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Our Approach to Anesthesia in Knee and Hip Arthroplasty

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Abstract- *Background:* Operations of total hip and knee arthroplasty are currently one of the most frequent surgical interventions performed for the purpose of functional rehabilitation of patients with osteoarthritis or patients who have received a fracture of the femoral neck. The best method for providing anesthesia and pain relief for total joint replacement has not been determined. Until now, a unified point of view on the choice of the optimal method of anesthesia and analgesia in surgical interventions for arthroplasty has not been formed.

Purpose of the study: To study the effectiveness of caudal anesthesia in hip and knee arthroplasty.

Material and research methods: The study was conducted in the surgical clinic of the AMU in 56 patients who underwent surgery for hip and knee arthroplasty. The age of the patients varied from 57 to 99 years.

Keywords: *total arthroplasty of large joints, general anesthesia, caudal anesthesia.*

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Our Approach to Anesthesia in Knee and Hip Arthroplasty

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Depending on the chosen anesthesia technique, the patients were divided into 2 groups: in the 1st group (n=28) endotracheal anesthesia was performed, induction of anesthesia with propofol and rocuronium bromide, anesthesia on the basis of sevoflurane 1.0 vol% with caudal administration of ropivacaine 2 mg/kg in combinations with dexamethasone 0.2 mg/kg; group 2 (n=28 patients) underwent multicomponent endotracheal anesthesia (propofol 3 mg/kg, rocuronium bromide 0.6 mg/kg, sevoluran 1.5–2.5 vol/% with high doses of fentanyl 5–6 μg /kg/hour.

Research results: During the traumatic moment of the operation, the average heart rate in group I (general anesthesia + caudal block) was significantly lower than in group II (general anesthesia) (69.4±2.0 versus 89.40±3.0, p=0.010), but there are significant differences in SBP or DBP between the two groups.

Conclusions: The inclusion of caudal blockade in the protocol of general anesthesia provides adequate pain relief, both intra- and postoperatively, in patients undergoing arthroplasty of large joints of the lower extremities.

Keywords: total arthroplasty of large joints, general anesthesia, caudal anesthesia.

I. Background

Operations of total hip and knee arthroplasty are currently one of the most frequent surgical interventions performed for the purpose of functional rehabilitation of patients with osteoarthritis or patients who have received a fracture of the femoral neck. Primary total knee and hip arthroplasty is one of the most common surgeries performed by orthopedic surgeons. And these operations should be accompanied by a minimum of side effects or not have them at all. In this situation, increased requirements are naturally imposed on the effectiveness and safety of their anesthetic management. Despite excellent surgical results, recovery after total joint replacement of large joints remains a serious problem for patients. Pain after orthopedic surgery is often considered particularly difficult to manage, with up to half of patients reporting severe pain immediately after total large joint replacement. This can be detrimental to postoperative recovery by delaying early mobilization and prolonging hospital stay. However, severe postoperative pain is also associated with significant complications, including myocardial ischemia, decreased lung function, increased risk of infection, and development of chronic pain. Postoperative pain can also affect the mental state of older patients, causing delirium or anxiety.

It should also be noted that the growing demand for arthroplasty of large joints, along with an increase in life expectancy, has a significant medical and economic impact on society. Effective planning of care for these people is vital. The best method for providing anesthesia and pain relief for total joint replacement has not been determined. However, new evidence suggests that the type of anesthesia may influence the morbidity and mortality of patients undergoing these procedures. Until now, a unified point of view on the choice of the optimal method of anesthesia and analgesia in surgical interventions for arthroplasty has not been formed.

II. Purpose of the Study

To study the effectiveness of caudal anesthesia in hip and knee arthroplasty.

III. Material and Research Methods

The study was conducted in the surgical clinic of the AMU in 56 patients who underwent surgery for hip and knee arthroplasty. The age of the patients varied from 57 to 99 years. All patients belonged to class II-III according to ASA. The duration of the operation ranged from 1.5 to 3.5 hours. Depending on the chosen anesthesia technique, the patients were divided into 2 groups: in the 1st group (n=28) endotracheal anesthesia was performed, induction of anesthesia with propofol and rocuronium bromide, anesthesia on the

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basis of sevoflurane 1.0 vol% with caudal administration of ropivacaine 2 mg/kg in combinations with dexamethasone 0.2 mg/kg; group 2 (n=28 patients) underwent multicomponent endotracheal anesthesia (propofol 3 mg/kg, rocuronium bromide 0.6 mg/kg, sevoluran 1.5–2.5 vol/% with high doses of fentanyl 5–6 μg /kg/hour. To determine the adequacy of the conducted anesthesia techniques, hemodynamic parameters, stress markers (cortisol and glucose) were studied at 5 stages of the study: stage 1 - initial data; Stage 2 - the peak of the action of the anesthetic; Stage 3 - the beginning of the operation; Stage 4 - at the most traumatic moment of the operation; 5- end of the operation. On the operating table, monitor equipment was connected to the patient for dynamic monitoring of the main functions of the patient, a vein was catheterized, and immediately before anesthesia, a preventive intravenous infusion was performed in a volume of 8–10 ml/kg of body weight.

a) Caudal block technique

In our clinical practice, the lateral position is usually used, without strong flexion in the knee joints. To find the hole, you need to find both sacral horns. Since they cannot always be clearly felt, it is necessary to project an equilateral triangle with a base between the spinae iliacae posterior superior, where the caudally directed apex lies in the region of the sacral foramen. Then you should feel the middle of the punctured membrane with your finger. After double disinfection (first with 10% betadine, then 96% alcohol), the skin is then punctured at an angle of 90°, followed by turning the needle 30-40° in the cranial direction by 3-4 mm when passing through the hiatus sacralis reaching the caudal space. In our daily practice, we use the "no turn technique" technique, which consists in puncturing the sacrococcygeal ligament at an angle of 60 degrees. After performing an aspiration test, if neither blood nor cerebrospinal fluid was aspirated, the local anesthetic ropivacaine was injected at the rate of 2 mg/kg for 60-90 seconds (injection too fast - risk of increased intracranial pressure, and slow injection - lateralization of the block). The onset of anesthesia depends on the drug administered and is observed in the range of 8 to 10 minutes. Heart rate, blood pressure (systolic, mean, diastolic), SaO2, gas exchange parameters, cortisol and glucose levels were monitored intraoperatively and in the postoperative period. In addition, pain syndrome was assessed after awakening.

IV. Discussion

Our study was motivated by a shift in practice towards total joint replacement and our lack of knowledge about the effect of anesthesia type on adverse postoperative outcomes in this patient population. Patients undergoing surgery under general anesthesia had more severe PACU pain despite receiving higher doses of intraoperative and postoperative opioids and more frequent use of non-opioid adjuvants. Higher opioid administration may have contributed to the higher incidence of moderate to severe postoperative nausea and vomiting in patients operated on under general anesthesia. Despite consistent use of antifibrinolytic agents, we were still able to demonstrate higher estimated blood loss and higher transfusion rates in patients under general anesthesia. Numerous studies with a large database (1, 2, 3, 4, 5) have compared types of anesthesia for total hip and knee arthroplasty. Memtsoudis and others. (6) examined 382,236 patients in a national database and compared perioperative outcomes between anesthesia methods in total hip and knee arthroplasty. They found that neuraxial anesthesia had a positive effect on reducing perioperative complications. General anesthesia, compared with neuraxial anesthesia, had a significantly increased chance of multiple serious postoperative complications and 30-day postoperative mortality. However, in contrast to their study and the results of other studies with large databases, (1, 2, 3, 4, 5) we found no difference in major complications between the types of anesthesia in our study. The benefits of neuraxial anesthesia are attributed to its physiological effects, such as decreased sympathetic stress response to surgery, reduced immunomodulation, and the elimination of mechanical ventilation associated with general anesthesia. However, these benefits of neuraxial anesthesia may be more pronounced in patients with more severe comorbidities (3).

The type of anesthesia can also influence the length of hospital stay and is an important factor in outpatient total joint surgery. Studies have shown that neuraxial anesthesia is associated with a shorter hospital stay compared to general anesthesia (4, 5, 6). For example, a recent study by Kelly et al. (7) A comparison of neuraxial and general anesthesia in 500 total hip replacement patients at their institution revealed a significant reduction in length of hospital stay in the neuraxial group (32.7 hours, SD 14.8 versus 38.1 hours, SD 24, p = 0.003).Slow recovery from residual leg weakness and urinary retention is known to increase the time required to meet discharge criteria.

The results of our study are also important for the perioperative care of patients undergoing total joint replacement and confirm the feasibility and benefits of using caudal block in this patient population. An analysis of numerous literature has shown that there are isolated data on the use of caudal anesthesia in arthroplasty of large joints.

V. Research Results

Patients in both groups were comparable in age, sex and weight. When comparing the duration of the operation, it was found that I the group (general anesthesia + caudal block) had a significantly shorter operation time (94 minutes vs. 84 minutes P = 0.040).The recovery time after extubation in the general anesthesia + caudal block group was significantly shorter than in the general anesthesia group (17.05±4.7 min vs. 10.79±4.2 min, P<0.01). Hemodynamic changes (HR, SBP and DBP) during operations between the two groups were similar before intubation and at the beginning of the operation (P>0.05). During the traumatic moment of the operation, the average heart rate in group I (general anesthesia + caudal block) was significantly lower than in group II (general anesthesia) (69.4±2.0 versus 89.40±3.0, p=0.010), but there are significant differences in SBP or DBP between the two groups. Thus, hemodynamic parameters during surgery in the group of general anesthesia + caudal block were more stable than in group II (general anesthesia). There was no significant difference in the incidence of side effects (including laryngospasm, restlessness, nausea and vomiting) between the two groups II (33%) versus I (24.2%,) (P>0.05). When assessing postoperative pain using the FLACC scale, it was found that in the group of general anesthesia + caudal block, pain appeared only 8 hours after surgery than in the group of general anesthesia (1 hour after surgery), but there were significant differences between the two groups after 12 and 24 hours after the operation was absent (P>0.05).

The use of vasopressors was not considered the best option for preventing possible arterial hypotension, because. most patients, especially in older age groups, have some initial degree of hypovolemia, which should be eliminated by infusion therapy before caudal anesthesia is started. The use of vasopressors, especially in elderly patients, is not always safe and, in our opinion, is justified if there are indications for them during surgery. We did not observe a negative effect from intravenous infusion of 8–10 ml/kg of body weight of plasma substitutes (a combination of colloids and crystalloids) immediately preceding the introduction of MA into the caudal space.

Hemodynamic parameters at the height of the effect of anesthetics indicate a decrease in BP mean both during general anesthesia and RA, regardless of the age of the patients (Tables 1 and 2). A decrease in BP mean in patients of group II (p > 0.05) occurred against the background of the action of general drugs (propofol, fentanyl, sevoflurane) and mechanical ventilation. At the same time, in patients under the age of 60, at the painful stages of the operation, an unreliable increase in blood pressure was noted, which may be associated with inadequate nociceptive and neurovegetative protection in patients of group II. In patients of this group, bradycardia was rarely noted, it was unexpressed, and an anticholinergic was administered during surgery in isolated cases.

Hemodynamic parameters at the height of the effect of anesthetics indicate a decrease in BP mean, both during general anesthesia and RA, regardless of the age of the patients.

Under the influence of CA in patients of group I, hemodynamic shifts occurred gradually, which retained the possibility of their timely correction, however, at the main stage, against the background of the above multifactorial influence, BP mean and CI significantly decreased compared to baseline values, especially in patients older than 60 years. Along with the tendency to arterial hypotension and bradycardia, coronary arteries were accompanied by a decrease in peripheral vascular resistance.

Probably, a decrease in TPVR and, consequently, a decrease in afterload, explains the fact that at the peak of MA action in patients of group I, SI changes insignificantly (p > 0.05).However, at the main stage, in patients over 60 years of age, who were sacrally injected with MA, there was a tendency to a decrease in CI. The explanation for this situation is that relatively large doses of LA, which are necessary for sufficient caudal anesthesia, exhibit not only sympatholytic, but also systemic effects by the time the main stage of the operation is performed. Conditions characteristic of the main stage: the peak of blood loss, Fowler's position, the use of cement - can aggravate hemodynamic disturbances.

General and caudal anesthesia at all stages of the study had an identical effect on the ECG. Shift of the ST segment was in 3% of the subjects - it occurred against the background of blood loss and arterial hypotension, it was short-term and had no negative consequences.

Table 1: Changes in hemodynamic parameters in patients of group I under the age of 60 years

Indicators	Operation stage				
	Initial parameters	Action peak	Operation start	Traumatic moment of the operation	End of operation
heart rate	78,2±1,6	78,1±1,6	67,1±1,3*	69,4±2,0*	77,1±2,5
BP_{mean}	96,2±1,8	84,1±2,4	86,1±2,2*	85,1±3,8*	89,2±3,8
CI	2,5±0,1	2,3±0,1	2,5±0,1	2,47±0,1	2,43±0,1
Total peripheral vascular resistance (TPVR)	1498±48	1435±58	1350±36*	1351±49*	1509±55

**significant differences compared to the initial stage (p<0.05).*

Table 2: Changes in hemodynamic parameters in patients of group II under the age of 60 years

Indicators	Operation stage				
	Initial parameters	Action peak	Operation start	Traumatic moment of the operation	End of operation
heart rate	82,6±2,7	78,1±1,6	67,1±1,3*	69,4±2,0*	77,1±2,5
BP_{mean}	93,2±3,6	84,2±3,4	96,1±2,2*	99,1±3,8*	95,2±3,8
CI	2,42±0,10	2,61±0,21	2,60±0,11	2,65±0,05	2,51±0,1
Total peripheral vascular resistance (TPVR)	1596±75	1349±108	1350±36*	1578±58*	1519±46

**significant differences compared to the initial stage (p<0.05).*

Thus, the analysis of special literature allows us to conclude that the question of choosing the optimal anesthetic tactics for total hip and knee arthroplasty remains debatable.

VI. Conclusions

The inclusion of caudal blockade in the protocol of general anesthesia provides adequate pain relief, both intra- and postoperatively, in patients undergoing arthroplasty of large joints of the lower extremities.

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