Mobile 3D fluoroscopes have become increasingly available in neurosurgical operating rooms. We recently reported its use for imaging cerebral vascular malformations and aneurysms. This study was conducted to evaluate various radiation settings for the imaging of cerebral aneurysms before and after surgical occlusion. Eighteen patients with cerebral aneurysms with the indication for surgical clipping were included in this prospective analysis. Before surgery the patients were randomized into one of three different scan protocols according default settings of the 3D fluoroscope: Group 1: 110 kV, 80 mA (enhanced cranial mode), group 2: 120 kV, 64 mA (lumbar spine mode), group 3: 120 kV, 25 mA (head/neck settings). Prior to surgery, a rotational fluoroscopy scan (duration 24 s) was performed without contrast agent followed by another scan with 50 ml of intravenous iodine contrast agent. The image files of both scans were transferred to an Apple PowerMac workstation, subtracted and reconstructed using OsiriX MD 10.0 software. The procedure was repeated after clip placement. The image quality regarding preoperative aneurysm configuration and postoperative assessment of aneurysm occlusion and vessel patency was analyzed by 2 independent reviewers using a 6-grade scale. This technique quickly supplies images of adequate quality to depict intracranial aneurysms and distal vessel patency after aneurysm clipping. Regarding these features, a further optimization to our previous protocol seems possible lowering the voltage and increasing tube current. For quick intraoperative assessment, image subtraction seems not necessary. Thus, a native scan without a contrast agent is not necessary. Further optimization may be possible using a different contrast injection protocol.

**Introduction**

We previously reported the use of intraoperative contrast-enhanced 3D fluoroscopy for the intraoperative visualization of intracranial aneurysms [1] and the post-clip control of vessel patency and aneurysm occlusion [2]. To apply this technique intraoperatively is a novel idea using radiographic devices that have originally been designed and constructed for other purposes. In particular, their primary target was the visualization of bony structures in spine surgery [3] and their use as the basis for neuronavigation in spine surgery and functional neurosurgery. Hence, there are no validated protocols for radiation doses, dose and speed of contrast administration and post-processing of fluoroscopic images in cerebrovascular diseases.

These parameters have partially been adopted from computed tomography angiography (CTA). However, the image acquisition technique is fundamentally different as it does not follow the contrast flow in a caudocranial direction primarily creating tomographic images but creates tomography-like images from a rotational scan by a mathematical algorithm. Therefore, the parameters resulting in optimum imaging quality have to be evaluated for this particular technique. This study was conducted to determine superior radiation doses for the imaging of intracranial blood vessels prior to microsurgical aneurysm clipping and for the postoperative control of vessel patency and aneurysm occlusion using 3D-fluoroscopy (O-arm).
Methods

The study was approved by the ethics committee of the medical faculty of the University of Wuerzburg (Reference 263/16-ge.). All patients in this analysis were informed of the potential risk of the administration of an iodine contrast agent and radiation exposure and all patients gave their written informed consent.

Inclusion criteria

Patients met the criteria for intraoperative 3D rotational fluoroscopic angiography if they had an incidental intracranial aneurysm, were over 18 years of age, and if microsurgical clipping of the aneurysm was indicated. Exclusion criteria were a history of hyperthyroidism, a known allergy against contrast agent, or serum creatinine concentrations over 100 \( \mu \text{mol/l} \) (1.2 mg/100 ml). 18 patients were included in this analysis. Patient characteristics and aneurysm details are listed in Table 1.

Patient positioning and image acquisition

Under general anesthesia, the patients received a central venous catheter in the right jugular vein for infusions of fluid, medication and contrast agent. Arterial blood pressure was continuously monitored via an arterial line in the left radial artery. Since all patients of this series had an aneurysm in the anterior circulation, all patients were placed in a supine position with their head fixed in a carbon Mayfield clamp. Prior to surgery, baseline imaging was performed. The positioning of the O-arm\textsuperscript{TM} Imaging system (Medtronic, Littleton MA) was verified by biplanar fluoroscopy. Subsequently, a 360° rotational native fluoroscopy scan was performed. Thereafter, a second, contrast-enhanced scan was performed using 60 ml of iodine contrast agent (Imeron\textsuperscript{R}, Bracco Imaging, Konstanz, Germany). Contrast injection was performed by an automated injector (Acutron CT, Medtron, Saarbrücken, Germany) The contrast agent was infused via the 16 gauge line of a 5-lumen central venous catheter over a period of 24 s. With a delay of 12 s, the 3D scan was started. For image acquisition, the ‘high definition mode’ or ‘enhanced cranial mode’, respectively, of the O-arm\textsuperscript{TM} Imaging system (digital flat panel detector 40 x 30 cm, camera resolution 2000 x 1500, reconstruction matrix 512 x 512 x 192) was applied both requiring an image acquisition time of 24 s for the 360-degree gantry rotation. After placement of the clips, all metallic surgical devices and spatula that were potential causes of artifacts were removed and the imaging procedure was repeated. The intraoperative setting is depicted in Figure 1. The timing protocol of fluoroscopy and contrast injection is depicted in Figure 2.

Before surgery the patients were randomized into one of three different scan protocols:

- **Group 1 (n = 6): ‘enhanced cranial mode’**
  - Patient size: Large
  - Tube voltage 110 kV
  - Tube current 80 mA
  - Dose length product: 549 mGy cm for each scan

### Table 1. Patient characteristics.

| Patient # | Group          | Aneurysm                                      | Age/gender |
|-----------|----------------|-----------------------------------------------|------------|
| 1         | Enhanced Cranial| MCA left, reperfusion after WEB                | 52, f      |
| 2         | Lumbar Spine    | MCA right, incidental                          | 67, f      |
| 3         | Head/Neck       | Pericallosal artery, intramural hematoma (dissecting) | 52, m      |
| 4         | Head/Neck       | MCA right, incidental                          | 60, m      |
| 5         | Enhanced Cranial| MCA and ICA right, incidental                 | 52, f      |
| 6         | Head/Neck       | MCA right, incidental                          | 70, f      |
| 7         | Head/Neck       | Pcom right                                    | 74, m      |
| 8         | Head/Neck       | MCA right, incidental                          | 64, f      |
| 9         | Enhanced Cranial| Terminal ICA left, incidental                  | 74, m      |
| 10        | Lumbar Spine    | Pericallosal artery, incidental                | 65, f      |
| 11        | Head/Neck       | MCA right, incidental                          | 47, f      |
| 12        | Lumbar Spine    | MCA left, SAH (no blood in cisterns)          | 43, m      |
| 13        | Lumbar Spine    | Acom, incidental                              | 53, m      |
| 14        | Lumbar Spine    | MCA left, incidental                           | 49, m      |
| 15        | Enhanced Cranial| Acom, incidental                              | 51, f      |
| 16        | Enhanced Cranial| Acom, incidental                              | 43, f      |
| 17        | Enhanced Cranial| MCA right, incidental                          | 52, f      |
| 18        | Lumbar Spine    | Terminal ICA left and Acom, incidental         | 43, m      |

Patient characteristics (gender, age), location of aneurysm and history of aneurysm of 18 patients enrolled in the study.

Acom: anterior communicating artery; SAH: subarachnoid hemorrhage; ICA: internal carotid artery; MCA: middle cerebral artery.

‘Group’ indicates study group and refers to the O-arm predefined settings ‘enhanced cranial mode – patient large’, ‘high definition lumbar spine – patient large’ and ‘high definition head/neck setting – patient large’.
Group 2 (n = 6): ‘lumbar spine mode’
- Patient size: Large
- Tube voltage 120 kV
- Tube current 64 mA
- Dose length product 376 mGy cm for each scan

Group 3 (n = 6): ‘head/neck mode’
- Patient size: Large
- Tube voltage 120 kV
- Tube current 25 mA
- Dose length product 301 mGy cm for each scan

Post-processing of digital imaging and communications in medicine (DICOM) data
The DICOM data couples (native and contrast-enhanced images) were exported, transferred from the O-arm\textsuperscript{TM} Imaging system to an Apple Mac Pro\textsuperscript{®} 6-core workstation and post-processed using OsiriX\textsuperscript{®} imaging (OsiriX MD 10.0). Since it was the aim of this study, to optimize the radiation protocol for intraoperative use, time-consuming reconstructions were not performed and analyzed in this context. Native and contrast-enhanced data sets were subtracted using the OsiriX\textsuperscript{®} software. The raw contrast-enhanced images and the subtracted images were evaluated according to the criteria described below.

Evaluation of images
The images before and after placement of the clips were assessed for visibility of the aneurysms, accessibility of distal vessel patency, and complete aneurysm occlusion by two observers (T.W. and T.L.) blinded to the patients’ pathology and the assigned radiation protocol using a 6-grade scale: 1 = excellent assessability, all relevant details visible (distal and proximal vessels/clip/clip stenosis), 6 = not visible at all. The observers were allowed to use all means of image reconstruction of the OsiriX software for their evaluation including non–subtracted and subtracted images and maximum intensity projections (MIP).
An interrater reliability analysis was performed using Kappa statistics in order to determine consistency among raters/reviewers (IBM SPSS Statistics 26, SPSS Worldwide, Chicago, IL, USA).

Postoperative digital subtraction angiography (DSA)

All patients received a postoperative DSA, which was performed by the colleagues of the Institute of Neuroradiology and evaluated with regard to aneurysm remnants.

Results

Patient characteristics

18 patients were included in the study. All patients of this series had aneurysms of the anterior circulation as the majority of aneurysms in the posterior circulation were treated by endovascular coiling in our department in the study period. One patient had a history of subarachnoid hemorrhage (SAH) and endovascular obliteration by a WEB-device. Follow-up angiography 6 months later showed reperfusion of the aneurysm and microsurgical clipping was decided. One patient had a history of recent SAH by clinical criteria but no signs of hemorrhage in computed tomography (CT). Another patient had an intramural hematoma around an aneurysm of the pericallosal artery and no SAH (Table 1).

Side effects

No cardiovascular side effects or anaphylactic reactions were noted during or after administration of the contrast agent. One patient with aneurysms of the terminal ICA and anterior communicating aneurysm and a history of alcohol and cocaine abuse had an intraoperative epileptic seizure after craniotomy and opening of the dura mater 30 min after contrast administration.

Workflow

The 3D fluoroscope was positioned during the preoperative preparation (e.g. shaving, disinfection) after Mayfield clamp fixation. The appropriate position was verified using anteroposterior (a.-p.) and lateral fluoroscopy. Acquisitions of the a.-p. and lateral images and the two 3D scans took approximately 2 min and were performed after surgical disinfection of the patients’ skin and during the surgeon’s hand disinfection. Thereafter, the fluoroscope was positioned inferiorly in order to provide a free operative field. Post-processing by the OsiriX® workstation occurred during surgical drape placement and was performed by the surgical assistant who had received a short briefing of approximately 30 min on the reconstruction procedure prior to surgery. In summary, the entire procedure took 5–6 min and was completely embedded in the normal preoperative workflow.

In two patients, contrast administration failed during the first (preoperative) contrast-enhanced 3D scan due to a leak in the connection line between the syringe and central venous line resulting in an insufficient contrast injection. The examination was taken out of the assessment. In another patient, 3D-fluoroscopy was interrupted during contrast administration and no images were generated. No technical problems occurred during the scan procedures after the placement of the clips.

Technical parameters and radiation exposure

The technical parameters of the fluoroscopy, including radiation exposure, are described above (Groups 1–3). The radiation doses in Groups 2 and 3 were in the approximate range of a 1-vessel DSA including oblique projections and a 3D data set off approximately 300 mGy.

Group 1 received doses in the approximate range of complete 4-vessel DSA of approximately 1000 mGy.

Image quality

There was only a minimum interrater variability between the two observers (Kappa = 0.453, p < 0.001). In no examination, ratings differed by more than one point. For matters of simplification, ratings of the 2 observers were therefore added. The ratings are presented in Figure 3(a–d).

Scan 1: Ratings were 3 ± 0.47 (enhanced cranial mode), 3.3 ± 1.3 (lumbar spine mode) and 4 ± 0.8 (Head/Neck mode), respectively, for the assessment of the native scans, 1.9 ± 0.6 (enhanced cranial mode), 2.7 ± 1.6 (lumbar spine mode) and 3.4 ± 1.0 (Head/Neck mode), respectively, for the assessment of the scans in the MIP of the OsiriX software and 2.2 ± 0.9 (enhanced cranial mode), 3.3 ± 1.6 (lumbar spine mode) and 3.3 ± 1.2 (Head/Neck mode), respectively, for the assessment of the subtracted scans using native images and the MIP mode of the OsiriX software (Figure 3(a)).

Scan 2: Ratings were 3.2 ± 0.4 (enhanced cranial mode), 3.1 ± 1.0 (lumbar spine mode) and 4.2 ± 0.8
(Head/Neck mode), respectively, for the assessment of the native scans, 1.9 ± 0.5 (enhanced cranial mode), 2.0 ± 1.1 (lumbar spine mode) and 2.9 ± 0.8 (Head/Neck mode), respectively, for the assessment of the scans in the MIP of the OsiriX software and 1.8 ± 0.7 (enhanced cranial mode), 2.9 ± 1.5 (lumbar spine mode) and 3.0 ± 1.0 (Head/Neck mode), respectively, for the assessment of the subtracted scans using native images and the MIP mode of the OsiriX software (Figure 3(b)).

Vessel patency: Ratings were 1.9 ± 0.6 (enhanced cranial mode), 2.4 ± 1.6 (lumbar spine mode) and 3.0 ± 1.0 (Head/Neck mode), respectively, for the assessment of the patency of blood vessels distal from the clip (Figure 3(c)).

Aneurysm occlusion: Ratings were 1.6 ± 0.8 (enhanced cranial mode), 3.1 ± 1.7 (lumbar spine mode) and 3.3 ± 1.5 (Head/Neck mode), respectively, for the assessment of the complete/incomplete occlusion of the aneurysm (Figure 3(d)).

**Intraoperative indocyanine green video-angiography (ICG-VA) and postoperative DSA**

All patients received postoperative DSA (Table 2). Aneurysm remnants were diagnosed in four cases. In three cases the inferior protocols in the evaluation (Lumbar Spine, Head/Neck) were applied. Patient no. 15 is an exception in this respect, as due to the intraoperative aneurysm rupture, only incomplete elimination was possible, which was visualized by 3D fluoroscopy (enhanced cranial mode) and confirmed in the postoperative DSA.

One patient had an aneurysm spurium and was treated by wrapping.

In two cases, an assessment could not be performed due to severe spasm formation of the cerebral vessels during the course of the disease.

Correlation with ICG-VA showed negative agreement in three cases of incomplete occlusion. A positive correlation regarding aneurysm remnant in DSA and in ICG both was shown in patient no. 18. However, an aneurysm rupture occurred in patient no. 15 after ICG-VA, which had previously shown complete occlusion. Furthermore, due to a technical problem, ICG-VA could not be used in patient no. 14.

**Discussion**

It has been previously reported that cerebral blood vessels can be depicted in good quality using intraoperative 3D rotational fluoroscopy and intravenous
contrast agent [1]. Furthermore, it has been demonstrated that a postoperative control of vessel patency is possible [2,4]. However, especially the correct occlusion of the aneurysm is not displayed with high quality. From the previous findings, we concluded that the parameters of contrast administration and radiation dose can possibly be optimized in order to improve the quality of defining the vessel and aneurysm anatomy and of post-clip follow-up in terms of complete aneurysm occlusion and adequate perfusion of peripheral vessels.

In our previous studies, parameters of contrast injection and radiation dose were extrapolated from CT-angiography and predefined O-arm settings. The present investigation was conducted in order to evaluate if lower or higher radiation doses were able to improve the quality of imaging. The particular focus was put on the quality of postoperative control. This includes a quick time-sparing evaluation of the acquired images because time is short to react and replace the clip, especially if the clip causes vessel stenosis and ischemia. For this reason, we decided to refrain from creating and evaluating 3D-reconstructions in this present study which would be much more time-consuming for practical intraoperative use. Perhaps more elaborate reconstructions can be integrated in the future as hardware and software development in medical technology advances quickly.

To date, DSA is still considered the gold standard for the imaging of cerebral aneurysms [5,6] as well as the use of ICG-VA which we also use in our daily routine. All patients of this series received postoperative DSA for aneurysm and clip control. ICG-VA is a fast and non-irradiant technology. But it is a visual technique that only visualizes structures that are in the microscopic field of view. Furthermore, it does not provide a 3D-visualization of the sites. Branching vessels or parts of the aneurysm may be concealed and escape the microscopic view. Concerning DSA as the gold standard in imaging cerebral aneurysms, the point of view has been challenged in the last few years. Computed tomography angiography (CTA) demonstrated similar precision and comparable depiction of vessel and aneurysm morphology using advanced image processing technologies [7,8]. Therefore, CTA has become the first-line diagnostic tool for stroke. Its advantages are that it takes but a couple of minutes and is a simple procedure that does not require a larger setup. Magnetic resonance angiography (MRA) has been a primary focus in recent years and has been investigated for its accuracy to show the vessel anatomy and configuration of intracranial aneurysms [9,10]. This technique has demonstrated a good

| Patient # | Group        | Aneurysm                                      | Age/gender | Post OP DSA | ICG   |
|-----------|--------------|-----------------------------------------------|------------|-------------|-------|
| 1         | Enhanced Cranial | MCA left, reperfusion after WEB | 52, f      | CO          | CO    |
| 2         | Lumbar Spine  | MCA right, incidental                        | 67, f      | CO          | CO    |
| 3         | Head/Neck    | Pericallosal artery, intramural hematoma (dissecting) | 52, m      | Remnant     | n/a   |
| 4         | Head/Neck    | MCA right, incidental                        | 60, m      | CO          | CO    |
| 5         | Enhanced Cranial | MCA and ICA right, incidental               | 52, f      | CO          | CO    |
| 6         | Head/Neck    | MCA right, incidental                        | 70, f      | CO          | CO    |
| 7         | Head/Neck    | Pcom right                                   | 74, m      | CO          | CO    |
| 8         | Head/Neck    | MCA right, incidental                        | 64, f      | CO          | CO    |
| 9         | Enhanced Cranial | Terminal ICA left, incidental              | 74, m      | CO          | CO    |
| 10        | Lumbar Spine  | Pericallosal artery, incidental              | 65, f      | Remnant     | CO    |
| 11        | Head/Neck    | MCA right, incidental                        | 47, f      | Remnant     | CO    |
| 12        | Lumbar Spine  | MCA left, SAH (no blood in cisterns)         | 43, m      | n/a         | CO    |
| 13        | Lumbar Spine  | Acom, incidental                             | 53, m      | CO          | CO    |
| 14        | Lumbar Spine  | MCA left, incidental                        | 49, m      | n/a         | technical problems |
| 15        | Enhanced Cranial | Acom, incidental                           | 51, f      | Remnant     | before rupture |
| 16        | Enhanced Cranial | Acom, incidental                            | 43, f      | CO          | CO    |
| 17        | Enhanced Cranial | MCA right, incidental                      | 52, f      | CO          | CO    |
| 18        | Lumbar Spine  | Terminal ICA left and Acom, incidental       | 43, m      | Remnant     | Remnant |

Patient characteristics (gender, age), location of aneurysm, results of intraoperative ICG and postoperative DSA of 18 patients enrolled in the study. CO: complete occlusion; n/a: not applicable.
correlation with DSA findings for the detection of aneurysms and estimation of aneurysm size. Its advantage is that it is radiation-free. Currently, it is the standard follow-up examination after endovascular obliteration of intracranial aneurysms [10,11]. However, it also requires a time-consuming setup and is, therefore, not useful for intraoperative control after microsurgical occlusion of aneurysms, even if a magnetic resonance imaging (MRI) scanner is present in the operating room (OR). Furthermore, metal-clips cause a local artifact that does not allow an assessment of aneurysm occlusion [7].

In many departments, angiography facilities and CT scanners to perform DSA and CTA are not localized in the OR. If they are, this means an interruption of the procedure [12] Intraoperative CT is a rather rapid procedure, but it interrupts the workflow because patients have to be transferred into the CT-scanner. Fluoroscopy scanners have the advantage that they can be repositioned any time during surgery, completely integrated into the operating field and workflow and reused whenever it is necessary.

Previous investigations showed high-quality images [1,2,4]. Previously, we used different radiation protocols due to the lack of an official protocol for this technique. Furthermore, the contrast agent had been injected 'free-hand' and it could not be guaranteed that the manual injection was continuous and exactly complied with the 24-s interval of the protocol. In the present study, an automated injector was used assuring compliance with the study protocol. In our previous series, we observed differences in image quality which suggested that there may be space for an optimization of the protocol of the procedure concerning (a) the radiation dose and (b) the dynamics of contrast injection. The present study evaluated the possible optimization of the radiation dose in a structured and prospective way.

Patients were allocated to one of three study groups with higher or lower tube voltage and current. Similar to our previous patients, we observed variations within those groups. In each group, good results with respect to image quality were seen. In average, however, the image quality in group 1 (enhanced cranial mode) was best. Whether this is due to the slightly reduced tube voltage or the increased tube current or both, cannot be determined in this study setup. Patients without a malignant disease such as our patients are a particularly sensitive patient collective when it comes to clinical studies and especially radiation as a potentially harmful measure. Thus, larger studies are not warranted. Considering these results, it might now be the next step to further reduce the tube voltage and/or increase the tube current. At this stage of the project, we cannot determine the impact of the thickness of the skull on the image quality of intracranial structures, in particular contrast-filled vessels. This may be another factor influencing image quality. In catheter DSA, initial single fluoroscopic shots taken before the start of the rotational scan automatically determine the optimum radiation parameters for the two scans that are used for subtraction angiography. In 3D rotational DSA, radiation parameters are somewhat lower. Tube voltages are around 90 mV, currents around 50 mA according to our own institutional observations. Altogether, there may be further potential to optimize the radiation settings.

One rather unexpected finding is that digital subtraction of native versus contrast-enhanced images does not result in a gain of image-quality compared to the contrast-enhanced images alone using the MIP function of post-processing software (Figure 4(a–e)). This may be due to the MIP function itself being a well-developed function particularly conceived for the imaging of structures such as blood vessels and automatically erasing intracranial soft tissue using mathematical algorithms [13]. For assessment of blood vessels and distal perfusion, we supposed that this may be sufficient.

We previously found that 3D reconstructions using the OsiriX software were highly superior to non-subtracted contrast-enhanced images. This is true for the depiction of aneurysms before surgery as well as for post-clip control. However, 3D image-reconstruction was not the issue of this present study. One possible reason for this observation might be that subtraction only works if there is an exact overlay of native and contrast-enhanced images. Figure 4(e) shows that this is possible at times. Theoretically, all artifacts should be calculated out of the image so that only the contrast-filling remains. But if there is an only minimal shift between the images for what reason ever, artifacts will not be counted out and digital subtraction is of little use. For the purpose of image fusion in tumor surgery or neuromodulation, all modern neuronavigation systems have an automatical adaptation of image overlay for fine-adjustment, for example, using bony structures as a reference [14,15]. However, none of them has a digital subtraction function to subtract the fine-adjusted images in a second step. In contrast, the OsiriX software has a digital subtraction function but unfortunately no automatic adjustment for image overlay. The problem of exact overlay and a further
gain of image quality could possibly be solved by the addition of the respective software components.

It should be emphasized that radiation settings do not alone determine the quality of vascular imaging. The flooding of the contrast agent is likely to play an equally important role. For CTA, this was extensively examined in the past. Maintaining stable blood pressure is certainly a prerequisite for good-quality contrast imaging but not in a proportional function [16]. To date, there is still no clear algorithm for the timing of contrast agents in CTA. For that reason, manufacturers added bolus tracking in the field of CTA [17]. In 3D-rotational fluoroscopy, this issue may be even more challenging because the arteriogram is – at least in peripheral vessels – hard to distinguish from the venogram. The latter, however, is not useful for the purpose of imaging cerebral imaging and may worsen image quality.

**Conclusion**

This present study is a structured and prospective evaluation of various radiation protocols for intraoperative cerebral angiography using a mobile 3D-fluoroscope. Since this is a novel technique, algorithms have to be developed. In contrast to our former protocol, that lower tube voltage and higher tube current seem to be of advantage in order to optimize image quality. This is the basis and the first step for further work targeting further optimization. Apart from the radiation settings, this may also include contrast-timing and post-processing software.

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**Ethical approval and consent to participate**

All patients in this analysis were informed of the potential risk of the administration of an iodine contrast agent and radiation exposure and all patients gave their written informed consent.

The study was approved by the ethics committee of the medical faculty of the University of Wuerzburg (Reference 263/16-ge.).

**Disclosure statement**

The project was supported by the External Research Fund of Medtronic Inc. The funder was not involved in the study design, collection, analysis, interpretation of the data or the decision to publish.

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**Data availability statement**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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