



# Superficial branch of the radial nerve passing through the supinator canal, emerging between the extensor digitorum and abductor pollicis longus muscles and consequently supplying the second finger and radial portion of the third finger: a case report and clinical implications

Anhelina Khadanovich<sup>1,2</sup> · Michal Benes<sup>1,2</sup> · Radek Kaiser<sup>2,3</sup> · David Kachlik<sup>1,2,4</sup>

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## Abstract

Awareness of unique path of the superficial branch of the radial nerve and its unusual sensory distribution can help avoid potential diagnostic confusion. We present a unique case encountered during a routine dissection of a Central European male cadaver. An unusual course of the superficial branch of the radial nerve was found in the right forearm, where the superficial branch of the radial nerve originated from the radial nerve distally, within the supinator canal, emerged between the extensor digitorum and abductor pollicis longus muscles and supplied the second and a radial half of the third digit, featuring communications with the lateral antebrachial cutaneous nerve and the dorsal branch of the ulnar nerve. Due to dorsal emerging of the superficial branch of the radial nerve the dorsal aspect of the thumb was innervated by the lateral antebrachial cutaneous nerve. To our best knowledge such variation of the superficial branch of the radial nerve has never been reported before. This variation dramatically changes aetiology and manifestation of possible entrapment syndromes which clinicians should be aware of.

**Keywords** Superficial branch of radial nerve · Supinator canal · Sensory distribution · Communication · Lateral antebrachial cutaneous nerve · Variation

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✉ David Kachlik  
david.kachlik@lfmotol.cuni.cz  
Anhelina Khadanovich  
xodanovich0112@gmail.com  
Michal Benes  
michalbenes24@icloud.com  
Radek Kaiser  
rkaiser@hotmail.cz

<sup>1</sup> Department of Anatomy, Second Faculty of Medicine, Charles University, V Úvalu 84, Praha 5, Prague 15006, Czech Republic

<sup>2</sup> Center for Endoscopic, Surgical and Clinical Anatomy (CESKA), Second Faculty of Medicine, Charles University, Prague, Czech Republic

<sup>3</sup> Spinal Surgery Unit, Oxford University Hospitals NHS Foundation Trust, Oxford, UK

<sup>4</sup> Department of Health Care Studies, College of Polytechnics Jihlava, Jihlava, Czech Republic

## Introduction

The superficial branch of the radial nerve (SBRN) is a somatosensory branch originating from the radial nerve within the cubital fossa and continuing distally along the forearm underneath the brachioradialis muscle. In the distal third of the forearm the SBRN emerges between the extensor carpi radialis longus and brachioradialis muscles and pierces the antebrachial fascia to supply the dorsal aspect of the lateral two and a half digits. The deep branch enters the supinator canal and leaves it to enter the posterior compartment of the forearm as the posterior interosseous nerve.

Variations of the SBRN course were extensively described in literature and are well-known to complicate differential diagnosis and treatment of different conditions. Three overlapping groups of variations were reported in literature: variable appearance of the brachioradialis muscle causing the entrapment syndrome [2, 4, 5, 17, 19], unusual

branching architecture of the SBRN itself [1, 4, 17] and variable emerging of the SBRN [12, 18]. The aforementioned variations cause not only diagnostic hesitations in case of nerve entrapments due to unexpected neurological deficit but also put the nerve at risk of iatrogenic injury during surgical approaches to surrounding structures. The unusual course of the SBRN should be taken into account during the treatment of De Quervain's tenosynovitis, percutaneous fixation of distal radius using Kirschner's wires, wrist arthroscopy and dorsal plate osteosynthesis in fractures of the distal radius. Moreover, the inability to state a diagnosis can delay the treatment with all undesirable consequences for patient meaning unemployment, central neural system changes [9] and decrease of quality of life.

We present a case of a unique SBRN course that lies outside these two groups and, to our best knowledge, has never been reported before.

## Case report

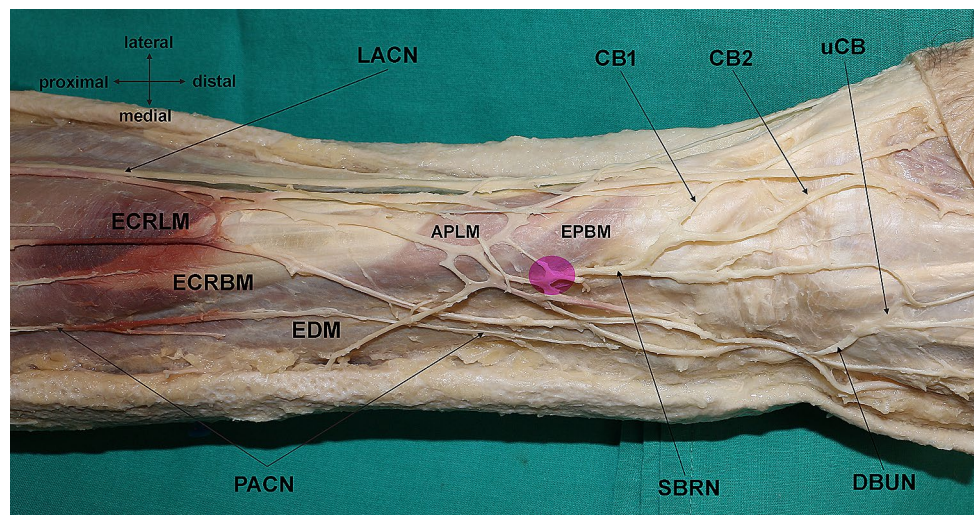
During routine dissection of an 81-years-old Central European male cadaver embalmed by classical formaldehyde method the unusual course of the SBRN was encountered in the right forearm. The length of the forearm was 260 mm (measured from the olecranon to the styloid process of the ulna). The left forearm showed classical anatomy without any related variation.

We opened the whole forearm with a longitudinal dorsal incision and dissected it layer by layer. The SBRN emerged

between the extensor digitorum and abductor pollicis longus muscles 92.4 mm proximal to the dorsal tubercle of the radius, continued subfascially and pierced the antebrachial fascia 49.1 mm proximal to the dorsal tubercle. We also observed a split insertional tendon of the brachioradialis muscle.

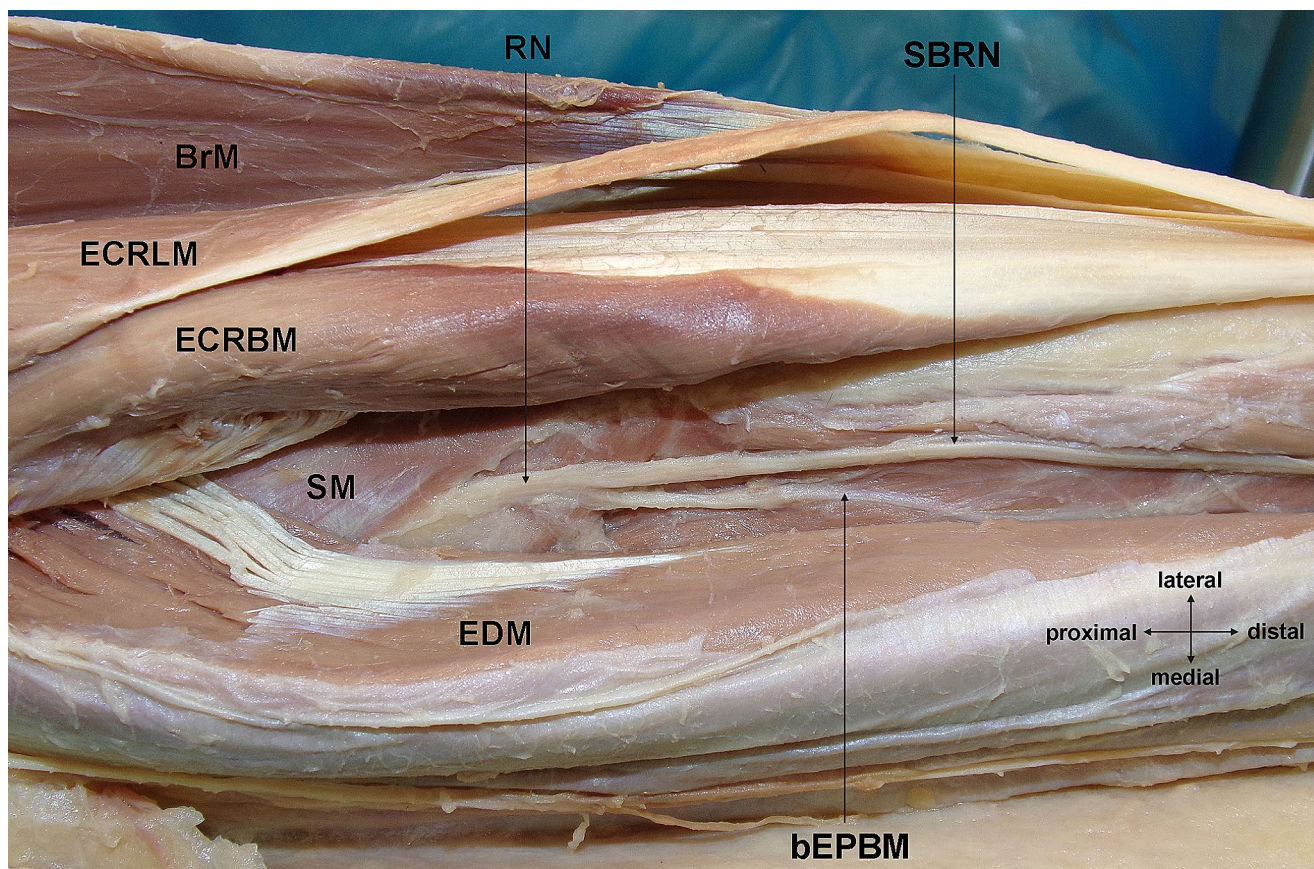
Due to such a dorsal emerging the branching pattern of the SBRN and cutaneous innervation of the dorsum of the hand were atypical (Fig. 1). The branch of the SBRN supplying the thumb was replaced by the lateral antebrachial cutaneous nerve (3.48 mm wide before its bifurcation), featuring a communicating branch (1.52 mm wide and 15.72 mm long) received from the SBRN. Distally, another communicating branch (1.04 mm wide and 12.58 mm long) was given off from the lateral antebrachial cutaneous nerve to join the SBRN as well. The other two branches of the SBRN showed normal distribution. More distally, the SBRN also communicated with the dorsal branch of the ulnar nerve by a short communicating branch (2.33 mm wide and 9.53 mm long). Without taking these communications in account the SBRN provided somatosensory innervation of the second finger and radial portion of the third finger (Fig. 1).

Consequent deep dissection showed that the SBRN emerged from the supinator canal (Fig. 2). The widths of the nerve trunk entering the supinator canal was 5.61 mm (Online resource 1 and 2). Within the supinator canal the radial nerve trunk divided into the SBRN (2.14 mm wide) and the deep branch supplying deep extensor muscles (2.43 mm wide), 51.12 mm distal to the interepicondylar line. The branching pattern of the radial nerve in the forearm



**Fig. 1** The SBRN emerging between the extensor digitorum and abductor pollicis longus muscles and communicating with the LACN through primary and secondary communicating branch. The dorsal branch of the ulnar nerve also communicates with the SBRN. Legend: APLM – abductor pollicis longus muscle; CB1 – first communicating branch; CB2 – second communicating branch; DBUN – dorsal branch of ulnar nerve; ECRBM – extensor carpi radialis brevis mus-

cle; ECRLM – extensor carpi radialis longus muscle; EDM – extensor digitorum muscle; EPBM – extensor pollicis brevis muscle; LACN – lateral antebrachial cutaneous nerve; PACN – posterior antebrachial cutaneous nerve; SBRN – superficial branch of radial nerve; uCB – ulnar communicating branch. Violet marked area corresponds to the point of SBRN piercing the antebrachial fascia.



**Fig. 2** The SBRN emerging from the supinator canal. Legend: bEPBM – branch for extensor pollicis brevis muscle; BrM – brachioradialis muscle; ECRBM – extensor carpi radialis brevis muscle; ECRLM

– extensor carpi radialis longus muscle; EDM – extensor digitorum muscle; EPBM – extensor pollicis brevis muscle; RN – radial nerve; SBRN – superficial branch of radial nerve; SM – supinator muscle

and muscles innervated by motor branches are depicted in Fig. 3.

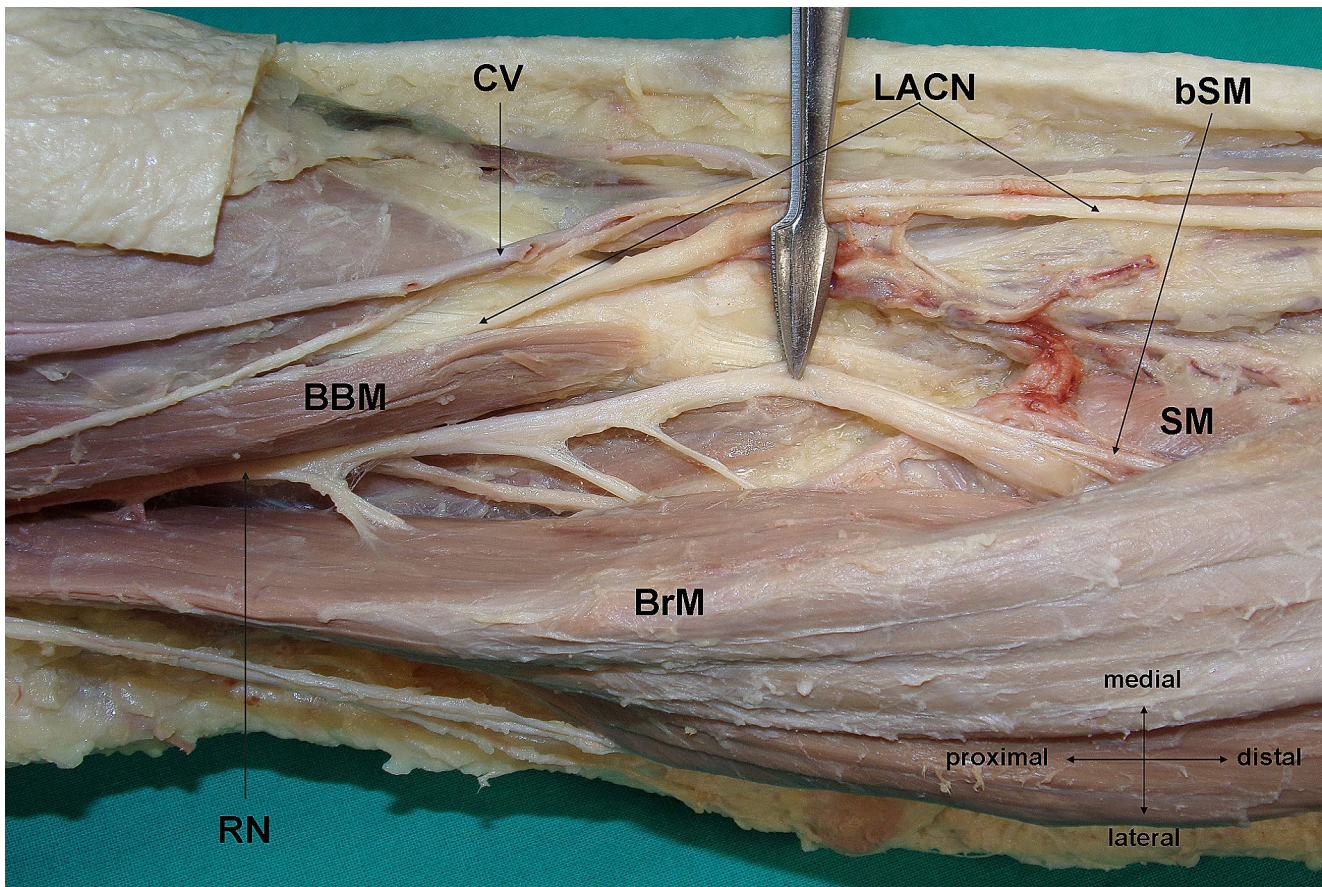
## Discussion

The unusual branching of the SBRN presented in our case report may cause diagnostic confusion which can mislead a physician while planning a surgical approach. The somatosensory portion of the radial nerve supplying the hand is well known as the SBRN usually separates from the motor fibres within the cubital fossa and continues distally through the forearm underneath the brachioradialis muscle till it emerges to become subcutaneous. In the described case the somatosensory fibres continued through the supinator canal in a common trunk with motor fibres. The SBRN separated from the radial nerve trunk variably as far as within the canal. This unique course of the SBRN may undoubtedly change differential diagnosis and clinical manifestation of different conditions.

During the embryonic period the anterior branches of the cervical spinal nerves (C5–T1) form the ventral and

dorsal group of fibres around the developing anlage of the humerus. With developing axillary artery (from the axial artery) the ventral group splits into the medial and lateral fascicle and as early as Carnegie stage 17 the main trunks of the infraclavicular part's nerves can be distinguished. At the stage 20, together with forearm growth and pronation, these nerve achieve their final topographical position [6]. Both the supinator and brachioradialis muscles are clearly visible in the CR25 mm embryo (9th week of gestation) but they appear already in the CR10.5 mm embryo (at the beginning of the 7th week of gestation) as recently proved by Diogo et al. in 2019 [3]. Also, a common primordium of the supinator muscle with the extensor carpi radialis and brachioradialis muscles was observed unlike the old theory of Lewis (1902) [14]. Based on these facts, our reported variation is probably a consequence of an impaired development before this stage.

McGraw (2019) [15] clarified different clinical presentation of the posterior interosseous nerve (PIN) palsy and radial tunnel syndrome (RTS) emphasizing its importance in successful outcome. The PIN palsy (also known as the supinator canal syndrome) is commonly presented by weakness



**Fig. 3** The scheme of the radial nerve branching pattern in the forearm and muscles innervated by its motor branches. Legend: BBM – biceps brachii muscle; BrM – brachioradialis muscle; bSM – branch for supinator muscle; CV – cephalic vein; LACN – lateral antebrachial cutaneous nerve; RN – radial nerve; SM – supinator muscle.

in fingers extension. The RTS includes pain localised to the lateral forearm and sensory disturbance due to the SBRN concomitant compression. There are five main structures causing the RTS: tendinous arch/arcade of the supinator muscle (of Frohse), supinator muscle itself, arterial leash of Henry, fibrous margin of the extensor carpi radialis brevis muscle and distal margin of the supinator muscle. For the compressive PIN palsy two main points were described: tendinous arch/arcade of the supinator muscle (of Frohse) and distal margin of the supinator muscle. A patient in the case described above could potentially develop the combination of the PIN palsy and sensory disturbance in the SBRN area nervina. However, in this particular case the sensory distribution is also different with the lateral antebrachial cutaneous nerve (LACN) almost completely supplying the thumb which can also cause diagnostic hesitations.

The other possibility is an isolated compression of the SBRN without any motor deficit. This situation can occur in our reported variant as a compression of the SBRN by the supinator muscle itself or by its distal margin. It could cause numbness, dysaesthesia and pain in the dorsoradial

aspect of the hand. Another possibility is the compression of the SBRN by hypertrophic muscles it emerges between: the extensor digitorum or abductor pollicis longus muscles. In accordance with normal anatomy this condition could be interpreted and treated as Wartenberg's syndrome. Consequent treatment of this syndrome includes conservative therapy and surgical treatment in case of unsatisfactory results of conservative treatment. Wartenberg's syndrome aetiology is often related to scissoring on the SBRN between the tendons of the extensor carpi radialis longus and brachioradialis muscles [13]. This condition is surgically treated by neurolysis and release of fascia between the tendons. Moreover, cases when the SBRN emerges between the split tendon of the brachioradialis muscle are also suspected of causing the entrapment [19]. In our case we also observed the split tendon of the brachioradialis muscle which logically could not cause the entrapment as the nerve was found emerging dorsally between other muscles. It might be surprising and confusing not to find a nerve for neurolysis that is why clinicians must be aware of this variation.

The unusual path of the SBRN described in the text above should be taken into account when performing the anterolateral approach to the elbow, or the anterior and posterior approach to the radius. When performing the anterolateral approach to the elbow the radial nerve and both its branches should be carefully identified [7]. In our case, the SBRN is absent in this area. During the anterior approach a surgeon can be surprised by the absence of the SBRN, usually coursing underneath the brachioradialis muscle during deep dissection. Particular attention should be paid performing the posterior approach to the radius, where there is a significant risk of injuring the nerve emerging between the extensor digitorum and abductor pollicis longus muscles during the initial skin incision and superficial dissection. Concerning the potential supinator canal syndrome, the nerve can be entrapped within the canal and an unexpected sensory loss can appear on the lateral portion of the dorsum of the hand. During rehabilitation procedures, the nerve could be potentially compressed by some manoeuvres or manual compression due to its unexpected course.

The variation when the SBRN pierces the brachioradialis muscle was also reported in literature [12, 18]. This case is specific by a more superficial position of the nerve in comparison with usual point of emergency leading to a higher risk of the iatrogenic injury [12]. It was predicted that such an emerging of the nerve can potentially cause its chronic compression [18]. An absent SBRN with compensation of sensory innervation by the lateral antebrachial cutaneous nerve was also described in literature and is set to be clinically silent [1].

It is important to notice that there were reported mainly variations of the brachioradialis muscle which can cause Wartenberg's syndrome. These variations were connected with the split tendon of the brachioradialis muscle and the SBRN emerging between them [19], accessory brachioradialis muscle [2, 17], double or absent brachioradialis muscle [2, 4, 5], variable origins and insertions of the muscle [2]. Moreover, some variations related to the SBRN itself were also described: duplicated SBRN [4], absent SBRN [1], superficial course of the nerve to the brachioradialis muscle [17] or the nerve piercing the brachioradialis muscle [4] or its tendon [12, 18]. Murphy and Blair (2012) reported a case of a patient who was indicated for decompression of the SBRN due to Wartenberg's syndrome. Intraoperative findings revealed the presence of an additional branch of the SBRN which emerged from the tendon of the brachioradialis muscle and was a cause of such clinical manifestation [16]. That is why awareness of the anatomical variation presented in the text above is important in diagnosis and treatment.

Moreover, the sensory disturbances due to the entrapment also differ from normality. The LACN extending to

the dorsum of the hand is a known issue [13]. There was already reported a case when the SBRN was absent and its innervation was provided by the LACN [1]. Huanmannop et al. (2007) reported a case of the similar distribution of the cutaneous nerves on the dorsum of the hand in their work describing the classification of the SBRN branching patterns. This case was classified as the extra type of the SBRN branching pattern when the branch of the SBRN supplying the thumb was absent and the LACN took its role. Further, this research group observed connections between the SBRN and the LACN (43%) with a commonly involved branch supplying the thumb [8]. Later on, it was proved that the connections between the nerves are commonly present (73.5%) and can explain the discrepancy in neurological skin examination [10]. Also, these authors divided the communicating branches into primary and secondary according to the nerve branches already involved emphasizing that the presence of both communication types would change the pathway of nerve fibres and create an overlap of the nerves involved. Applying this classification of the communications we can predict that in the presented case the SBRN fibres spread through the primary communication (more proximal one) to the LACN that is why we can anticipate that the SBRN also participated in the somatosensory innervation of the thumb. However, the secondary communication (more distal one) from the LACN back to the SBRN was also observed so we conclude that these fibres could stem from both nerves. One more communication of the dorsal branch of the ulnar nerve to the SBRN was also noticed. Based on the communications described herein we consider that the SBRN also supplied a minor area of the thumb and the ulnar nerve extended to the SBRN area nervina which could influence the distribution of the symptoms due to possible entrapment. Communication and overlap between the LACN and the SBRN can result in a smaller sensory loss than anticipated [18]. Understanding these communication patterns between the nerves is crucial in surgical treatment of neuromas, as both contributing nerves need to be denervated [8, 11]. Recently, new ideas were introduced how the neuroma of the SBRN could be influenced by the neural communication presence [11].

There are two limitations of our contribution: (1) Measurements can potentially differ in preserved cadavers and in living patients; (2) Inability to correlate this anatomical variation with clinical symptoms due to the nature of the study (cadaveric dissection).

In conclusion, we described a variation of the SBRN originating within the supinator canal and emerging distally between the extensor digitorum and abductor pollicis longus muscles with consequent unusual arrangement on the dorsum of the hand. This variation dramatically changes aetiology and manifestation of possible entrapment syndromes

which clinicians should be aware of. Moreover, such variation of the nerve path puts the nerve at risk of iatrogenic injury during different orthopaedic approaches. This is the first variation describing a completely distinct path of the superficial branch of the radial nerve and as such it deserves closer attention in future clinical-anatomical research in this region.

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**Author contributions** Anhelina Khadanovich: Methodology, Investigation, Data Curation, Visualization, Writing – Original Draft. Michal Benes: Formal Analysis, Visualization, Writing – Review & Editing Radek Kaiser: Validation, Writing – Review & Editing David Kachlik: Supervision, Validation, Resources, Visualization, Writing – Review & Editing.

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## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest.

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