy (2nd group) 20 patients. All patients were undergone primary or late secondary isolated valve surgery (repair or replacement).

**Inclusion criteria:** Primary or late secondary tricuspid valve surgery, Tricuspid valve repair or replacement, Median sternotomy or an anterolateral

thoracotomy approach and Isolated tricuspid surgery.

**Exclusion criteria:** Concomitant cardiac surgery, Pervious right thoracic surgery, Inapplicable arterial cannulation (femoral artery) and Poor pulmonary functions.

**All patients in this study were evaluated by the following parameters:**

**Preoperative Parameters:** Full clinical assessment, General examination (Signs of right sided heart failure, Signs of left sided heart failure and Local (Cardiac) examination)) and Investigations (Laboratory investigations, Electrocardiography (ECG), Radiography, Echocardiography & Doppler examination and Other investigations.

**Symptoms of right sided heart failure and its duration:** Dyspnea, Dyspepsia and Right hypochondrial or epigastric pain.

**Operative Parameters**

**Intraoperative TV assessment**: Pre repair or replacement and Operative procedures.

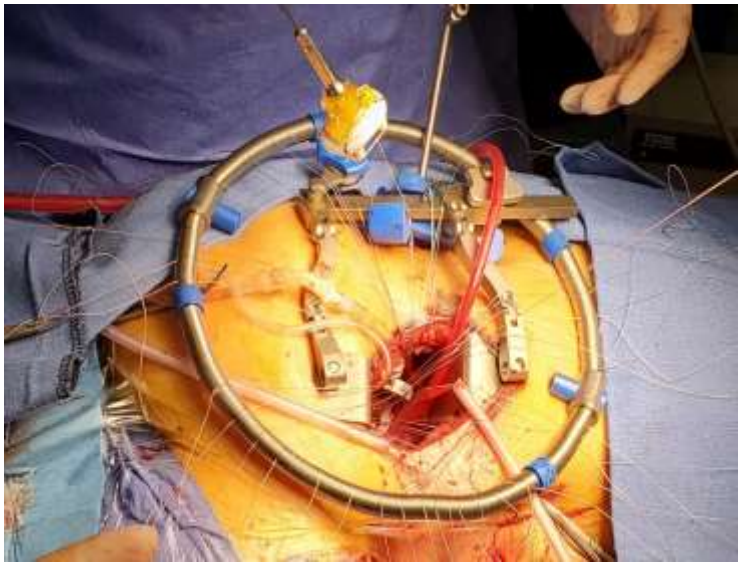

**Figure (1): Right anterolateral thoracotomy approach.**

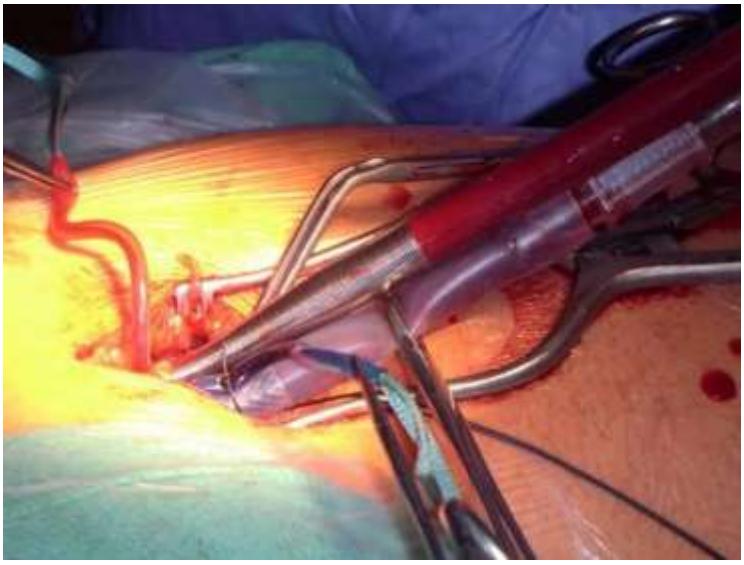

**Figure (2): Femoral-femoral cannulation for cardiopulmonary bypass.**

**Surgical techniques:** There are many techniques used for repair of tricuspid valve due to functional or organic regurgitation and stenosis. Replacement of tricuspid valve was done for valves could not be repair due to failure of repair or valve stenosis.

**Suture annuloplasty:** Tricuspid annuloplasty was done using DeVega, modified DeVega, segmental annuloplasty and pericardial strip).

**Prosthetic ring annuloplasty:** Tricuspid valve annuloplasty was done using a prosthetic ring.

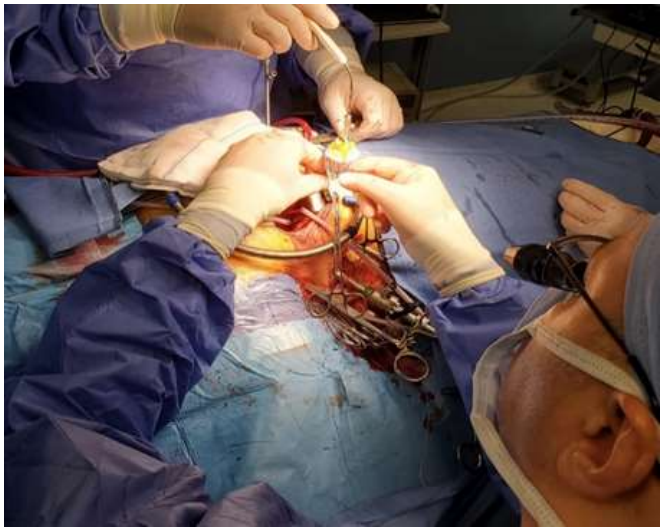

**Figure (3): Tricuspid valve replacement using bioprosthetic valve.**

**Postoperative Parameters:** Patients were followed-up postoperatively, in hospital, and clinic for one month after surgery by full clinical assessment, general and local examination.

Statistical Analysis: Statistical analysis was performed using the following tests, Arithmetic mean standard deviation and hypothesis "t" test (student test) for quantitative values. The sign (+ or -) test and the chi-square test ($x^2$) for comparison of qualitative variables expressed as proportions. For all the statistical tests done, the threshold of significance is fixed at the 5% level (p-value): non-significant difference if $p > 0.05$, Significant difference if $p < 0.05$ and highly significant difference if $p < 0.01$.

**RESULTS**

**Table (1): Analysis of patient's age and sex.**

| | | 1st group | 2nd group | p-value |
|---|---|---|---|---|
| Mean age | | 44.75 years ±11.355S.D | 40.75 years ±9.973SD | P=0.244 P > 0.05* |
| Sex | Male | 12 (60 %) | 8(40 %) | P > 0.05* (p=0.206) |
| | Female | 8 (40 %) | 12 (60%) | |

**P> 0.05= NS***

The difference in the mean age between the two groups is statistically non-significant (p> 0.05). The difference in the sex distribution between the two groups is statistically non-significant (p>0.05).

**Table (2): Analysis of preoperative patient's clinical picture.**

| | 1st group | 2nd group | P-value |
|---|---|---|---|
| **Right Sided Symptoms:** | | | |
| Dyspnea | | | |
| NYHA Functional Class (n) | | | |
| Class II | 8(40%) | 9(45%) | P > 0.05*(0.349) |
| Class III | 10(50%) | 11(55%) | |
| Class IV | 2(10%) | 0(0%) | |
| Dyspepsia | 4 (20%) | 6 (30%) | P > 0.05*(0.46) |
| Right hypochondrial pain | 11 (55%) | 13 (65%) | P > 0.05*(0.52) |
| **Right Sided Signs** | | | |
| 1- Neck vein congestion | 15 (75%) | 17 (85%) | P > 0.05* |
| 2- Liver enlarged | 3.8 ± 0.76 | 3.95 ± 0.75 | P > 0.05* |
| 3- Ascites | 4 (20%) | 3 (15%) | P > 0.05* |
| 4- Lower limb oedema | 13 (65%) | 15 (75 %) | P > 0.05* |
| **Cardiac Signs** | | | |
| TV murmurs | 18 (90%) | 17(85%) | P > 0.05* |
| Manifestations of P.H. | 16(80%) | 15 (75%) | P > 0.05* |
| Manifestations of R.V.E. | 20 (100%) | 20 (100%) | ---- |

**P> 0.05 = NS*** PND= Paroxysmal nocturnal dyspnea, PH= Pulmonary hypertension, RVE= Right ventricular enlargement.

There was a statistically significant difference between both groups regarding Right Sided Symptoms, Right Sided Signs and Cardiac Signs

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**Table (3): Analysis of preoperative patient's echocardiography.**

| | 1st group | 2nd group | p-value |
|---|---|---|---|
| **T.R** | 13 (65 %) | 14 (70%) | P > 0.05 * |
| **T. S** | 4(20%) | 3(15%) | P > 0.05 * |
| **T. R and S** | 3(15%) | 3(15%) | P > 0.05 * |
| **P.A.S.P.** (mmHg)± SD | 62.50 ± 8,.95 | 61.25 ± 10.24 | P > 0.05 * |
| **R.V.** (cm)± SD | 2.93 ± 0.37 | 2.99 ± 0.40 | P > 0.05 * |
| **L.A.** (cm)± SD | 7.10 ± 0.97 | 7.27 ± 1.00 | P > 0.05 * |
| **L.V.** | | | |
| • L.V.E.D.D.(cm)± SD | 5.80 ± 0.64 | 5.72 ± 0.75 | P > 0.05 * P > |
| • L.V.E.S.D. (cm)± SD | 3.92 ± 0.36 | 3.90 ± 0.45 | 0.05 * |
| **E.F.** (%)± SD | 50.30 ± 3.13 | 52.35 ± 3.26 | P > 0.05 * |

**P> 0.05= NS*** TR= Tricuspid regurgitations, TS= tricuspid stenosis, PASP= Pulmonary artery systolic pressure, RV= Right ventricle, LA= Left atrium, LV= Left ventricle, EED= End diastolic diameter, ESD= End systolic diameter, EF= Ejection fraction, PH= Preoperative systolic PAP (> 40 mm Hg).

The difference between both groups is statistically non-significant (p > 0.05) regarding Tricuspid regurgitation, Tricuspid stenosis, Tricuspid regurgitation and stenosis, Pulmonary artery systolic pressure (PASP), Right ventricle dimension (RV), Left atrial dimension (LA), Left ventricle dimensions (LV) and Ejection fraction (EF).

**Table (4): Comparison of intraoperative data in different study groups.**

| | 1st group | 2nd group | p-value |
|---|---|---|---|
| **Operation duration time (min)** | 294.85±16.816 | 232.15±21.683 | **P< 0.05 (P=0.001)** |
| **Bypass time (min)** | 141.2±28.2 | 161.5±15.1 | P> 0.05 |
| **Cross clamp time (min)** | 91.7±19.5 | 118±13.6 | P> 0.05 |
| **Inotropic support** | 16(80%) | 13(65%) | P> 0.05 |

**P > 0.05 = NS P< 0.05 = S**

Table illustrates that there was highly statistically significant difference with p-value <0.05 between study groups as regards operation duration time [294.85±16.816 in 1st group vs 232.15±21.683 in 2nd group (P=0.001)].

On the other hand, there is no statistically significant difference with p-value >0.05 as regards inotropic support, bypass time and cross clamp time.

**Table (5): Comparison of post-operative data in different study groups.**

| | 1st group | 2nd group | p-value |
|---|---|---|---|
| **Re-exploration for bleeding** | 3(15%) | 1(5%) | P> 0.05 |
| **Drainage(ml)** | 1023.5 ±439 | 632.5±399 | **P< 0.05 (P=0.001)** |
| **Inotropic drug usage in ICU** | 10(50%) | 8(40%) | P > 0.05 |
| **Need for blood(units)** | 5(25%) | 4(20%) | P > 0.05 |
| **Need for fresh frozen plasma** | 7(35%) | 5(25%) | P > 0.05 |
| **Hospital Mortality** | 2(10%) | 1(5%) | P > 0.05 |

**P > 0.05 = NS***
Post-operative data, regarding, re-exploration for bleeding, need for blood and fresh frozen plasma transfusion and inotropic drug usage in ICU. Table illustrates that there is no statistically significant difference with p- value >0.05 between study groups as regards post-operative.
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On other hands, the mean postoperative drainage quantities are 1023.5 ±439S.D in 1st group, while in 2nd group 632. 5±399S.D **(P=0.001)** that is found a highly statistically significant difference with p-value < 0.05 between study groups

**Table (6): Comparison of hospitalization variables in different study groups.**

| | | 1st group | 2nd group | p-value |
|---|---|---|---|---|
| **Mechanical ventilation** (hours) | | 18.02±25.385 | 17.55±42.973 | P> 0.05 |
| **ICU stay** (days) | | 3.9±0.96 | 3.6±1.1 | P> 0.05 |
| **Hospital stay** (days) | | 7.50±2.306 | 6.05± .999 | **P<0.05 (P=0.016)** |
| **Post operative pain** | | | | |
| | **Mild** | 1(2.5%) | 3(7.5%) | P> 0.05 |
| | **Moderate** | 11(27.5%) | 14(35%) | P> 0.05 |
| | **Sever** | 8(20%) | 2(5%) | **P<0.05** |
| **Wound infection (total)** | | 6(15%) | 2(5%) | P> 0.05 |
| **superficial Wound infection** | | 4(10%) | 2(5%) | P> 0.05 |
| **Deep wound infection** | | 2(5%) | 0(0%) | P> 0.05 |

**P > 0.05 = NS*** **P< 0.05 = S**
Table illustrates that there is statistically significant difference with p-value<0.05 as regards length of hospital stay, the mean hospital stay for 1st group was 7.50±2.306 S.D, while in 2nd group was 6.05±.999S.D. Regarding postoperative pain according to severity of pain that we found, there are no statistically significant difference with p-value >0.05 between study groups as regards mild or moderate pain except sever pain. In wound infection, we found there is statistically significant difference with p-value<0.05 between study groups (6 (15%) in 1st group vs 2(5%) in 2nd group) as total number. On the other hand, there is no statistically significant difference with p-value >0.05 between study groups as regards superficial or deep infection.

## DISCUSSION

Different approaches for tricuspid valve surgery access have been proposed for the frequency of reoperations for heart valve diseases increases due to the rising number of reparative procedures, prosthetic valve dysfunctions and the progressive feature of the primary disease. Unfortunately reoperation for tricuspid position is a risk factor for early mortality **[6]**.
Age in our study, the mean age of patients in 1st group (median sternotomy group) was 44.75 years ±11.355 S.D. while in 2nd group (right anterolateral thoracotomy group), it was 40.75 years ±9.973 S.D.

Hanedan et al. reported that the mean age affected in both groups respectively was 48.23±9.54 53.29±11.16**[1]**. The middle age in both series may be attributed to Patients are rarely referred for isolated surgical tricuspid valve repair, and most repairs are done in the context of other planned cardiac surgery, because significant tricuspid regurgitation (TR) occurs usually with late-phase myocardial and valvular heart disease except for congenital anomalies such as Ebstein's anomaly. We found no statistically significant difference between mean ages in both of our study groups.
Gender in our study, females represented 50% of the patients and males represented 50%. The sex

distribution in the 1st group, there were 12 males (60%) and 8 females (40%) while in the 2nd group, there were 8 males (40%) and 12 females (60%). Although females were attractive to anterolateral thoracotomy, however, we could not find statistically significant difference between sex distributions in both of our study groups.

Nkomo et al. reported that there was no difference in the frequency of valvular heart diseases between men and women and that women are less often diagnosed than men **[7]**.

In our study, dyspnea was present in all patients according to The New York Heart Association (NYHA) functional classification: In 1st group the number patients presented with NYHA class II, III, IV respectively were (8(40%), 10(50%), 2(10%)), While in 2nd groups the number patients presented with NYHA class II, III, IV respectively were (9(45%), 11(55%),0(0%)). The difference between both groups is statistically non-significant ($p > 0.05$).

Hanedan et al. reported the difference between both groups is statistically non-significant ($p > 0.05$) that is similar to our study. His results were in 1st group (resterntomy group N=13) the number patients presented with NYHA class II, III, IV respectively were (6, 6, 1), While in 2nd groups (anterolateral thoracotomy N=17) the number patients presented with NYHA class II, III, IV respectively were (5, 11, 1) **[1]**. In addition, the advanced classes III and IV are reflections of remain left sided heart failure leading to pulmonary hypertension, right sided heart dilatation and tricuspid insufficiency. The concomitant left heart failure often will dominate the clinical picture.

The clinical sign of tricuspid valve disease is based on these signs; tricuspid murmurs, hepatomegaly, ascites and lower limb oedema. In our study, these signs were the most prevalent. Hepatomegaly, ascites and lower limb oedema were present in our study 65%, 55% and 77% respectively.

Rodés-Cabau et al. a pulsatile, enlarged liver is a late finding, as are ascites and lower extremity oedema. Right ventricular systolic function is usually impaired when such signs of right heart failure are present **[8]**.

Doppler echocardiography is currently the reference complementary examination in tricuspid disease, simultaneously enabling a definitive and etiological diagnosis to be arrived and a semi-quantitative assessment of the extent of regurgitation to be made **[9]**. Color-coded Doppler imaging is an extremely sensitive, accurate and specific method for assessing the presence, severity and etiology of tricuspid disease **[10]**. This technique helps in patients' selection for tricuspid repair. In fact, it is proved to be a superior tool as it is non-invasive, free of catheter-induced artifacts and dye related complication **[11]**.

There was significant correlation between the degree of elevation of pulmonary artery pressure and the severity of tricuspid regurgitation. Mutlak et al. assessed the determinants of TR severity in 2139 patients with pulmonary hypertension. In this population, elevated pulmonary artery systolic pressure was associated with more severe TR **[12]**.

LA, LVESD, LVEDD and EF by Echocardiography reflected the effects of remain left sided heart failure rather than the tricuspid valve disease. In our study, the mean ejection fraction values were 50.30% ± 3.13 S.D. In 1st group and 52.35 ± 3.26 S.D. in 2nd group. The difference between both groups is statistically non-significant ($p > 0.05$).

Hanedan et al. Preoperative mean EF (%) was in 1st group 51.69±6.24 S.D and in 2nd group 54.29±3.85 S.D which is similar to our study with non-statistically significant difference between both groups ($p > 0.05$) **[1]**.

Concerning to which surgical technique we used for tricuspid valve surgery repair or replacement, we found in 1st group, the tricuspid valve lesions were corrected by tricuspid valve repair in 12 patients (60%), tricuspid valve replacement with bioprosthetic valve in 6 patients (30%), and 2 patients with mechanical valve (10%).

In 2nd group, the tricuspid valve lesions were corrected by tricuspid valve repair in 12 patients (60%), tricuspid valve replacement with bioprosthetic valve in 7 patients (55%) and 1 patient with mechanical valve (5%). The differences between both groups are statistically non-significant ($p>0.05$).

Panagiotis Sarris-Michopoulos et al. who did meta-analysis for ten retrospective studies involving 1407 patients (isolated TV repair group = 779 patients and isolated TV replacement group = 628 patients) were included. A cumulative analysis demonstrated a significant difference favoring isolated TV repair for 30-day mortality (odds ratio [OR]: 10 studies [95% confidence interval [CI]]: 0.34 [0.18–0.66]); 4.7% versus 12.6%, for isolated TV repair and isolated TV replacement, respectively. Post-op pacemaker placement favored isolated TV repair (OR: 6 studies [95% CI]: 0.37 [0.18–0.77]). Although stroke rates and TV reoperation favored isolated TV repair. This meta-analysis demonstrates that isolated TV repair has better 30-day mortality and fewer permanent pacemaker placements. Etiology and severity of TR, as well as careful patient selection remain the most important factors for optimal outcomes **[13]**.

Wang et al. who reported that isolated tricuspid valve repair was associated with significantly reduced in-hospital mortality, renal failure and pacemaker implantation compared with replacement and is therefore recommended where feasible for isolated tricuspid valve disease **[14]**.

Operation duration time **(**min); that was longer in (median sternotomy group 294.85±16.816S.D VS right anterolateral thoracotomy 232.15±21.683S.D P=0.001) that is explained with right anterolateral approach, there is no need to dissolve adhesions and

scar tissues with previous sternotomy versus right anterolateral thoracotomy in order to gain an access for cannulation. Moreover, most of our cases had previous cardiac operation with sternotomy.

This is similar to the results obtained by Hanedan et al. who compared re-sternotomy versus right anterolateral thoracotomy which was longer duration of operation in the Median Re-sternotomy Group (298.08±76.64 vs 246.76 ±47.40 min, p=0.032) that is statistically significant **[1]**.

No statistical difference was found between the 2 groups regarding Bypass time (min) that was in (median sternotomy group141.2±28.2 VS right anterolateral thoracotomy 161.5±15.1 P> 0.05).

that is similar to Maimaiti et al. there was significantly less total drainage volume for patients in the Right anterolateral thoracotomy group compared with patients in the median sternotomy group (1150±803.5/2.270±1.920 P=0.012) **[15]**.

On the other hand, there is statistically significant difference with p- value <0.05 between study groups, the mean hospital stay for 1st group was 7.50±2.306 S.D, while in 2nd group was 6.05±. 999 S.D as regards length of hospital stay.

On contrary to Maimaiti et al. Postoperative hospital stay (day) was (11.3±7.9 (median sternotomy) VS 10.1±6.6 (anterolateral thoracotomy) **[15]**.

## CONCLUSION

After assessing all our results, we can say that right antero-lateral thoracotomy for isolated tricuspid valve surgery is a practical and safe technique with less operative time and postoperative bleeding and more importantly, with lower mortality rates particularly in patients with previous sternotomy.

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