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ACCURACY OF ANESTHESIA IN RECONSTRUCTIVE-PLASTIC SURGERY IN THE LOWER EXTREMITIES

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Abstract: The successful conduct of operations in the RPS to a large extent depends on effective anesthetic management. The introduction of the achievements of RPS, namely the patch patch method, made it possible to take a qualitatively new step in the treatment of cicatricial contractures and the elimination of cosmetic defects after the removal of keloid scars. Unfortunately, existing generally accepted criteria for assessing the adequacy of anesthesia do not always inform in a timely manner about disorders of the microvasculature of the blood circulation, especially in the area of surgical intervention. The expansion of the possibilities of perioperative control of the peripheral blood flow of the operated area in the RPS can provide more in-depth information on the effectiveness of anesthesia during surgical interventions of this type. The article presents the results of studies of 81 patients with reconstructive plastic surgery on the lower extremities regarding the effects of burns and injuries of the 1-2 degree (ASA I-II class).

Keywords: Reconstructive plastic surgery, methods of anesthesia, potentiated anesthesia, oxygen pressure

Introduction

Achieving a positive result in reconstructive plastic surgery (RPS) is impossible without special measures to ensure the viability of revascularizedautotissue complexes. The basis of this approach is the prevention of peripheral vasospasm and maintaining the patency of microvascular anastomoses, which leads to the search for methods to effectively control the state of the microvasculature under conditions of general anesthesia (3,6,7,9,12,15). Therefore, in RPS, in addition to generally accepted methods for assessing the adequacy of pain relief, constant information on the state of microcirculation is necessary (11,19,21). There are a number of methods that allow controlling the state of microcirculation in the perioperative period: tetrapolarrheoplethysmography, continuous non-invasive transcutaneous monitoring of gases in tissues of PTCO2 and PTCCO2 (2, 5,16, 21).

All these modern monitoring methods, reflecting the state of tissue perfusion, are expensive and time-consuming. Their use in the conditions of an ordinary district and city hospital is not possible, therefore, the use of simple methods to control the adequacy of perfusion of the operative activity zone in RPSis quite relevant (1, 4, 10, 13, 17, 18). In this regard, the study of temperature changes in different parts of the body in the perioperative period and determination of the temperature of the central and peripheral gradient is more promising.

In RPS, an assessment of thermal homeostasis and its parameters may be useful for controlling the depth of anesthesia from the standpoint of maintaining an adequate state of the microvasculature.

The aim of the work was to evaluate the adequacy of anesthesia for various combinations of modern techniques and techniques in anesthetic management in reconstructive plastic surgery.

Material and methods. Studies in 81 patients aged 16-55 years (35 men and 46 women) with reconstructive plastic surgery on the lower extremities regarding the effects of burns and injuries of the 1-2 degree (ASA I-II class). 73.8% of patients were young (up to 30 years) of age without concomitant pathology. Combined plastic surgery (42 patients), plastic surgery with a displaced flap (19), cross plastic surgery (16), and expander implantation (4 patients) were performed. Duration of operations is from 0.5 to 2.5 hours.

All patients received intramuscular atropine, antihistamines and tranquilizers in common doses 20 min before surgery.

According to the applied anesthesiological aid, the patients were divided into 4 groups. In the 1st group 26 (32%) patients used subarachnoidal anesthesia (SA) (5% lidocaine 1-2 mg/kg).

In the 2nd group 22 (29%) patients underwent epidural anesthesia (EA) at LIII-LIV level (2% lidocaine 2 mg/kg/segment). All patients of the 1st and 2nd groups underwent volumetric crystalloid infusion (650+70 ml on the average) before and after the operation. If necessary, the patients received benzodiazepine drugs in common doses (5-7.5 mg of relanium) for sedation.

In the 3rd group 16 (19,7%) patients underwent the operation under total intravenous anesthesia (TIA) with benzodiazepines, calypsol, fentanyme, arduanmyoplegia in standard age doses. The Mechanical Ventilation Equipmentwas performed by the apparatus "Polinarkon" (Russia).

In the 4th group 17 (20,9%) patients used local infiltration anaesthesia (0,25 - 0,5% novocaine with adrenaline in dilution 1:500 to 400 ml) with its potentiation bolus benzodiazepines (relanium 5 - 10 mg) and ketamine (25 - 50 mg).

No complications associated with anesthesia have been noted. Adequacy of the anesthesia manual was controlled according to cumulative clinical features: systolic (AH_{syst}), diastolic (AH_{diast}), mean AH ($AD_{ov.}$), changes in heart rate (HR), pulse oximetry dynamics (S_PO_2) and thermometry.

The temperature in dynamics was measured with electric thermometer "TEMP - 60" (Russia) with fixation of central Tº1C (oral cavity, outer ear, rectum) and peripheral Tº2C (index finger of the healthy upper limb or nail phalanx of the first finger of the intact foot), as well as in the area of lesion (Tº3C). The temperature gradient was assessed as $_\Delta$Tº1C - between Tº1C and Tº2C, $_\Delta$Tº2C - between Tº1C and Tº3C, $_\Delta$Tº3C - between Tº2C and Tº3C.

All the above mentioned parameters were recorded before the surgery (stage I), in the surgical stage of anesthesia (stage II), during the main stage of surgery (stage III), after the end of surgery (stage IV).

Results and discussion. During the whole operation period in patients of all 4 groups the main indices of blood circulation and pulse oximetry did not undergo significant changes, remaining within the limits close to the preoperative level (Table 1).

Table 1

Hemodynamics and pulse oximetry indicators in patients at the main stages of the study (M±m).

Groups	Indicators	Stage			
		1st	2nd	3rd	4th
1st	Bloodpressu reaveragem mHg	87,3 ± 1,4	77,4 ± 1,4*	80,0 ± 1,3*	83,6 ± 1,3*,**,***
	Heartratebea ts / min	73,6 ± 1,3	69,4 ± 1,4 *	67,4 ± 1,2*	72,9 ± 0,8 $^{** ***}$
	SpO_2	97,9 ± 0,1	97,6 ± 0,1 *	96,9 ± 0,1*	97,2 ± 0,1 *,**
2nd	Bloodpressu reaveragem mHg	88,3 ± 1,9	77,3 ± 1,4 *	77,4 ± 1,4*	82,6 ± 1,6*,**,***
	Heartratebea ts / min	71,1 ± 1,0	70,5 ± 1,0	69,7 ± 1,1	76,4 ± 1,0 $^{*.\ ***\ +}$
	SpO_2	96,4 ± 0,1^{+}	96,2 ± 0,1$^{*,+}$	96,0 ± 0,1$^{*,+}$	96,6 ± 0,1$^{***\ +}$
3rd	Bloodpressu reaveragem mHg	84,4 ± 2,3	82,5 ± 1,9	82,0 ± 1,4	80,8 ± 1,8
	Heartratebea ts / min	73,3 ± 1,9	73,4 ± 1,7	71,3 ± 1,6^{+}	74,1 ± 1,5
	SpO_2	97,0 ± 0,1$^{+, ++}$	98,2 ± 0,2$^{*,+,++}$	98,0 ± 0,3$^{*,+,++}$	97,4 ± 0,2 $^{*,**,++}$
4th	Bloodpressu reaveragem mHg	84,1 ± 1,8	86,1 ± 2,3$^{+,++}$	86,7 ± 2,0 $^{+,++}$	82,7 ± 1,8
	Heartratebea ts / min	69,9 ± 1,6	92,7 ± 2,2$^{*,+,++,+++}$	96,1 ± 2,3$^{*+,++,+++}$	78,0 ± 1,6$^{*,**,***,+}$
	SpO_2	97,8 ± 0,1$^{++, +++}$	97,5 ± 0,1$^{*++,+++}$	96,7 ± 0,1$^{*,++,+++}$	97,2 ± 0,1$^{*,**,++}$

Note: * $p < 0.05$ compared with the 1st stage, ** $p < 0.05$ compared with the 2nd stage,
*** $p < 0.05$ compared with the 3rd stage, + $p < 0.05$ compared with the 1st group,
++ $p < 0.05$ compared with the 2nd group; +++ $p < 0.05$ compared with the 3rd group.

Only significant changes in HR in patients of the 4th group were found during the main stage of the operation and after its completion both in comparison with the initial data and in comparison with this index in other groups.

When using potentiated local anesthesia, HR increased by 32.2, 37.4% ($p < 0.05$) in the 2nd and 3rd stages compared to the initial data. These changes were due to the presence of traces of adrenaline in the solution of novocaine infiltrated in the tissue of the operated area. Nevertheless, focusing on the general clinical indicators of anesthesiological aid adequacy, no obvious signs of ineffective protection of the patient from the operational trauma were revealed in any of the follow-up groups.

Control of central T^{o}1C in the perioperative period in the investigated patients showed the same dynamics of this index changes in all groups. In patients during the main stage of the operation (3rd) a reliable decrease of the central temperature (T^{o}1C) in the 1st group by 2,7%, in the 2nd group by 1,6%, in the 3rd group by 0,6% and in the 4th group by 2,4% (p <

0,05) was observed in comparison with the descending levels (Table 2). By the end of the operation to 140 - 150 minutes this indicator has reliably increased, approaching the initial figures. Only in patients of the 3rd group, where TIAwas used, the central body temperature tended to decrease from stage to stage. At the end of the operation at the 4th stage, Tº1C in this group was 0.5 ºC lower than the initial one ($p < 0.05$). The dynamics of central temperature changes we found is consistent with the literature data indicating a tendency towards perioperative hypothermia as a phenomenon associated with a disturbance of heat production and heat transfer under the influence of intraoperative factors (8, 14).

Table 2

Indicators of changes in temperature and temperature gradients at the stages of the study (M±m)

Groups	Indicators	Stages			
		1st	2nd	3rd	4th
1st	T_1 °C	37,0 ± 0,1	36,6 ± 0,1 *	36,0 ± 0,1 * **	36,6 ± 0,1 * ***
	T_2 °C	29,5 ± 0,1 ▲	29,2 ± 0,1 * ▲	28,8 ± 0,1 * ** ▲	29,3 ± 0,1 *** ▲
	T_3 °C	28,6 ± 0,4 ▲ ▲▲	33,0 ± 0,4 * ▲ ▲▲	33,2 ± 0,4 * ▲ ▲▲	30,6 ± 0,6 * ** *** ▲ ▲▲
	$_{\Delta}T_1$ °C	7,5	7,4	7,2	7,3
	$_{\Delta}T_2$ °C	8,4	3,6	2,8	6,0
	$_{\Delta}T_3$ °C	0,9	-3,8	-4,4	-1,3
2nd	T_1 °C	37,2 ± 0,3	37,1 ± 0,5	36,6 ± 0,1 0	37,1 ± 0,1 *** 0
	T_2 °C	29,5 ± 0,2 ▲	29,1 ± 0,1 ▲	28,8 ± 0,1 * ** ▲	29,3 ± 0,1 *** ▲
	T_3 °C	28,7 ± 0,3 ▲	33,7 ± 0,2 * ▲ ▲▲	34,7 ± 0,17 * ** ▲ ▲▲ 0	30,2 ± 0,3 * ** *** ▲ ▲▲
	$_{\Delta}T_1$ °C	7,7	8,0	7,8	7,8
	$_{\Delta}T_2$ °C	8,5	3,4	1,9	6,9
	$_{\Delta}T_3$ °C	0,8	-4,6	-5,9	-0,9
3rd	T_1 °C	37,1 ± 0,1	36,8 ± 0,1 *	36,9 ± 0,1 0 00	36,6 ± 0,1 * *** 00
	T_2 °C	29,0 ± 0,3 ▲	28,6 ± 0,3 ▲	28,2 ± 0,3 ▲	28,9 ± 0,3 ▲
	T_3 °C	28,9 ± 0,4 ▲	28,2 ± 0,3 ▲ 0 00	27,7 ± 0,3 * ▲ 0 00	28,4 ± 0,4 ▲ 0 00
	$_{\Delta}T_1$ °C	8,1	8,2	8,7	7,7
	$_{\Delta}T_2$ °C	8,2	8,6	9,2	8,2
	$_{\Delta}T_3$ °C	0,1	0,4	0,5	0,5
4th	T_1 °C	37,2 ± 0,1	36,8 ± 0,1 *	36,3 ± 0,1 * ** 0 00 000	36,8 ± 0,1 * *** 00
	T_2 °C	29,2 ± 0,2 ▲	28,9 ± 0,3 ▲	28,8 ± 0,3 ▲	29,2 ± 0.2 ▲
	T_3 °C	29,1 ± 0,3 ▲	28,7 ± 0,3 ▲ 0 00	28,4 ± 0,3 ▲ 0 00	28,9 ± 0,3 ▲ 0 00
	$_{\Delta}T_1$ °C	8,0	7,9	7,5	7,6
	$_{\Delta}T_2$ °C	8,1	8,1	7,9	7,9
	$_{\Delta}T_3$ °C	0,1	0,2	0,4	0,3

Note:

* p <0.05 compared to stage I, ** p <0.05 compared to stage II,

*** p <0.05 compared with stage III,
▲ p <0.05 compared with T1 ° C,
▲▲ p <0.05 compared with T2 ° C,
^{0} p <0.05 compared with group 1,
^{00} p <0.05 compared to group 2,
^{000} p <0.05 compared to group 3
^{0000} p <0.05 compared with the 4th group

Peripheral temperature (Tº2C) in the intact regions was reliable below the central temperature and ranged from 28.2 to 29.8ºC. In all groups, this index was reliably reduced to stage 3, which coincided with the dynamics of central temperature change (Tº1C). The temperature gradient between Tº1C and Tº2C in patients in all four groups remained between 7.2 and 8.2. Since this gradient indirectly indicates the state of homeostasis of the organism, reflecting changes in perfusion of peripheral tissues under operational stress, there is reason to believe that its stability to some extent testified to the adequacy of all used options for pain relief. Absence of sharp deviations of $_{\Delta}$Tº1C from normal values of about 7.8ºC also confirms our assumption.

At the preoperative stage, the temperature parameters of the affected zone (Tº3C) did not significantly differ from the temperature in healthy parts of the body. The difference between them $_{\Delta}$Tº1C was from 0.1 to 0.9ºC. However, immediately after regional anesthesia both CA and EA Tº3C increased by 15.4% in Group 1 and by 17.4% in Group 2 ($p < 0.05$). This led to the decrease of $_{\Delta}$Tº2C in Group 1 from 8.4 to 3.6 and in Group 2 from 8.5 to 3.4 and changed $_{\Delta}$Tº3C from 0.9 and 0.8 to -3.8 and -4.6, respectively. This condition continued during the main stage of the operation (stage 3) and was due to the regional sympathetic blockade, which improves microcirculation in the blockade area.

Detailing the changes in peripheral temperature in different areas at the study stages with different anesthesiology options, it was found that in CA conditions the temperature in a healthy limb was lower by 20.3-19.9% compared to the central temperature. In the damaged limb before surgery, the temperature was 1ºC lower than in healthy tissue and 22.7% lower than the central temperature. By the beginning of the operation Tº3C and stage 3 of the study there was an increase of Tº3C by 4 - 5 C, so that $_{\Delta}$Tº3C decreased to 9.8 and 7.8% ($p < 0.05$) at stage 2 and 3, respectively. At the end of the operation the difference increased to 16.4%. The temperature difference in a healthy and operated limb has always been significant.

During EA, a similar dynamics of peripheral temperature changes in a healthy limb was observed: Tº2C was 20.7 below the central temperature, respectively, at the stages of the study. 21,6, 21,3, 21,0% (p< 0,05). The temperature in the operated zone under the influence of EA changed somewhat differently: if before the operation it was 22,8% lower than the central one (p < 0,05), then at the initial and main stages of the operation there was a temperature increase in the operation zone and it was much higher and differed from the central temperature only by 9,2 and 5,2% respectively. At the end of the operation, the difference due to the reduction of Tº2C was 18.8%. As in CA in EA, in the 1st stage of the study, the temperature of a healthy limb was only 2.7 higher than in the damaged tissue, while in the 2nd, 3rd, 4th stages, the difference increased to 15.8, 20.4, 3.1% due to temperature increase in the operation area respectively.

In TIA, the peripheral temperature of a healthy limb did not differ significantly from that of the central block and was also 21.8%, 22.3%, 23.6% and 21.0% lower than the central temperature respectively ($p<0.05$). On the other hand, the temperature of the operated zone practically did not differ from the temperature of healthy areas. The difference between the indicators was insignificant and the temperature of healthy limbs at all stages of the study exceeded the temperature of the affected zone by 0.3%, 1.4%, 1.8% ($p>0.05$). The absence of temperature rise in the operative zone with this type of anesthesia, high $_{\Delta}$Tº2C and low $_{\Delta}$Tº3C indirectly indicated the presence of peripheral spasm in this observation group, which should be avoided in RPS.

In patients of the 4th group, the change in the studied temperature parameters resembled that in TBA. The difference between the central temperature of the body and healthy tissues of the limb was 21.5%, 21.5%, 20.7% and 20.7% ($p < 0.05$), respectively, at the stages of the study, and there was practically no significant difference for the difference and for ΔTº3C of the affected area.

Also, there was a slight increase in temperature in healthy tissue sites compared with the operated area. The difference was insignificant and amounted to 0.3%, 0.7%, 1.4% and 1.0% at the research stages, respectively. Consequently, with a combination of local anesthesia with sedation during reconstructive-plastic interventions, the operative zone did not have advantages over healthy areas, where peripheral spasm also persisted.

A comparative analysis of studies of temperature changes with various options for anesthetic benefits showed the advantages of regional methods of anesthesia in RPS. A significant increase in the temperature of the operated area, reflecting an improvement in tissue perfusion, created favorable conditions for transplanted tissues.

The temperature changes we discovered in various areas had their clinical reflection in the results of reconstructive plastic interventions (Table 3).

Table 3

The frequency and nature of complications from the operated tissues, depending on the variant of the anesthetic aid

Groups	Numberofcomplications, %			
	Flapnecrosis	Woundsuppuration	Subcutaneoushematoma	Graftlysis
1st	3,3	1,9	5,7	1,0
2nd	1,9	-	3,3	-
3rd	6,9	2,3	4,6	5,7
4th	7,7	3,8	5,7	1,9

As can be seen from table 3, the smallest percentage of complications from the transplanted flap was observed in CA and EA, which is associated with the optimization of blood supply to the area of surgical procedures in the conditions of central segmental blockade

Conclusion

1. Measurement of peripheral temperature with fixation of the difference with central temperature is a fairly informative method for monitoring the adequacy of anesthesia, since it reflects the state of circulation in the microcirculation.
2. During reconstructive plastic surgery on the lower extremities, the temperature in the surgical area due to the effects of sympathetic blockade is higher with regional methods of analgesia compared with TIA and potentiated local anesthesia.
3. The use of regional anesthesia in reconstructive plastic surgery of the lower extremities helps to reduce the number of complications from the operated tissues.

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