PŮVODNÍ PRÁCE

Superficial and interfascial cervical block – MRI study

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Abstract

Objective: **The aim of the study was to clarify the distribution of injected solution during superficial and medial cervical plexus block.**
Design: **Prospective MRI study on volunteers.**
Setting: **Tertiary Hospital, Depts. of Radiology and Anaesthesiology.**
Materials and methods: **Total 12 volunteers were randomly assigned to receive either a simulation of a superficial cervical plexus block or a simulation of a medial cervical plexus block. The distribution of the solution was verified by MRI.**
Results: **Superficial cervical block: In four volunteers the solution was distributed in the interfascial space but did not reach the front part of the space. In two cases the solution did not reach the investing fascia. Medial block: The administered solution was found in the whole interfascial space in all volunteers.**
Conclusion: **We speculate that the solution leak into the interfascial space during superficial cervical plexus block can explain its effectiveness for carotid endarterectomy. The medial block ensures constant filling of the interfacial space.**
Keywords: **anaesthesia – local anaesthesia – nerve block – cervical plexus – MRI**

Souhrn

Povrchový a mediální cervikální blok – MRI studie

Cíl studie: **Objasnit distribuci tekutin při aplikaci povrchového a mediálního cervikálního bloku.**
Typ studie: **Prospektivní MRI studie na dobrovolnících.**
Typ pracoviště: **Rentgenové a anesteziologické pracoviště krajské nemocnice.**
Materiál a metoda: **Dobrovolníci v počtu 12 byli rozděleni do dvou skupin. Na jedné skupině dobrovolníků byl simulován povrchní cervikální blok, na druhé skupině mediální blok. Rozšíření aplikovaného fyziologického roztoku bylo zobrazeno pomocí MRI.**
Výsledky: **Povrchový krční blok – interfasciální prostor jako cílové místo mediálního bloku se vyplnil částečně u 4 osob se simulací povrchového bloku. U dvou dobrovolníků první skupiny nedošlo k proniknutí tekutiny přes vmezeřenou fascii. U skupiny se simulací mediálního bloku došlo vždy k náplni interfasciálního prostoru.**
Závěr: **Únik tekutiny do interfasciálního prostoru při povrchním bloku může vysvětlit účinnost povrchní blokády pro karotickou endarterectomii. Mediální blok zajišťuje konstantní náplň interfasciálního prostoru.**
Klíčová slova: **anesteziologie – lokální anestezie – nervové bloky – cervikální plexus – MRI**

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Introduction

In order to achieve a satisfactory block, a sufficient quantity of a local anaesthetic solution needs to be injected in the right place surrounding the nerves. Local anaesthetic solution spread after its administration is dependent on two significant factors: the compliancy of the surrounding tissues and the permeability of the surrounding fascias [1]. In addition, the spread of a liquid in tissues relies on the position of the tip of the needle during injection, the total volume of the local anaesthetic solution and the pressure applied during the injection.

A routine anaesthetic technique in carotid surgery comprises a combination of the superficial and deep cervical plexus (DCP) blocks with minimum sedation to enable simple and reliable neurological monitoring. In contrast to superficial cervical plexus block, DCP is potentially associated with serious complications [2]. Some recent studies propose using the superficial block alone in carotid surgery with satisfactory results [3].

Methods

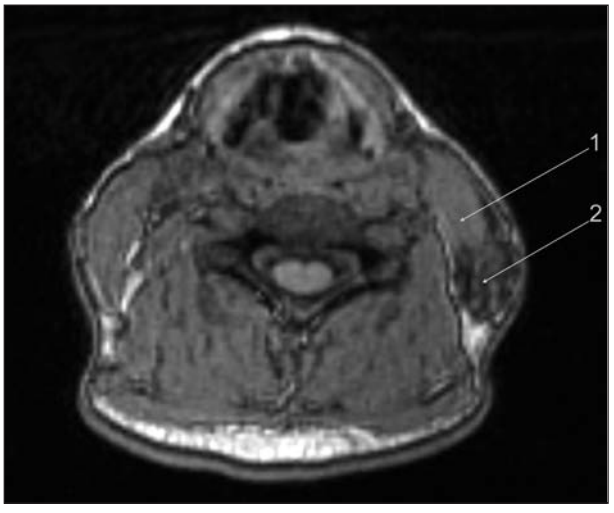
The aim of the study was to clarify the distribution of the injected solution during cervical plexus block. After ethics committee approval and obtaining a written informed consent, 12 volunteers were randomly assigned to receive either a single injection superficial cervical plexus block – Murphy [4] (group A), or a single injection interfascial cervical plexus block at C3 level – Nalos [5] (group B). The puncture site for this block is in the middle of the posterior border of sternocleidomastoid muscle and the needle is inserted approximately 5 mm bellow the muscle. This technique has been described as the medial cervical block [6, 7]. In both groups we used 20ml of normal saline solution. C1-T1 MRI was done 20 minutes after the injection. Transverse, coronal and oblique (in the course of the plexus) MRI images were taken and 3D reconstructions of this region performed. The distribution of the solution in the interfascial space at C3 level was assessed and described in all the scans. We specifically examined mode Turbo inversion recovery T1W scans at this level for a standard comparison.

Distribution of solution in the interfascial space at C3 was described as

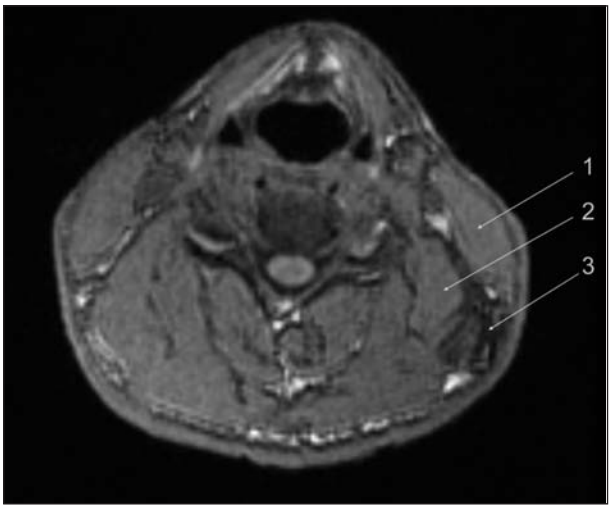
1. Solution not found in the interfascial space and was distributed along the posterior part of the sternocleidomastoid muscle (pic. 1).
2. Solution found partially in the interfascial space but not reaching the medial scalene muscle (pic. 2).
3. Solution found in the interfascial space and reaching the medial scalene muscle (pic. 4).

Results

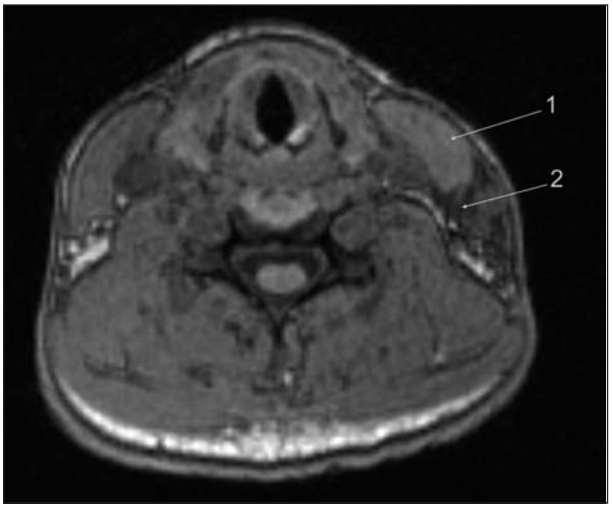
Group A: The normal saline solution did not reach



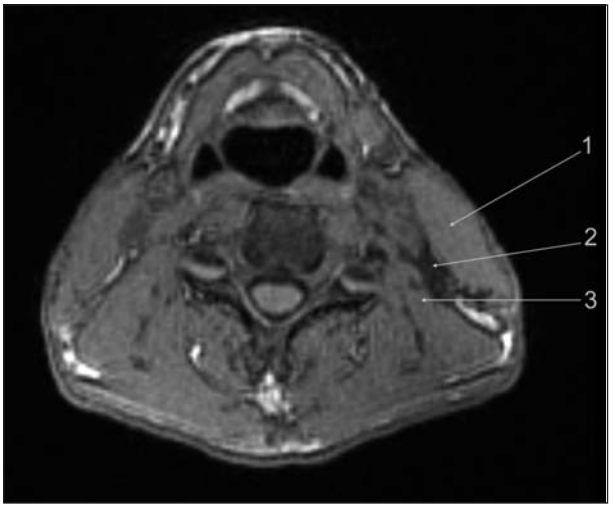
Pic. 1. 1. M. sternocleidomastoideus, 2. Injected solution



Pic. 2. 1. M. sternocleidomastoideus, 2. M. levator scapulae, 3. Injected solution



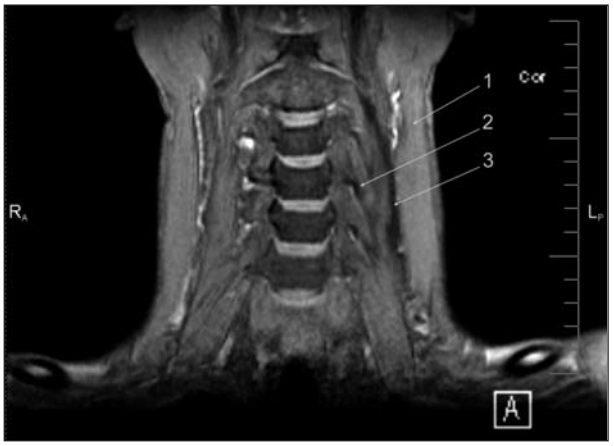
Pic. 3. 1. M. sternocleidomastoideus, 2. Injected solution



Pic. 4. 1. M. sternocleidomastoideus, 2. Injected solution, 3. M. levator scapulae

the interfascial space in two volunteers (see pic. 1). In four volunteers the solution was distributed in the interfascial space, but did not reach the front part of the space (see pic. 2, 3).

Group B: The normal saline solution was found distributed in the whole interfascial space in all volunteers (see pic. 4). The solution reached the attachment of the medial scalene muscle to the cervical vertebra which is the space where deep cervical nerve block proper is placed. (pic. 5).



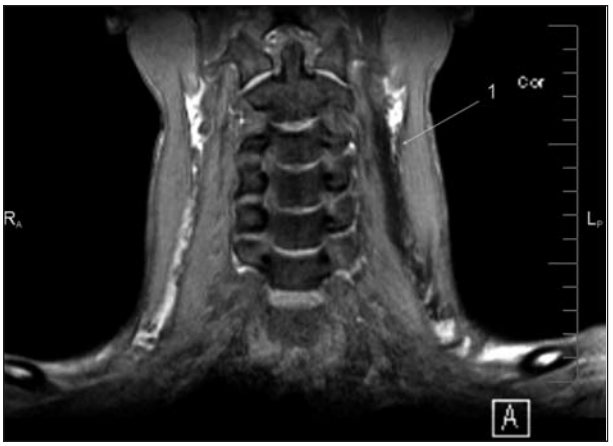
Pic. 5. 1. M. sternocledomatoideus, 2. Perivertebral space, 3. Interfascial space

Discussion

In all the volunteers in group B we found presence of the solution close to the spinal nerves C2-C4. The solution filled the perivertebral space in all these cases. This type of distribution was not found in any volunteer in group A.

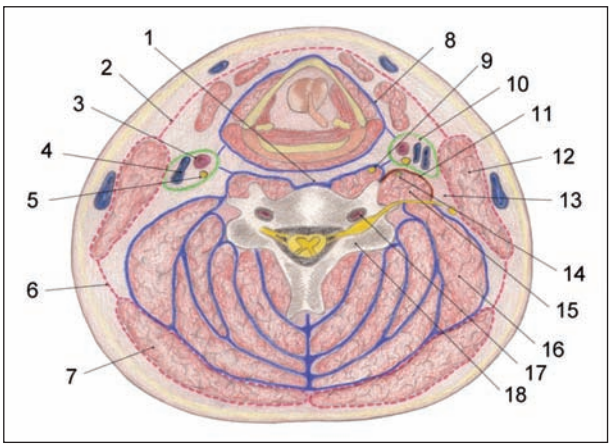
Deep cervical plexus block is associated with a significant risk of serious complications including epidural, intrathecal and intra-arterial injection. There are several studies describing the distribution of a local anaesthetic solution during peripheral nerve blocks in the neck [7, 8, 9]. Some of them confirm the results of A P Winnie [10] showing the same efficacy of the single needle technique and the three-needle technique in deep cervical block. Taking into account the common volume of the local anaesthetic (15–40 ml) and the volume of the perivertebral space (about 3 ml), most of the solution is distributed peripherally. Some studies suggested a distribution of the local anaesthetic in the interfascial space [7, 8, 9]. In all the volunteers in our group B we found presence of the solution in the interfascial space from C2 to C7 (pic. 6). The single injection technique of deep cervical block is probably effective on the grounds of local anaesthetic spread along the cervical plexus towards the interfascial space. The solution can be relatively freely distributed in the cranio-caudal direction in this space (pic. 6, 7).

Understanding the cervical fascia anatomy is essential for all blocks covering the cervical and brachial plexus (pic. 8).



Pic. 6. 1. Interfascial space

Pic. 7. 1. Interfascial space, 2. M. sternocleidomastoideus



Pic. 8. 1. Fascia colli profunda, 2. Fascia colli superficialis, 3. A. carotis, 4. V. jugularis interna, 5. Nervus vagus, 6. Investing fascia, 7. M. trapezius, 8. Fascie visceralis, 9. Sympatetic ganglion, 10. Fascie alaris, 11. Fascia scalenica, 12. M. sternocleidomastoideus, 13. Interfascial space, 14. N. phrenicus, 15. MM. scalenii, 16. M. levator scapulae, 17. A. vertebralis, 18. Vertebra

Medial (external) cervical fascia extends in various thicknesses all around the neck. It contains the sternocleidomastoid muscle and trapezius muscles. It covers both muscles with its superficial and deep part. Superficial cervical nerves penetrate this fascia just behind the sternocleidomastoid muscle.

Deep anterior (visceral) cervical fascia covers deep muscles of the neck surrounding the larynx and oesophagus.

Deep posterior cervical fascia has its anterior and posterior parts divided by the scalene fascia. The anterior part covers muscles attached to the anterior parts of the cervical vertebrae. This fascia contains the cervical sympathetic nerve trunk. There is a narrow space between the deep anterior cervical fascia and the anterior part of the deep posterior cervical fascia. It runs down to the medial part of the mediastinum.

Scalene fascia. The scalene muscles are in their origin intercostal muscles. They gradually leave the transverse processes of the cervical vertebrae. The fascia covering the scalene muscles plays its role in distribution of the local anaesthetic solution during supraclavicular brachial plexus blocks. This fascia covers the scalene muscles, the brachial plexus and the phrenic nerve. It is cone-shaped with its apex at the transverse process of C2. This impermeable fascia prevents the leak of a local anaesthetic solution to the different cervical nerves during interscalene brachial plexus block. Ideally the only nerves covered by this type of blocks are the phrenic nerve and the brachial plexus nerves.

The posterior part of the deep posterior cervical fascia is tied together with a posterior part of the scalene fascia and covers the levator scapulae muscle, the rectus capitis muscle and the posteromedial group of muscles. The cervical plexus, in contrast to the brachial plexus, is located outside the scalene and deep posterior cervical fascia. The cervical nerves run dorsolaterally and reach the space between the medial cervical fascia and the dorsal part of the deep cervical fascia covering the levator scapulae muscle. This space is the source of the cervical plexus.

Alar fascia is thin and partially permeable for local anaesthetic solutions. It covers the carotid artery, the deep jugular vein and the vagus nerve. This fascia is tied together with surrounding fascias by tiny fascial bridges.

Zhang [11] in his anatomy study denied the impermeability and integrity of the medial cervical fascia between the sternocleidomastoid and trapezoid muscles.

Contrary to this study we suggested a significant impact of the cervical fascias on the distribution of local anesthetic solutions along the nerve structures [1]. We showed the scalene fascia covering rudimental intercostal muscles was tied together with the thoracic fascias and in particular it was separated from the deep cervical fascia. It conforms to the easy cranio-caudal distribution of a solution in contrast to the limited horizontal distribution.

Spinal nerves C2-4 leave the paravertebral space and make the cervical plexus in the interfascial space. This space is made by the medial cervical fascia laterally, the fascia of the levator scapulae muscle dorsomedialy, the fascia of the medial scalene muscle ventromedialy and the alar fascia anteriorly.

In some studies superficial cervical block without deep cervical block or deep sedation was successful enough for carotid surgery.

Pandit [12] in his study impeached the integrity of the medial cervical fascia.

Counter to this study we suggested a significant impact of the cervical fascias on the distribution of local anaesthetic solutions along the nerve structures [1]. In four volunteers of group A the medial cervical fascia was probably accidentally penetrated by the needle and the solution was seen in the interfascial space.

Based on our findings the interfascial space seems to be the ideal space for the distribution of local anaesthetics to the cervical plexus. This approach is probably able to minimize the risks of serious complications of the deep cervical plexus block.

Conclusion

In some patients superficial cervical block is associated with the leak of the local anaesthetic underneath the medial cervical fascia and its distribution in the interfascial space. An intended injection of the local anaesthetic below the medial cervical fascia just below the sternocleidomastoid muscle is able to fill the interfascial space and provide a successful block of the cervical plexus without the necessity of the deep cervical block. Localization of the right space is more important than the distance of the tip of the needle from the nerve. A leak of the local anaesthetic beneath the medial cervical fascia explains the effectiveness of the superficial block in some patients undergoing carotid surgery.

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