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# Sonographic evaluation of peri-arterial nitroglycerine for radial artery cannulation in morbidly obese patients: a prospective randomized study

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## Abstract

**Background:** Arterial cannulation is usually indicated for both sampling and invasive pressure monitoring. Radial artery access is increasingly favored over other sites for arterial cannulation. However, radial cannulation in morbidly obese patients is an anesthetic challenge.

This study evaluates the effect of subcutaneous infiltration of nitroglycerine on radial artery cannulation in morbidly obese patients. Sixty patients were randomly allocated into two equal groups according to subcutaneous infiltrate used before radial artery cannulation. In the LN group, the syringe contains 0.2 ml of nitroglycerine (NTG) plus 0.8 ml lidocaine hydrochloride 2%, while in L group, the syringe is filled with 1 ml of lignocaine 2%.

**Results:** Subcutaneous infiltration of the lignocaine-NTG mixture in the LN group resulted in a significant increase in arterial dimensions in comparison to lignocaine alone in the L group. Consequently, a significantly higher overall success rate, first attempt success was observed in the LN group. Also, insertion time and number of attempts were significantly lower in the LN group in relation to the L group.

**Conclusions:** Subcutaneous infiltration of nitroglycerin mixed with a lignocaine before ultrasound-guided radial artery cannulation increases the procedure success rate with no detected side effects.

**Keywords:** Arterial, Obese, Radial, Nitroglycerine

## Background

Clinicians are increasingly dealing with morbidly obese patients. In morbidly obese patients, difficult sampling and problems encountered with non-invasive blood pressure monitoring make arterial cannulation an essential skill. Arterial access may be used for perioperative purposes or for trans-radial procedures for coronary or carotid interventions (Turan et al. 2015; Sandhu et al. 2017).

Radial artery access is preferred over other sites for arterial cannulation due to the lower incidence of bleeding, better hemostasis, more patient satisfaction, and immediate ambulation. However, radial artery cannulation is technically more demanding and challenging with relatively higher rates of failure and procedure-related complications (Attaran et al. 2008; Candemir et al. 2009). This is probably related to the fact that the radial artery has smaller caliber and a large muscular media with a higher receptor-mediated vasoconstriction compared with other similar arteries (Attaran et al. 2008; Candemir et al. 2009; Pancholy et al. 2006; Kwok et al. 2015).

Multiple techniques have been studied either to facilitate difficulties with radial artery catheterization in morbid obese or to decrease procedure-related complications, especially arterial spasm (Ezhumalai 2016; Turan et al. 2016; Ezhumalai et al. 2014).

In this study, subcutaneous nitroglycerine (NTG) was used to facilitate radial artery cannulation aiming to decrease insertion time, increase success rate, and decrease related complications.

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## Methods

This prospective randomized double-blinded study was conducted from May 2015 to December 2016. After approval of institutional research board (R/16.12.76) and clinical trials registry (ClinicalTrials.gov ID: NCT03006640), a written informed consent was obtained from morbidly obese patients scheduled for elective abdominal surgeries with an anesthetic plan requiring arterial cannulation. Patients were of either sex, age from 20 to 50, and body mass index (BMI) more than 35. Exclusion criteria included +ve modified Allen test, coagulopathy (international normalized ratio, ≥ 1.5; platelet count, $\leq 70 \times 10^3/\mu L$), peripheral arterial disease, hand deformities, and infection or burn at the site of insertion.

Depending on the results of a previous study (Abdalla et al. 2017), the mean time needed for ultrasound-guided radial artery cannulation was 28 s with a standard deviation of 9 s. We considered a 20% decrease in insertion time to be clinically significant. Assuming a two-sided type I error of 0.05 and a power of 0.80, an estimated sample size of 30 patients per group was required. Patients were randomly divided into two equal groups according to the study protocol: L group ($n = 30$) where 1 m of lignocaine Hcl 1% will be injected subcutaneously before arterial cannulation and LN group ($n = 30$) where the subcutaneous infiltrate is composed of a mixture of 0.2 ml of nitroglycerine (NTG) plus 0.8 ml lidocaine hydrochloride Fig. 1.

Modified Allen test was done for all patients and confirmed to be negative before proceeding. The patients were seated in the supine position during the procedure. The nondominant arm was rested upon a flat surface. Moderate dorsiflexion of the wrist was maintained by a towel situated dorsally. The hand was secured to the working surface by adhesive tape. Afterwards, the forearm was sterilized and draped. Ultrasound transducer gel was put in contact with the superficial probe (Toshiba Xario, Japan, PLT 805AT transducer), and then, the probe and its connection were threaded into a sterile cover. The transverse view was utilized in all cases. Initially, the machine was set to a preset mode MSK (frequency, 8 MHz; depth, 3 cm); thereon, gain and depth were modified to get the most accepted view by the operator. The same catheter-needle system (Leadercath Arterial; Vygon, United Kingdom) was used for arterial cannulation in all cases.

**Table 1** Patient characteristics in the two studied groups. Data are presented as median (IQR)

| | Group L ($n = 30$) | Group LN ($n = 30$) | *P* |
|---|---|---|---|
| Age (year) | 51(15) | 49(11) | 0.06 |
| Weight (kg) | 106(14) | 119(24) | 0.31 |
| Height (m) | 1.57(0.08) | 1.65(0.14) | 0.07 |
| BMI (kg/m$^2$) | 38(13) | 43(14) | 0.24 |

*IQR* interquartile range, *BMI* body mass index
*P* value is significant if less than 0.05

An independent anesthetist prepared the infiltrate mixture. In the LN group, the syringe contains 0.2 ml of NTG (NITRONAL 1 mg/ml, Sunny pharmaceutical, Egypt) plus 0.8 ml lidocaine hydrochloride 2% (lidocaine hydrochloride 2%, Pharmacell, Egypt), while in the L group, the syringe is filled with 1 ml of lignocaine 2% (lidocaine hydrochloride 2%, Pharmacell, Egypt). The insulin syringe was delivered to the blinded operator who infiltrated it subcutaneously along the radial artery course at the planned insertion site as determined by ultrasound guidance.

Basal patient characteristics, age, weight, height, heart rate (HR), and mean arterial pressure (MAP), were documented. Radial artery diameter and surface area were recorded before and after subcutaneous infiltration. The time required till radial cannulation was defined as the time elapsed from skin puncture till catheter insertion. A number of attempts

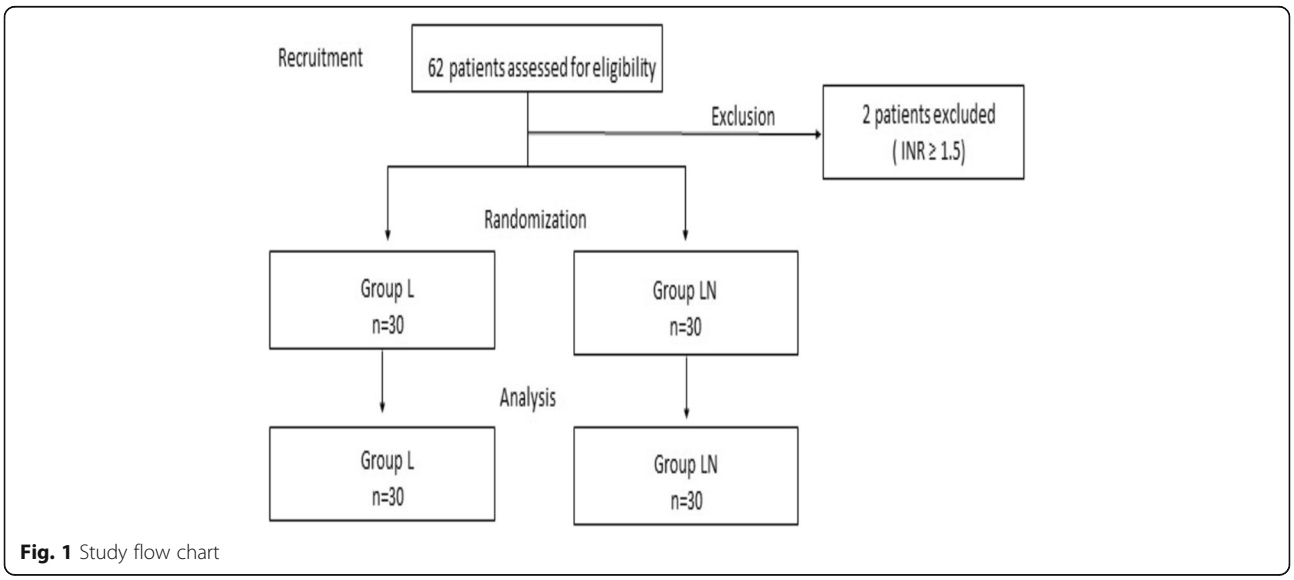


**Fig. 1** Study flow chart

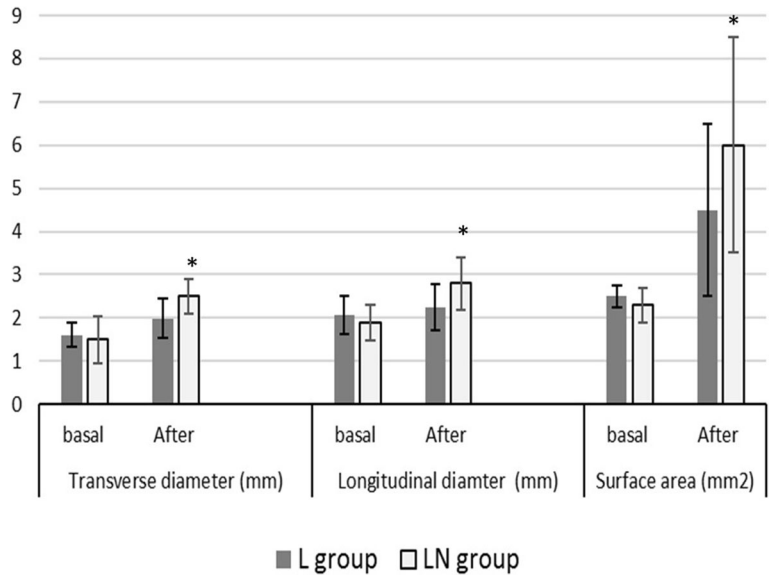


**Fig. 2** Radial artery dimensions before and after subcutaneous infiltration in both groups. **P* value is considered significant of less than 0.05

needed for radial artery cannulation were also documented. An attempt is considered failed if the needle is retracted out of the skin. If the operator could not cannulate the radial artery after three attempts, the trial is considered failed. Also, the number of retractions required before successful cannulation were recorded. Patients were followed up for 24 h after procedure-related complications (hematoma, spasm, infection, thrombosis).

Data were collected and analyzed using SPSS software (SPSS Inc., version 22, Chicago: SPSS Inc). Continuous data were tested for normality of distribution where normally distributed data were presented as mean ± SD while non-normally distributed data were presented as median (interquartile range). Categorical and nominal data were presented as number and or percentage. Independent sample *t* test and chi-square test were used to detect statistical differences between the two groups. *P* value was considered significant if less than 0.05.

## Results

In this study, 60 patients were allocated into two groups; group L ($n = 30$) and group LN ($n = 30$). Table 1 shows that patients of both groups were statistically matched regarding basal demographic characteristics (age, weight, height, BMI, HR, MAP). Similarly, there was no statistically significant difference between the two studied groups regarding basal radial artery dimensions (transverse, longitudinal, and surface area) (Fig. 2).

Subcutaneous infiltration of the lignocaine-NTG mixture in the LN group resulted in a significant increase in arterial dimensions in comparison to lignocaine alone in the L group (Figs. 2 and 3). Consequently, a significantly higher overall success rate, first attempt success was observed in the LN group. Also, the insertion time and number of attempts were significantly lower in the LN group in relation to the L group, Fig. 4. No procedure-related complications were recorded in

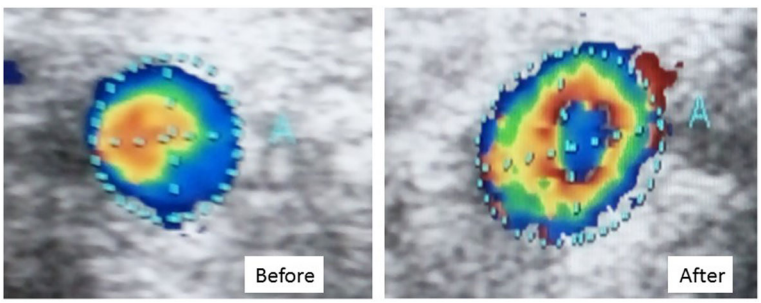


**Fig. 3** Ultrasound imaging of radial artery before and after subcutaneous infiltration of NTG

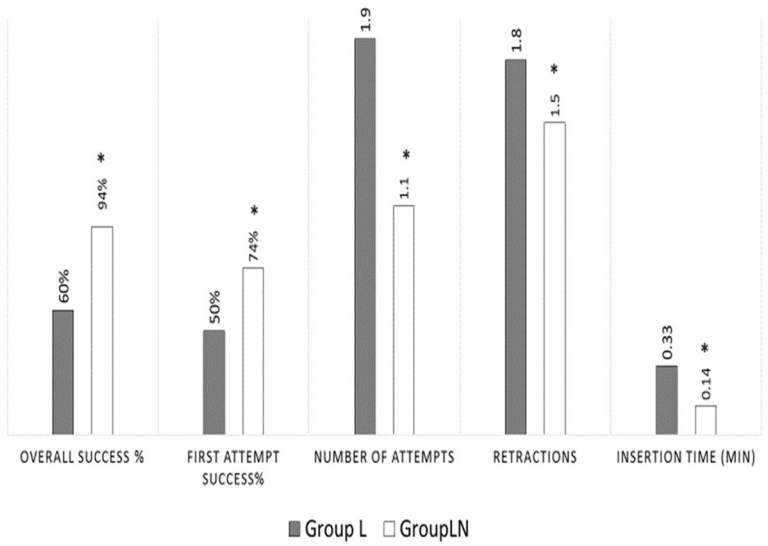


**Fig. 4** Characteristics of radial artery cannulation attempts in both studied groups. **P* value is considered significant of less than 0.05

both groups. Peri-procedural hemodynamic changes are shown in Table 2. Despite LN groups showing a minimal rise in HR and a decrease in MAP, this effect did not reach clinical or statistical significant level.

## Discussion

In this prospective randomized study, adding subcutaneous infiltration of NTG to lignocaine, during arterial cannulation in morbidly obese, resulted in a significant increase in radial artery dimensions compared to lignocaine alone. This arterial dilatation resulted in better arterial visualization by ultrasound resulting in a significantly higher success rate, lower insertion time, and lower number of attempts.

NTG has been used widely either to prevent or treat radial artery spasm during trans-radial procedures. Different routes were utilized including intra-arterial injection, topical application, subcutaneous infiltration, and sublingual tablets. Most of these studies were during coronary angiographic procedures.

Preferable effects of adding nitrates to locally infiltrated lidocaine before radial artery cannulation were demonstrated by Ouadhour et al. as a higher success rate, lower number of attempts, and shorter access time in 42 patients scheduled for coronary interventions (Ouadhour et al. 2008). In the same study, the use of nitrates was not associated with increased complications or hemodynamic consequences.

In concordance with our results, subcutaneously infiltrated NTG leads to significant vasodilation of radial artery. This was associated with the lower incidence of arterial spasm and improved palpability. Also, a number of punctures and insertion time were lower when NTG was added to lignocaine versus lignocaine-saline mixture (Ezhumalai et al. 2014).

In the study performed by Pancholy and his colleagues, subcutaneous NTG succeeded to relieve arterial spasm more effectively than systemic administration. This was also associated with less hemodynamic response (Pancholy et al. 2006).

Safety of subcutaneous NTG was investigated compared to other routes of NTG administration and also versus other spasmolytic agents like verapamil (Caputo et al. 2011). Verapamil is associated with hypotension and bradycardia limiting its use in case of left ventricular dysfunction (Ho et al. 2012). Also, it could not produce any superior effect when compared to NTG (Chen et al. 2006).

Although systemic administration of nitroglycerin, either sublingual, intravenous, or intra-arterial, could improve cannulation conditions, it is associated side effects in the form of hypotension, tachycardia, and headache (Pancholy et al. 2006. These side effects were not detected when the subcutaneous route was used (Turan et al. 2016; Ouadhour et al. 2008; Chugh et al. 2015).

**Table 2** Procedure-related hemodynamic changes in the studied groups

| | HR | | | MAP | | |
|---|---|---|---|---|---|---|
| | Basal | 1 min after | *P** | Basal | 1 min after | *P** |
| Group L (*n* = 30) | 77 ± 30 | 79 ± 26 | 0.53 | 79 ± 9 | 75 ± 8 | 0.48 |
| Group LN (*n* = 30) | 80 ± 28 | 92 ± 21 | 0.31 | 78 ± 10 | 79 ± 12 | 0.14 |

*HR* heart rate, *MAP* mean arterial pressure
**P* value is considered significant if less than 0.05 (paired sample *t* test)

## Conclusions

The results of this study suggest that subcutaneous infiltration of nitroglycerin mixed with a lignocaine before US-guided radial artery cannulation increases the procedure success rate with no detected side effects. To our knowledge, this is the first study that addresses the use of subcutaneous NTG infiltration for facilitation of radial artery cannulation in morbidly obese population. Further studies are encouraged to establish its routine use.

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

**Authors' contributions**
AA analyzed and interpreted the patient data. EE performed data collection and tabulation. Both authors shared the writing and revision of the manuscript. AA was assigned as the corresponding author. Both authors read and approved the final manuscript.

**Ethics approval and consent to participate**
Approval of institutional research board (R/16.12.76) and clinical trials registry (ClinicalTrials.gov ID: NCT03006640) were obtained prior to start of the study.

**Consent for publication**
Not applicable

**Competing interests**
The authors declare that they have no competing interests.

## Publisher's Note



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