Ain-Shams Journal of Anesthesiology

ORIGINAL ARTICLE Open Access

Restrictive versus liberal perioperative fluid strategies to prevent post-dural puncture headache after cesarean delivery

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Abstract

Background: Post-dural puncture headache is a common complication after cesarean delivery. The role of fluid therapy in prevention of post-dural puncture headache is not clear. The aim of this work is to compare restrictive versus liberal perioperative fluid protocols in prevention of post-dural puncture headache. A randomized controlled trial was conducted including 100 full-term pregnant women undergoing cesarean delivery under spinal block. After receiving spinal block, all patients received 1.5 mcg/kg phenylephrine and crystalloid co-load at a rate of 10 mL/h. Patients were assigned into either restrictive group (did not receive fluid preload + received postoperative crystalloid therapy at a rate of 2 mL/kg/h till resuming oral fluids) or liberal group (received crystalloid preload 5 mL/kg before spinal block + received postoperative crystalloids at a rate of 6 mL/kg/h till resuming oral fluids. Both groups were compared according to the incidence of post-dural puncture headache, pain scores, systolic blood pressure, heart rate, incidence of post-spinal hypotension, nausea, and vomiting.

Results: The incidence of post-dural puncture headache was lower in the restrictive group compared to the liberal group {10(20%) vs 22(44%), $P = 0.018$}. All other secondary outcomes were comparable between both groups.

Conclusion: Restrictive fluid therapy was associated with lower incidence of PDPH after cesarean delivery without impacting patient hemodynamic profile.

Background

Post-dural puncture headache (PDPH) is a common complication of diagnostic, therapeutic, or inadvertent lumbar punctures (Bradbury et al. 2013; Bezov et al. 2010). The pathophysiology of PDPH has not been fully described. The postulated mechanism of PDPH is cerebrospinal fluid (CSF) leak from the subarachnoid space through the dural gap, resulting in a decrease in CSF volume and pressure (Ahmed et al. 2006; Clark et al. 1996). This CSF volume loss induces headache by two mechanisms: (1) downward pull on pain-sensitive structure (Ahmed et al. 2006). (2) Vasodilatation of cerebral blood vessels to maintain stable intracranial volume after the loss of CSF (Clark et al. 1996).

Obstetric population are usually more vulnerable to PDPH; this was attributed to many theories such as younger age which makes the highly elastic dura more likely to gap, and the high levels of estrogen which decrease the tone of cerebral blood vessels. PDPH usually resolves within few days; however, it sometimes last for longer periods with marked disability, impaired care of the newborn, and prolonged hospitalization (Sprigge and Harper 2007).

As the main mechanism for PDPH was loss of CSF, it had been suggested that additional fluid intake might prevent and/or manage it by replacing lost corporal fluid and increasing CSF production (Ahmed et al. 2006), thus, preventing a hydrostatic pull on pain-sensitive structures and vasodilation (Jensen et al. 1987). However, this theoretical suggestion lacks evidence. According to the available Cochrane database reviews, evidence

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is inadequate for the role of fluid supplementation in prevention of PDPH (Arevalo-Rodriguez et al. 2013).

The aim of this work is to evaluate the impact of restrictive versus liberal perioperative fluid strategy on the incidence of PDPH.

Methods

A randomized, controlled trial was conducted in hospital after approval of institutional board review (N-98-2017). Patients' consents were obtained after full explanation of the procedure. An online randomizer was used to generate patient codes which were enclosed in sequentially numbered opaque envelopes, where the investigator who assess the post-dural puncture headache presence and strength is other than the one who gave the fluid protocol strategy and record the vital signs, nausea, and vomiting and an additional investigator to cross match the results.

The study included full-term pregnant females undergoing elective cesarean section under spinal block. Exclusion criteria included history of migraine headache, hypertensive disorders of pregnancy, and contraindications of regional anesthesia.

Patients with more than one single attempt and patients with blood loss over 1000 mL who needed additional fluid supplementation or blood transfusion were also excluded from the study.

After receiving spinal block, all patients received 1.5 mcg/kg phenylephrine and crystalloid co-load at a rate of 10 mL/h. According to the group randomization, patients were assigned into either restrictive group (did not receive fluid preload + received postoperative crystalloid therapy at a rate of 2 mL/kg/h till resuming oral fluids) or liberal group (received crystalloid preload 5 mL/kg before spinal block + received postoperative crystalloids at a rate of 6 mL/kg/h till resuming oral fluids.

After application of full monitors, spinal block was performed in sitting position, using a 22-gauge quincke spinal needle for injection of 2.2 mL (12 mg) hyperbaric bupivacaine and 20 mcg fentanyl.

After spinal anesthesia block (SAB), the patient was positioned in supine position with left lateral pelvic tilt. The success of the block was assessed using pinprick for sensory blockage. The block was considered failed of the sensory level did not reach T4 dermatome. Intraoperative hypotension (defined as a decrease in SBP by 20% or below 100 mmHg during the period starting from SAB till delivery of the fetus) was managed by IV ephedrine bolus (9 mg). Intraoperative bradycardia (defined as heart rate below 55 bpm) was managed by IV atropine (0.5 mg).

PDPH was assessed postoperatively by questioning the patients for the presence of any headache. PDPH was explained to the patients as headache which is throbbing in nature, located in the frontal and/or the occipital region, aggravated in the upright position, and relieved by recumbence. Headache might be accompanied by photophobia, double vision, blurred vision, dizziness, tinnitus, decreased hearing, nausea, and vomiting. Patient assessment was done every 6 h for 48 h. Patients were asked to sit in bed for 5 min and then asked for the presence of headache. Patients reporting PDPH were asked to rate it according to Wong-Baker Faces pain rating scale which ranged from 0 (no pain) to 10 (worst pain) (Miró et al. 2016). PDPH was managed by IV paracetamol (15 mg/kg/6 h). Patients were also assessed for the presence of postoperative nausea and vomiting (PONV) using a three-point scale: 0 = no nausea or vomiting, 1 = nausea only, 2 = nausea and vomiting.

Outcomes

Primary outcome

- The incidence of PDPH: headache was considered relevant if Wong-Baker Faces pain rating scale was above 4.

Secondary outcomes

- Incidence of post-spinal hypotension
- Systolic blood pressure (continuously monitored every 3 min intraoperative, then every hour for postoperatively 24 h)
- Heart rate (continuously monitored intraoperatively, then every hour postoperatively for 24 h)
- Wong-Baker Faces pain rating scale
- Intraoperative atropine and ephedrine consumption
- Incidence of intraoperative and postoperative nausea and vomiting

Statistical analysis

We performed a pilot study on 20 patients in whom we reported the incidence of PDPH to be 37%. We calculated our sample size that could be sufficient to detect reduction of the incidence of PDPH to 10%. A Minimum number of 45 patients was needed in each group to have a study power of 80% and an alpha error of 0.05. The number of envelopes was increased to 55 patients per group to compensate possible dropouts.

Statistical package for social science (SPSS) software, version 15 for Microsoft Windows (SPSS Inc., Chicago, IL, USA) was used for data analysis. Categorical data were expressed as frequency (%). Continuous data were tested for normality using Shapiro-Wilk test and presented as either mean (standard deviation) or median (quartiles) as appropriate. Categorical data were analyzed using chi-squared test. Continuous data were analyzed using unpaired *t* test (for normally distributed data) and

Mann-Whitney test on ranks (for skewed data). For repeated measures, a two-way repeated measures ANOVA was used to evaluate fluid strategy (between-groups factor) and time (repeated measures). Post hoc pairwise comparison was performed using Bonferroni test. A p value of ≤ 0.05 was considered statistically significant.

Results

One hundred and twenty-four were screened for eligibility. Fourteen patients did not meet our inclusion criteria, and 110 patients were included in the study. Nine patients were lost for follow-up and 100 patients were available for final analysis (Fig. 1).

Both groups were comparable in demographic data. Restrictive group received median (quartiles) total fluids of 1200 (1000, 1500) mL whereas, liberal group received 2400 (2200, 2600) mL ($p < 0.001$) (Table 1). No clinically relevant differences were reported between both groups in hemodynamic data (SBP, heart rate, and incidence of post-spinal hypotension). Atropine consumption and ephedrine consumption was also comparable between both groups (Table 1) (Figs. 2 and 3)

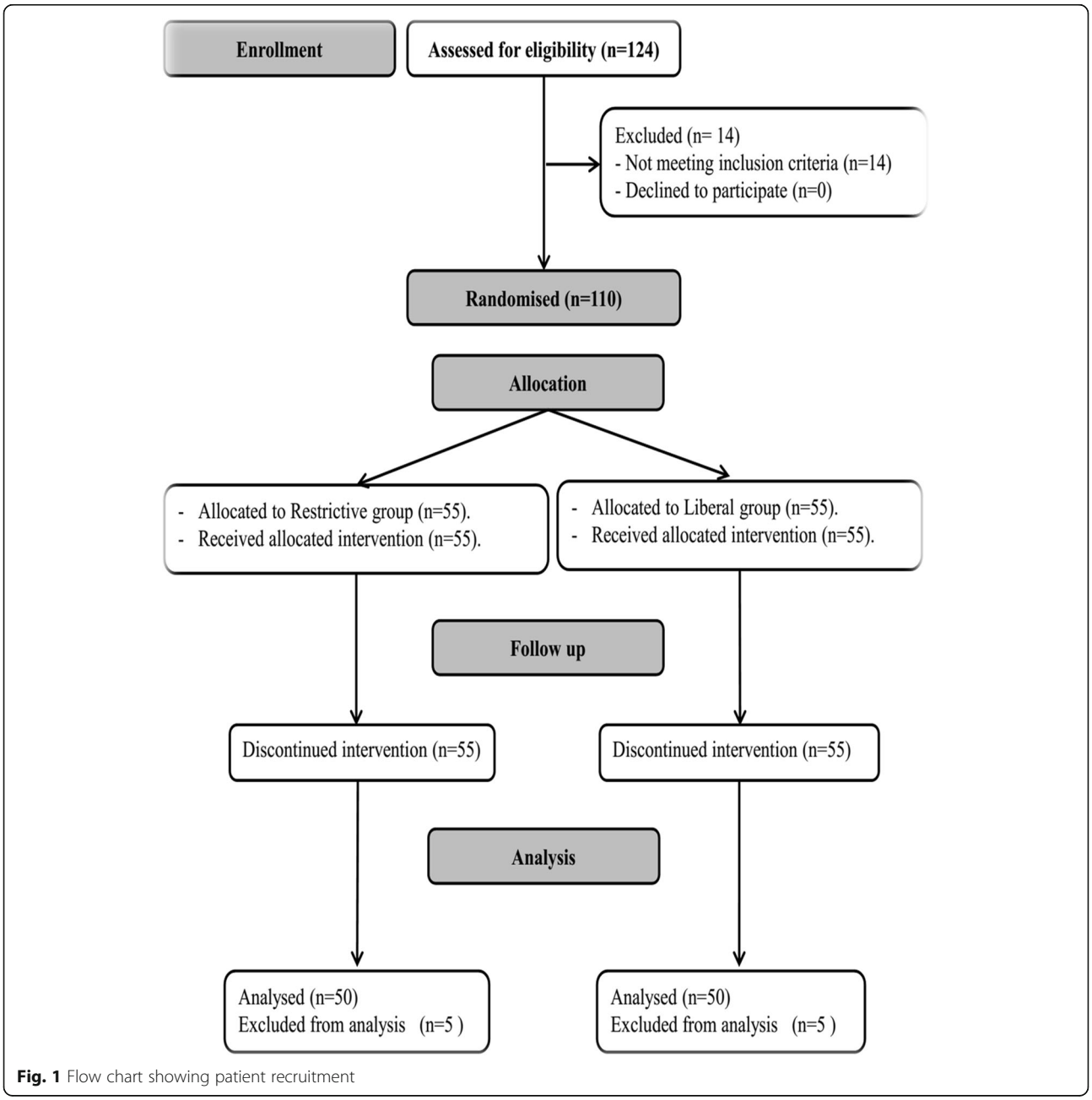

Fig. 1 Flow chart showing patient recruitment

Table 1 Demographic data and patient outcomes

	Restrictive group (n = 50)	Liberal group (n = 50)	p value
Age	29 ± 6	28 ± 5	NS
Weight	80(74–95)	78(79–93)	NS
Total fluids in first 3 postoperative hours	1200(1000–1500) [a]	2400(2200–2600)	< 0.001
Incidence of postspinal hypotension	27(54)%	24(48%)	NS
Number of atropine boluses			NS
- 0	- 47(94%)	- 47(94%)	
- 1	- 2(4%)	- 3(6%)	
- 2	- 1(2%)	- 0(0%)	
Nausea and vomiting			NS
- No nausea	- 43(86%)	- 44(88%)	
- Nausea only	- 7(14%)	- 4(8%)	
- Nausea and vomiting	- 0(0%)	- 2(3%)	
Incidence of PDPH	10 (20%) [a]	22(44%)	< 0.001

Data are presented as mean ± standard deviation, median (quartiles), and frequency (%)
PDPH post-dural puncture headache
[a]Statistical significance

Restrictive group showed lower incidence of PDPH {10(20%) vs 22(44%), p = 0.018} (Table 1, Fig. 4) and lower Wong-Baker Faces pain rating scale compared to the liberal group (Figs. 2 and 3). On intragroup analysis, Wong-Baker Faces pain rating scale scores were lower within each group compared to the first postoperative reading (Figs. 2 and 3). No significant differences were reported between both groups with regard to the incidence of nausea and vomiting (Table 1).

Discussion

We reported that restrictive therapy was associated with lower incidence of PDPH and lower pain scores compared to the liberal therapy without relevant differences in hemodynamic data (SBP and heart rate). To the best of our knowledge, this the first study that investigate the impact of perioperative fluid volume on the incidence and severity of PDPH in after cesarean delivery.

The role of fluid therapy in either prevention or management of PDPH is unclear. Although the most widely acceptable cause of PDPH is cerebrospinal fluid leak from the subarachnoid space, resulting in a downward pull on pain-sensitive structures (Ahmed et al. 2006), no evidence guarantee that liberal fluid replacement would improve the CSF volume and prevent PDPH.

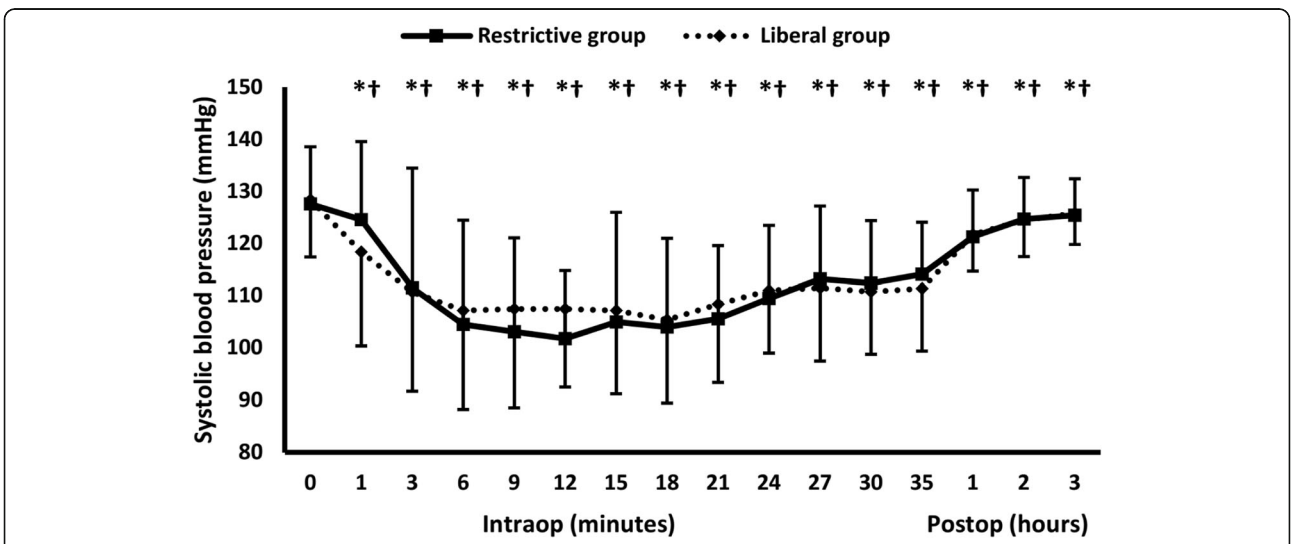

Fig. 2 Systolic blood pressure. * denotes statistical significance compared to the baseline reading within restrictive group, † denotes statistical significance compared to the baseline reading within liberal group. Intraop.: intraoperative, postop.: postoperative

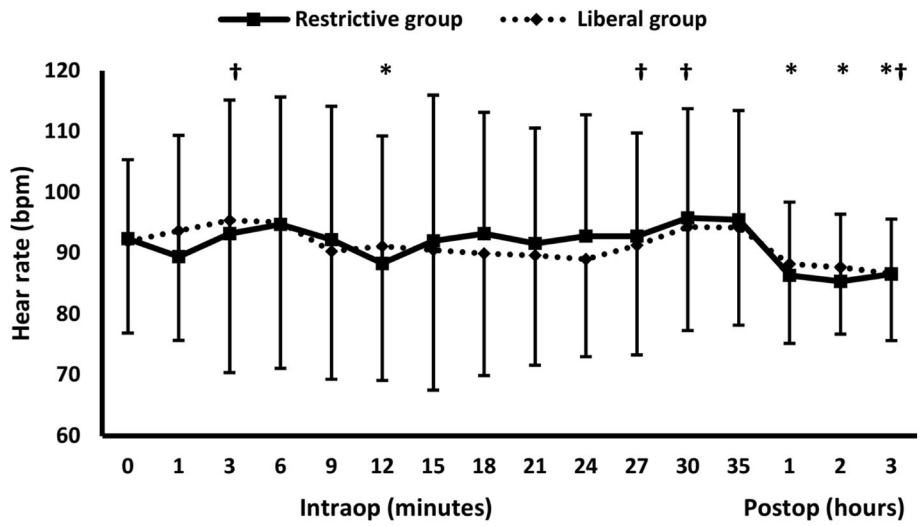

Fig. 3 Heart rate. * denotes statistical significance compared to the baseline reading within restrictive group, † denotes statistical significance compared to the baseline reading within liberal group. Intraop.: intraoperative, postop.: postoperative

Liberal fluid intake might lead to dural vein congestion due to increased blood volume. Liberal fluids might also lead to some brain edema aggravating the PDPH. Even the relation between the volume of CSF and occurrence of PDPH is not clear, it was previously reported that keeping the patient in recumbent position did not decrease the incidence of PDPH (Kim et al. 2012). Another study reported that the position of rest (supine or prone) did not change the incidence of PDPH (Afshinmajd et al. 2014); these findings indicate that the gravity did not impact PDPH, and consequently we could suggest that the volume of CSF does not impact the incidence of PDPH.

Our results favored fluid restriction which is the contrary to what was previously suggested. The general trend in perioperative fluid management nowadays is toward fluid restriction (Della Rocca et al. 2014). Increased fluid balance is usually associated with organ edema and poor outcomes (Simões et al. 2018).

One available study has evaluated the role of fluids in prevention of PDPH; this study was conducted by Dieterich and Brandt (Dieterich and Brandt 1988) who investigated the role of rehydration (1.5 L versus 3 L in 100 patients, over a period of 5 days) in prevention of post-lumbar puncture headache. They reported that rehydration was of no value in prevention of headache, and they

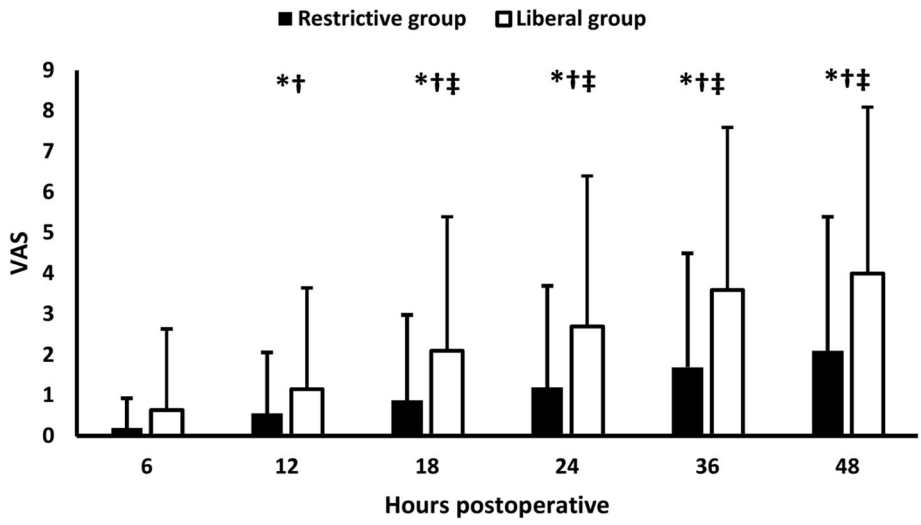

Fig. 4 Pain score. * denotes statistical significance compared to the baseline reading within restrictive group. † denotes statistical significance compared to the baseline reading within liberal group. ‡ denotes statistical significance between both groups

suggested that post-lumbar puncture headache is not a CSF dynamics problem, but it may be a mechanical problem due to CSF leakage process. Although Dieterich and Brandt had conducted this study in non-obstetric population, we assume that their findings support ours. According to the available Cochrane database reviews (Arevalo-Rodriguez et al. 2013; Arevalo-Rodriguez et al. 2016), the evidence is still lacking for supporting any fluid strategy in prophylaxis against PDPH.

Neuraxial anesthesia and analgesia is the most widely used route in normal labor as well as cesarean delivery (Osterman and Martin 2011; Martin et al. 2015). PDPH markedly devastates the post-partum experience, including the ability of new mothers to tend to their own needs and provide proper care to their newborn infants (Apfel et al. 2010). PDPH increases the length of hospital stay with unplanned expenses (Bezov et al. 2010) and its management is not easy and lacks good evidence (Buddeberg et al. 2019; Ioscovich et al. 2018). Our results provide new insight toward fluid management during the perioperative period in cesarean delivery. There were some limitations in our study: it is a single center study. We investigated the role of fluids in obstetric population, more studies are warranted to confirm our findings in other patient groups. We included elective and not emergency cesarean sections. We encourage future research to confirm our findings in other populations.

Conclusion

In conclusion, restrictive fluid therapy was associated with lower incidence of PDPH after cesarean delivery without impacting patient hemodynamic profile.

Abbreviations

PDPH: Post-dural puncture headache; CSF: Cerebrospinal fluid; SAB: Spinal anesthesia block; SBP: Systolic plod pressure; SPSS: Statistical Package for Social Science

Acknowledgements

Not applicable.

Authors' contributions

M E: the idea and revision. N A: data collector and writing. T A: main supervisor. H S: statistics and revision. All authors have read and approved the manuscript.

Funding

This work was funded by Cairo University.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Ethics approval was obtained from ethical community of Faculty of Medicine, Cairo University, and informed written consent was obtained from the patient after the description of the intervention and its potential complications (N-98-2017) and trail number (clinical trial identifier: NCT03475784).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: 4 December 2020 Accepted: 8 February 2021
Published online: 01 March 2021

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