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## THE TECHNIQUE OF MONOLATERAL SPINAL ANESTHESIA WITH THE USE OF ELECTRONEUROSTIMULATION



Monolateral spinal anesthesia (MSA) is accompanied by less number of disorders of the central nervous system and respiratory complications due to sympathetic blockade on only one side. At the same time, the technique of performing anesthesia is not enough effective and safe.

**The purpose of the study.** To develop the technique of unilateral spinal anesthesia (MSA), which would be more efficient, safer and economical compared to already known USA technique.

**Material and methods.** The study involved 39 patients divided into 2 groups. In the 1st control group which included 22 patients, group II 17 patients, respectively. All the patients were involved in unilateral vascular and traumatologic operations. In the control group a standard needle for spinal anesthesia with sizes from 22 to 25 G was used. In the main group there were used special insulated needles for ENS - Stimuplex 21-22G, special device for ENS - Stimuplex-HNS-12 (B. Braun) and Pajunk (Germany).

**Results and discussion.** All patients in the main group received a motor response at the time of puncture of Dura mater and doctor determined the location of the needle tip according to the median line. The frequency of intraoperative complications was higher for patients of the 1st group compared to the second group. Thus, 6 (27,2%) patients of the control group experienced the hypotension below 80 mm of mercury after the onset of anesthesia, 2 (9%) - nausea and 4 (18,1%) - vomiting. In the main group, 4 (18,3%) patients experienced the hypotension below 80 mm of mercury, 1 (4,5%) - nausea.

**Conclusions.** In comparison with the known techniques, MSA with ENS allows to determine the location of the needle tip in the subarachnoid space according to the median line at the moment of puncture of the dura mater and more accurately introduce a local anesthetic. Thus, the application of the MSA technique with the ENS usage, increases the efficacy and safety of patients. An innovative patent of the NIIS of the Republic of Kazakhstan was obtained.

**Key words:** regional anaesthesia, spinal anesthesia, electroneurostimulation, unilateral, needle, injection, local anaesthetic, subarachnoid space, vascular surgery, hypotension, post dural puncture headache, intrathecal space, spinal cord, baricity, monolateral, unilateral.

Monolateral (unilateral) spinal anesthesia (MSA) was firstly described by Tanasichuk M.A., Schultz E.A., Matthews J.H. et al. [1]. According to the literature, there are several methods of monolateral spinal anesthesia (MSA) such as suggested by the authors: Koryachkin V.A., V.I. Strashnov, A.A. Khryapa, D.A. Shelukhin, T.I. Dumpis «Odnostoronnyaya spinalna anestheziya» [2], as such as suggested by the authors: "Spinalna anestheziya u travmatologichnih hvorih visokogo riziku: perevagi unilateralnoi tehnyaki z vikororistaniyam gipobarichnih rozchiniv." Y.P. Kuchin, Glumcher F.S. et al. // BII, zneboluyvaniya I intensivna terapiya [3].

The technique of anesthesia involves the puncture of the subarachnoid space of the patients lying on the side prior to surgery, and then a local anesthetic hyperbaric solution was slowly injected into the subarachnoid space. This led to the fact that the local anesthetic fell down in the cerebrospinal fluid under the action of gravity and was located only on one side of the subarachnoid space along the spinal cord, which blocked the pain and motor sensitivity only on one side.

Another MSA technique is based on the application of bupivacaine hypobaric solution, in which the puncture is made to the patient laying on the side opposite the intended operation.

After the local anesthetic injection the latter, due to its hypobaric properties, blocked pain and motor sensitivity of operated side. The authors noted that unilateral spinal anesthesia was accompanied by less disruption of central hemodynamics and respiration due to sympathetic blockade only on one side.

The disadvantages and dangers of MSA techniques can be the fact that they are made with usual needles for spinal anesthesia, which do not allow to determine the location of the needle tip in the subarachnoid space toward the midline, i.e. practically "blindly". During the process of puncture, a needle may deviate from the midline, there are no objective criteria for the location of the needle tip within the subarachnoid space, which is especially important in MSA, in which local anesthetic should be distributed along the spine on one side only and cause adequate block of pain and physical sensitivity. This MSA technique is associated with greater risk of neurological complications, due to the fact that the unknown depth of insertion and the direction of needle in the subarachnoid space. Then there is a high probability of damage to the neural structures, blood vessels of both subarachnoid and front/rear epidural space. There is a high probability of receiving inadequate unilateral spinal and mosaic anesthesia as a result of random insertion of

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the needle and local anesthetic on the opposite side. This MSA technique requires wide experience and high qualification of anesthesiologist. On the other hand, the MSA technique with the use of hypobaric local anesthetic solution requires to produce a local anesthetic dilution with bidistilled water for injection to reduce the baricity of original local anesthetic. The large dilution of the local anesthetic leads to a reduction of its working concentration, which reduces the quality of the blockade and its effectiveness. As a result, and it was noted by the authors of the method, the frequency of inadequate blockade was higher in comparison with the MSA with the use of a hyperbaric solution of local anesthetic.

However, in the last decade there is implementation of special insulated needles for electroneurostimulation (next ENS). The use of needles for ENS facilitates and speeds up the search of the nerve plexus and major nerves. This allows providing blockades with the least amount of complications – Pashchuk A.Y. [4], Rathmell James P. Neal Joseph M., Viscomi Christopher M. [5]. The use of ENS during MSA formed the basis for the development of our new technique of unilateral spinal anesthesia [6, 7].

The purpose of the study - to develop the technique of unilateral spinal anesthesia (MSA), which would be more efficient, safer and economical compared to already known USA technique.

#### MATERIAL AND METHODS

The study was carried out with the permission of the Ethical Committee of Semey State Medical University. The study involved 39 patients divided into 2 groups. In the 1st control group which included 22 patients at the age of 28 to 57. There were 18 men, 4 women. In the 2d group there were 17 patients at the age of 31 to 58. There were 15 men, 2 women. The profile of the surgery patients comprised vascular surgery and trauma who underwent operative treatment for femoral-popliteal bypass grafting, thrombectomy, varicose veins of the lower extremities, and the removal of osteosynthesis. In the control group a standard needle for spinal anesthesia with sizes from 22 to 25 G was used. In the main group there were used special insulated needles for ENS - Stimuplex 21-22G, special device for ENS - Stimuplex-HNS-12 (B. Braun) and Pajunk (Germany). All patients had the puncture of the subarachnoid space in a sideways position, on the side of the surgery.

##### The MSA technique with electroneurostimulation.

The patient was placed in position on the side of the surgery. Intravenous line was secured in forearm with 16-18G intravenous cannula and monitoring of non-invasive blood pressure, SpO<sub>2</sub> were established. For 15-20 minutes, all the patients were hydrated with 6-10 ml/kg of crystalloid solutions such as 0.9% sodium chloride solution, ringer solution before the spinal block. With strict aseptic precautions, puncture of subarachnoid space was made at level LII-LIII or LIII-LIV by needle Stimuplex 21-22G, connected to the ENS device, with the loss of resistance test made with 2 ml syringe. After puncturing the Dura mater, if the patient showed a motor response and felt irritation with electric current on the side of the upcoming surgery, we injected a full dose of a local anesthetic hyperbaric solution in amount of 7.5-10 mg of 0.5% bupivacaine slowly without barbotage or aspiration for 100-120 seconds. Slow

speed of injection minimizes mixing of local anaesthetic with cerebro-spinal fluid and thus facilitates unilateral block. After injection, patients were maintained in the lateral position for 18-20 minutes for fixation of a local anesthetic on the nervous structures, before turning supine.

At the moment of puncturing dura mater, depending on the degree of deviation of the needle and its location towards the median line, we received a clear motor response and subjective sensation of electrical stimulation that allow the anesthesiologist to determine the location of the needle tip towards the midline and depending on its location, then we turned the bevel in the required direction and injected a local anesthetic. On the other hand, if there was not the above feeling of irritation with electric current and motor response on the intended side, it meant that the needle tip was placed wrong.

For example, if the location of the needle tip was in the midline or above it, we turned bevel into the side of the operated limb and injected local anesthetic. In cases when the needle tip was located on the side of the planned operation, depending on the level of the puncture, the severity of lordosis of the spine, and body and position of the patient on the operating table, we turned bevel either cranially or caudally and injected the full dose of local anesthetic.

In the control group, MSA was injected by usual needles for spinal anesthesia.

#### RESULTS AND DISCUSSION

Hemodynamic parameters of the patients in a control group after the onset of anesthesia were unidirectional and accompanied with a decrease of arterial pressure by 12.3%, for patients of the main group - by 10.5%.

The frequency of intraoperative complications was higher for patients of the 1st group compared to the second group. Thus, 6 (27,2%) patients of the control group experienced the hypotension below 80 mm of mercury after the onset of anesthesia, 2 (9%) - nausea and 4 (18,1%) - vomiting. In the main group, 4 (18,3%) patients experienced the hypotension below 80 mm of mercury, 1 (4,5%) - nausea.

It should be noted that hypotonia for the 1st group patients occurred much faster and required a lot of efforts for its correction, in comparison with II group patients.

3(13,6%) group I patients and 2(11,7%) group II patients had post dural puncture headache. There were not complications developed by our MSA technique.

Thus, we were first to do MSA, using special insulated needles for ENS, in particular Stimuplex – 21-22G with of 100 mm, which allow to determine the moment of puncturing dura mater and the location of the tip in the subarachnoid space of the spinal cord towards midline, according to the received motor response and sensation of the irritation of lower extremities with an electric current. The possibility to determine the localization of the needle tip in the subarachnoid space toward the midline, which is determined by the electric current stimulation and motor response, allow to predict success of the ongoing MSA and 100% guarantee the injection of local anesthetic into the subarachnoid space and to have high-quality unilateral spinal anesthesia. This technique provided the possibility to correct the direction of injection of the local anesthetic, turning the bevel in the desired direction, according to the location of the needle tip

in the subarachnoid space. MSA with ENS increased the quality and efficiency of the unilateral spinal anesthesia and helped to reduce the number of complications.

This technique allowed to reduce the amount of local anesthetic injected into the subarachnoid space of the spinal cord by 2 times, due to a more precise identification of the place of its injection, compared to the conventional MSA techniques. This technique opens broad prospects for the MSA application for surgical patients who have been shown surgery on one side. This was particularly important for immunocompromised patients whose routine spinal anesthesia may be accompanied by severe disturbances of hemodynamics and respiration. In the case of any neurological complications (paresis, palsy, etc.), you can clearly see the relationship between produced puncture of the subarachnoid space, the location of the needle tip inside of it during the anesthesia and the resulting neurological deficits.

The MSA with ENS technique, developed by us, formed the basis for the development of a new method of spinal anesthesia. As a result of the studies, we obtained an innovative patent for the invention of NIIP of the Republic of Kazakhstan.

#### Research transparency

Research did not have a sponsorship. The author are absolutely responsible for presenting the release script for publication.

#### Declaration about financial and other relations

The release script was approved by author. The author did not get the honorary for the article.

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#### ТҰЖЫРЫМ

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Семей қаласының мемлекеттік медицина университетінің Павлодар қаласындағы филиалы, Қазақстан Республикасы  
**МОНОЛАТЕРАЛДЫ ЖҰЛЫН АНЕСТЕЗИЯ ЭЛЕКТРОНЕЙРОСТИМУЛЯЦИЯСЫН ПАЙДАЛАНУ МЕН ТЕХНИКАСЫ**

**Зерттеудің мақсаты.** Белгілі МЖА техникалармен салыстырғанда, неғұрлым тиімді, қауіпсіз және үнемді монологатеральды жұлын анестезия (МЖА) техникасын әзірлеу.

**Материал және әдістері.** Зерттеу 2 топқа бөлінген 39 науқаста өткізілді. I бақылау тобын 22 науқас, II тобын 17 науқас құрды. Барлық науқастарда біржақты тамыр және травматологиялық операциялар өткізілді. Бақылау тобында стандартты омыртқа анестезия инелері қолданылды. Негізгі топта арнайы оқшауланған ЭНС үшін Stimuplex инелер, ЭНС үшін аппараттар Stimuplex-HNS-12 (B. Braun) және Pajunk (Германия) қолданылды.

**Нәтижесі және талқылауы.** Негізгі топтың барлық науқастарынан қатты жұлын ми қабығын тескен кезде қимыл-қозғалыс алынды және де ине ұшының субарахноидальды кеңістігінде ортаңғы сызыққа қатысты орналасуы анықталды. Интра- және операциядан кейінгі асқынулардың саны, бақылау тобымен салыстырғанда төменірек болды. Гипотония АҚорт. 80 мм. сын. бағ. 6 (27,2%) науқас, жүрек айнуы 2 (9%) және құсу 4 (18,1%) науқастарда тіркелген. Пункциядан кейінгі бас ауруы I топта 3 (13,6%) науқаста, II топ 2 (11,7%) науқаста тіркелді.

**Қорытынды.** Белгілі техникалармен салыстырғанда, МЖА ЭНС пайдалану ине ұшының субарахноидальды кеңістігінде ортаңғы сызыққа қатысты орналасуын, қатты жұлын ми қабығын тескен кезді анықтауға мүмкіндік береді. Осылайша, МОА ЭНС қолдану мен техникасы науқастардың тиімділігі мен қауіпсіздігін арттырады. Қазақстан Республикасы Ұлттық зияткерлік меншік институтының инновациялық патенті алынды.

**Негізгі сөздер:** монологатеральды жұлын анестезия, электронейростимулятор, субарахноидальды кеңістігі, жұлын ми қабығы, Stimuplex, Pajunk.

#### РЕЗЮМЕ

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#### ТЕХНИКА МОНОЛАТЕРАЛЬНОЙ СПИНАЛЬНОЙ АНЕСТЕЗИИ С ИСПОЛЬЗОВАНИЕМ ЭЛЕКТРОНЕЙРОСТИМУЛЯЦИИ

Монологатеральная спинальная анестезия (МСА) сопровождается меньшими нарушениями центральной гемодинамики и дыхания за счет симпатической блокады только с одной стороны. Вместе с тем, техника выполнения анестезии недостаточно эффективна и безопасна.

**Цель исследования.** Разработать более эффективную, безопасную и экономичную технику монологатеральной спинальной анестезии (МСА), по сравнению с уже известными техниками.

**Материал и методы.** Исследование проведено у 39 больных, разделенных на 2 группы. I контрольную группу, составили 22 больных, II группу 17 больных соответственно при односторонних сосудистых и травматологических операциях. В контрольной группе применяли стандартные иглы для спинальной анестезии. В основной группе применяли специальные изолированные иглы для ЭНС Stimuplex, аппараты для ЭНС Stimuplex-HNS-12 (B. Braun) и Pajunk (Германия).

**Результаты и обсуждение.** У всех больных основной группы был получен двигательный ответ в момент прокола ТМО и определялось расположение кончика иглы по отношению к срединной линии, а частота интра- и послеоперационных осложнений была ниже. Частота интраоперационных осложнений основной группы ниже, в сравнении с контрольной. Так, гипотония ниже АДср. 80 мм рт. ст. была зафиксирована у 6 (27,2%) больных, тошнота у 2 (9%) и рвота у 4 (18,1%) больных. Постпункционная головная боль была отмечена у пациентов I группы у 3 (13,6%), у пациентов II группы у 2 (11,7%) больных.

**Выводы.** В сравнении с известными техниками, МСА с ЭНС позволяет определить расположение кончика иглы в субарахноидальном пространстве по отношению к срединной

линии в момент прокола твердой мозговой оболочки и более точно ввести локальный анестетик. Данная техника МСА также имеет объективные критерии попадания кончика иглы в субарахноидальное пространство. Таким образом, применение техники МСА с ЭНС повышает эффективность и безопасность больных.

Получен инновационный патент НИИС Республики Казахстан.

**Ключевые слова:** монолатеральная спинальная анестезия, электронейростимулятор, субарахноидальное пространство, твердая мозговая оболочка, локальный анестетик, Stimuplex, Pajunk.

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## ВЫПОЛНЕНИЕ ОТКРЫТОГО ОСТЕОСИНТЕЗА КЛЮЧИЦЫ ПРИ УЛЬТРАЗВУК-АССИСТИРОВАННОЙ КОМБИНИРОВАННОЙ РЕГИОНАРНОЙ АНЕСТЕЗИИ

**Б**лагодаря современным технологиям в регионарной анестезии улучшается реализация ее преимуществ над общей анестезией, таких как улучшение послеоперационного обезболивания, экономическая эффективность, снижение послеоперационных осложнений и ускорение послеоперационного выздоровления. Одной из таких технологий является ультразвуковая визуализация, позволяющая проводить точный контроль положения иглы и распределение местного анестетика по отношению к нервам в реальном времени. Выполнение блокады плечевого сплетения по наружным анатомическим ориентирам сопровождается достаточно высоким риском осложнений и большим количеством неудачных блоков, что является основанием для редкого использования регионарной анестезии при операциях на ключице и поводом для внедрения ультразвуковой визуализации при выполнении регионарной анестезии.

Однако технические аспекты выполнения регионарной анестезии под ультразвуковой навигацией при остеосинтезе ключицы до настоящего времени изучены недостаточно. В отечественной литературе имеется небольшое количество работ, посвященных данной теме. В связи с вышеизложенным, представляется актуальным и перспективным проведение регионарной анестезии под ультразвуковым контролем при открытом остеосинтезе ключицы.

Цель исследования - оценить результаты выполнения комбинированной регионарной анестезии под ультразвуковым контролем при открытом остеосинтезе ключицы.

### МАТЕРИАЛ И МЕТОДЫ

В операционно-анестезиологическом отделении РНЦЭМП было проведено исследование, включающее 40 пациентов (анестезиологический риск ASA I-III класса), которым выполнялся открытый остеосинтез ключицы под регионарной анестезией с ультразвуковым контролем. Проводилась комбинированная блокада плечевого сплетения межлестничным доступом с блокадой поверхностного шейного сплетения. Ультразвуковая навигация осуществлялась аппаратом SAMSUNG MEDISON SonoAce R3 мультисекторным линейным датчиком 5-12 МГц. Во всех случаях регионарные анестезии выполнялись 2% лидокаином в общем количестве 20 мл для двух блокад с добавлением адреналина в концентрации 1:200000. С целью седации во время операции всем пациентам назначался пропофол от 2 до 4 мг/кг/ч, при этом пациент оставался контактным с врачом. Адекватность анестезиологического обеспечения оценивалась по мониторингу гемодинамических показателей (среднее АД, пульс) на этапе разреза кожи и остеосинтеза. Успешность блока отмечалась до разреза путем укола иглы в зону операции. При сохранении болевой чувствительности перед разрезом (неудачный или частичный блок) проводилась общая анестезия. Также регистрировалось время начала сенсорной анестезии. У всех пациентов было получено согласие на выполнение регионарной анестезии.

### РЕЗУЛЬТАТЫ И ОБСУЖДЕНИЕ

У 38 (95%) пациентов блокада была успешной. Одному

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