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The Tigertriever 13 for mechanical thrombectomy in distal and medium intracranial vessel occlusions

Sebastian Fischer[1] · Lena Will[1] · Timo Phung[2] · Werner Weber[1] · Volker Maus[1] · Hannes Nordmeyer[2,3]

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Abstract

Purpose To report our two-center initial experience using the Tigertriever 13 in the treatment of acute stroke of distal, medium vessel occlusions (DMVO).

Methods We performed a retrospective analysis of all patients treated by mechanical thrombectomy using the Tigertriever 13 device (a manually expandable low profile stent retriever) due to an acute DMVO. Locations included the anterior, middle, and posterior cerebral artery in the A2 and A3, the M3 and M4, and the P2 or P3 segment and the superior cerebellar artery.

Results Forty-three patients with 45 DMVOs underwent MTE using the Tigertriever 13 with the intention-to-treat approach between May 2019 and December 2020. After a median of two thrombectomy maneuvers, the successful recanalization rate (mTICI 2b-3) was 84.4% (38/45) with a first pass effect of 26.7% (12/45). The rate of symptomatic intracranial hemorrhages (sICH) and subarachnoid hemorrhages (SAH) was 7.0% (3/43) and 14.0% (6/43), respectively. At discharge, 53.5% (23/43) of the patients had a favorable clinical outcome (mRS 0–2).

Conclusion Mechanical thrombectomy in DMVOs using the Tigertriever 13 leads to high recanalization rates. The incidence of mostly asymptomatic hemorrhagic events appears higher compared to MTE procedures in LVOs. Further studies will help to identify anatomic and clinical criteria to define a guideline for MTE in DMVOs.

Keywords Mechanical thrombectomy · Stent retriever · Distal medium vessel occlusion

Introduction

Mechanical thrombectomy (MTE) is the standard of care of patients suffering from acute ischemic stroke due to a proximal large vessel occlusion (LVO) within the anterior circulation [1–5]. Within the last few years, numerous technical innovations of devices dedicated to the endovascular treatment of acute stroke were presented. While some new devices or strategies focus on a faster and more efficient first pass success (e.g., balloon occlusion catheters), others allow for the treatment of distal, medium vessel occlusions (DMVOs) [6–8]. With this trend towards smaller more flexible low-profile devices, a debate on the benefit and the need for recommendations regarding MTE in DMVOs emerged, while conclusive data regarding technical and clinical aspects are still scarce. However, DMVOs account for up to 40% of acute ischemic stroke cases without clearly defined and satisfying treatment recommendations [6].

In this retrospective study of DMVOs treated by MTE using a manually adjustable stent retriever, we report our initial clinical and angiographic experience. Cases in this study were exclusively carried out with the Tigertriever 13 (Rapid Medical, Yoqneam, Israel), a novel low-profile stent retriever that allows for a controllable stepwise adjustment of the radial force towards the vessel wall and the clot. The device is intended for the application in DMVOs since it is compatible with a 0.013-in. microcatheter.

✉ Sebastian Fischer
sebif101@googlemail.com

1 Institut für Diagnostische und Interventionelle Radiologie, Neuroradiologie und Nuklearmedizin, In der Schornau 23-25, 44892 Bochum, Germany

2 Institut Für Interventionelle Radiologie Und Neuroradiologie, Neurozentrum Solingen, Radpax St. Lukas Hospital, Solingen, Germany

3 School of Medicine, Department of Health, Witten/Herdecke University, Witten, Germany

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Material and methods

Data analysis

We retrospectively analyzed all cases of acute stroke due to an intracranial DMVO treated by MTE using the Tigertriever 13 between May 2019 and December 2020.

DMVOs were defined as acute occlusions of the middle cerebral artery distal to the M2 segment in the M3 and M4 segment (MCA M3 and M4), the anterior cerebral artery in the A2 and A3 segment (ACA A2 and A3), the posterior cerebral artery in the P2 and P3 segment (PCA P2 and P3), and the superior cerebellar artery (SCA). Only occlusions treated with the intention-to-treat approach with the Tigertriever 13 were included. Occlusions of the M2 segment of the middle cerebral artery (MCA M2) treated by mechanical thrombectomy within the sample period were excluded from this analysis. This was done because the M2 segment is generally accessible with conventional stent retrievers, so that miniaturized devices such as the Tigertriever 13 are not required in the majority of cases.

Two scenarios were identified and resulted in the definition of two groups. Group 1 comprises cases of acute stroke due to a primary occlusion in one of the specified locations, while group 2 summarizes cases performed following MTE of LVOs. Cases in group 2 had preexisting DMVOs within the territory of the underlying LVO or distal occlusions due to embolism to a new territory (ENT) following the index MTE, the differentiation between an ENT and a preexisting DMVO not being possible in retrospect. The subdivision into these groups was inspired by a previously published study on MTE in DMVOs by Rikhtegar et al. [9].

Cases where the Tigertriever 13 was used outside the inclusion criteria were excluded from this analysis. These were 19 occlusions of the MCA in the M2 segment and four cases where the Tigertriever 13 was used after failure of alternative techniques ("bail-out").

The individual decision to perform a MTE in DMVOs was a result of interdisciplinary consensus by the neurological and neurointerventional team members based on the clinical symptoms (measured by the NIHSS) and imaging findings (Alberta Stroke Program Early CT Score) and CTA within the 6 h window supplemented by CT perfusion (CTP) beyond 6 h) for cases in group 1. Arguments to perform MTE were a relevant clinical deficit and a low volume of ischemic tissue detected on plain CT or CTP. Moreover, it was upon the operator's discretion to weigh the specific procedural risk against the potential benefit of recanalization, and given the current absence of evidence for MTE in DMVOs, the decision was not based on fixed criteria.

For cases of group 2, the decision to continue with MTE following recanalization of an LVO was made by the operator alone, while the anatomy of the occluded segment and the presumed eloquence of the affected territory were the main criteria in favor of or against MTE in remaining or new DMVOs.

On admission and at discharge, a neurological team member evaluated the clinical status of each patient using the NIHSS and mRS score, while the angiographic results were independently analyzed by two interventional neuroradiologists. In cases of inconsistency, the final classification was reached at a consensus.

Following the institutional standards, all patients received a postprocedural computed tomography (CT) within 24 h following the intervention. Two neuroradiological team members analyzed these in retrospect with regard to hemorrhagic events following the procedure [10].

The territory distal to the occlusion was set as 100%, and reperfusion rates were translated into mTICI grades [11]. A TICI 2b to 3 result was the primary endpoint. For primary DMVOs (group 1), a further primary endpoint included the alteration of the patient's clinical status following the procedure (measured by the NIHSS on admission and at discharge). Secondary endpoints included the first pass effect (mTICI3) (only applied for cases in group 1; for cases in group 2, the first pass effect cannot be applied by definition), the number of MTE maneuvers, and the rate of subarachnoid (SAH) and symptomatic intracerebral hemorrhages (sICH) within 24 h following the procedure.

Tigertriever 13/endovascular procedure

The fundamental concept of the Tigertriever was described before [12–14]. As a brief summary, the basic difference compared to conventional stent retrievers is the possibility to adjust the radial force of the mesh towards the thrombus or the vessel wall manually which is facilitated by a wire inside the mesh that is connected to the distal end of the device. This wire can be pulled or pushed stepwise by a clicker-based control handle, which opens and closes the mesh of the device. There are four versions of the Tigertriever available, the Tigertriever 13 being the smallest one and compatible with a 0.013-in. microcatheter.

The basic technical setup does not differ from MTE procedures for LVOs. Procedures were performed using an 8F guiding catheter together with 6F or 5F aspiration catheters within the internal carotid artery (ICA), the middle cerebral artery (MCA), or the vertebral artery (VA). Once an occlusion within one of the defined locations was identified, a Headway Duo (Microvention, Tustin, CA, USA) microcatheter was navigated distal to the occlusion. Once the Tigertriever

13 was advanced towards the occlusion, the microcatheter was gently pulled back with the device kept stable in the desired position, which is within but mainly distal to the occlusion. The Tigertriever 13 was then opened stepwise under continuous fluoroscopy until occurrence of a shift of the target artery on the previously prepared road map. At this point, the device was no longer expanded to minimize the risk of vessel injuries due to an over-expansion of the mesh. After a slight release, the Tigertriever was carefully withdrawn under continuous aspiration on the guiding/balloon guiding catheter or manual aspiration on the 6F or 5 F aspiration catheter that was consciously left within the proximal vasculature (ICA, MCA M1, or VA) in order to minimize the risk of distal artery injuries. In case of a mesh prolapse over the distal marker of the device, to be characterized as a "tear-drop phenomenon," further release by the handle was applied. In cases of a remaining occlusion following this maneuver, the decision whether to continue with MTE or to cease the procedure was upon the operator's discretion.

Figure 1 illustrates an over-expansion of the Tigertriever 13 including a shift documented on the road map and a deformation of the mesh ("tear-drop phenomenon").

Ethical statement

The study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. A separate informed consent from each patient before inclusion in this study was not required due to the retrospective design of the study.

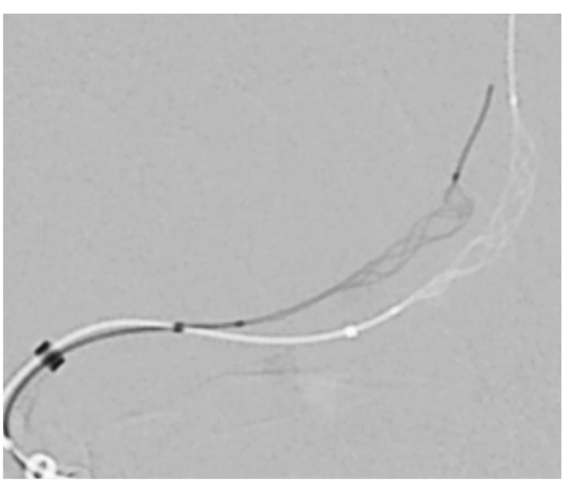

Fig. 1 An over-expansion of the Tigertriever 13 including a shift documented on the road map and a deformation of the mesh ("tear-drop phenomenon"), road-map

Results

Entire population

Forty-three patients (22 female and 21 male, median age 77, range 40–97 years) with 45 DMVOs underwent MTE using the Tigertriever 13 with the intention-to-treat approach during the above mentioned sample period of 20 months. In 41.9% (18/43 patients), bridging intravenous therapy (IVT) was applied. The median interval from symptom onset to groin puncture was 170.5 min (range 54.0–458.0 min) with a median procedure time (groin puncture to recanalization) of 45.0 min (range 11.0–137.0 min). A median of 2 MTE attempts (range 1–7) resulted in an overall successful recanalization rate (mTICI 2b-3) of 84.4% (38/45 cases) with a first pass effect of 26.7% (12/45 cases). In 15.6% (7/45 cases), the procedure remained unsuccessful (mTICI 0-2a).

In 17.8% (8/45 procedures), the operator decided to switch to a device other than the Tigertriever 13. This was done after a median of two unsuccessful (range 1–2) maneuvers. The successful recanalization rate in this subgroup was 75.0% (6/8 procedures). Devices successfully used in this context were the Catch Mini Device (Balt, Montmorency, France) in four cases, and the remaining two cases were successful by aspiration alone by 3MAX Aspiration Catheter (Penumbra, CA, USA) or Sofia Aspiration Catheter (Microvention, Tustin, CA, USA). In the remaining two cases, successful recanalization failed despite a bail-out device (3 MAX aspiration catheter in each case). Two out of the four bail-out cases were successfully treated by aspiration alone (3MAX and Sofia) and two failed (3MAX each).

The median NIHSS score of the 43 patients was 9 (range 2–22) on admission and improved to a median of 3 (range 0–18) at discharge. Five patients died during hospitalization. At discharge, 53.5% (23/43) of the patients had a favorable clinical outcome (mRS 0–2).

The overall rate of SAH detected on CT performed within 24 h following the procedure was 14.0% (6/43). In 7.0% (3/43) of the patients, a sICH was identified within 24 h after the procedure.

No technical complications related to a malfunction of the device were encountered. In one patient with a primary MCA M3 occlusion, an active extravasation occurred after one unsuccessful MTE maneuver. This active bleeding ceased spontaneously after a short observational period under systolic blood pressure reduction. Nonetheless, the patient experienced a relevant SAH, which was the probable cause for the fatal outcome since the patient initially had mild clinical symptoms (NIHSS 3) and died 9 days after the procedure.

Four additional patients died during hospitalization as consequence of their underlying stroke. Of those, two (both in group 2) experienced a sICH.

Detailed analysis

The detailed analysis of the 31 patients with 32/45 primary DMVOs (71.1%) in group 1 revealed a successful recanalization rate of 81.3% (26/32) with a first pass effect of 21.9% (7/32). MTE procedures were successful after a median of 2 maneuvers (range 1–7). In 37.5% of these cases (12/32), IVT was initiated prior to the endovascular procedure. The SAH and sICH rates in this subgroup were 9.6% (3/31) and 0.0% (0/31), respectively.

The NIHSS score of the 31 patients in group 1 was 7 (range 2–22) on admission and improved to a median of 3 (range 0–18) at discharge. The rate of favorable clinical outcome at discharge was 64.5% (20/32 patients) in this group.

In the 13 cases (28.9%) with the DMVO treated in the context of an LVO occlusion (group 2), the successful recanalization rate was 92.3% (12/13). The median number of MTE attempts in this group was 1 (range 1–3). IVT was administered in 46.2% (6/13) with the intention to treat the underlying LVO.

In group 2, the median NIHSS score on admission and at discharge was 13 (range 3–19) and 7 (0–13), respectively, resulting in a favorable outcome of 23.1% (3/13 patients) at discharge. All cases of sICH occurred within group 2 (23.1%), and the SAH rate was 30.8% (4/13).

In one patient with a primary M3 occlusion, an additional A2 occlusion occurred during the procedure (ENT). Consequently, this patient was included into both groups. Since this was a patient with a SAH, the complication was as well counted in both groups.

An illustrative case of DMVO treated by MTE using the Tigertriever 13 is given in Fig. 2a–f.

Table 1 gives a summary of the entire and subgroup angiographic and clinical results including the location of the DMVO treated.

Discussion

MTE plays an important role in the treatment of acute ischemic stroke due to LVO. Inclusion criteria within the randomized controlled trials that provided evidence for MTE were restricted to acute occlusions of the terminal ICA or MCA within the M1 segment, while more distally located occlusions were excluded from these studies [1–4]. The main reason behind this was a presumably higher response to intravenous therapy (tPA) in distal occlusions and a higher likelihood of complications following catheterization and maneuvering in small caliber distal arteries. The latter is plausible as the mentioned studies were initiated more than 5 years ago where dedicated miniaturized thrombectomy devices were not yet available [6, 7]. Since then, extensive technical advancements resulted in dedicated thrombectomy devices intended for the treatment of DMVOs.

Our retrospective analysis of DMVOs treated by MTE using the Tigertriever 13 showed a successful recanalization rate of 84.4%. This rate is comparable to the rates reported for LVOs treated by MTE [1–3]. A direct comparison of recanalization rates in DMVOs and LVOs appears appropriate because a successful and complete restoration of blood flow strongly correlates with a good clinical outcome; however, there are still some important differences remaining [15, 16].

These differences are mainly related to the lack of evidence regarding the optimal treatment strategy in DMVOs. Given the smaller absolute amount of salvageable tissue compared to LVOs, it is crucial to identify occlusions of those distal arteries that supply eloquent brain areas. In cases of primary DMVOs, the infarct pattern detected on CTP or MRI studies together with the clinical impairment helps to identify patients with DMVOs of eloquent areas. In these patients, the benefit of MTE will most likely outweigh the potentially higher risk of complications of MTE in small caliber vessels. An example within our series is a patient in group 1 with an initial NIHSS of 22 due to an occlusion of the A2 segment causing a complete infarction of the A2 territory.

Complications are not only related to the presumably higher risk of hemorrhagic events in distal MTE procedures, as indicated by the rate of SAH and sICH found in our series. The procedure of MTE especially if carried out under general anesthesia does not only put the patient at a higher risk of hemorrhagic events. Further clinical impairment following MTE might result from a decrease of blood supply through collaterals due to a blood pressure drop during the procedure (general anesthesia).

In patients with only mild clinical impairment due to a distal branch occlusion, a conservative treatment regimen including an elevation of blood pressure in order to support the blood supply via leptomeningeal anastomoses might be preferable.

However, in some patients, additional discrepant infarcts outside the expected territory supplied by the occluded artery may occur. These "discrepant infarcts" are caused by a secondary migration of the clot, additional infarcts in different locations, or as complications during endovascular procedures. Discrepant infarcts due to DMVO are associated with more severe deficits and poor outcomes according to Ospel et al., which might justify MTE in distal and medium vessels [17].

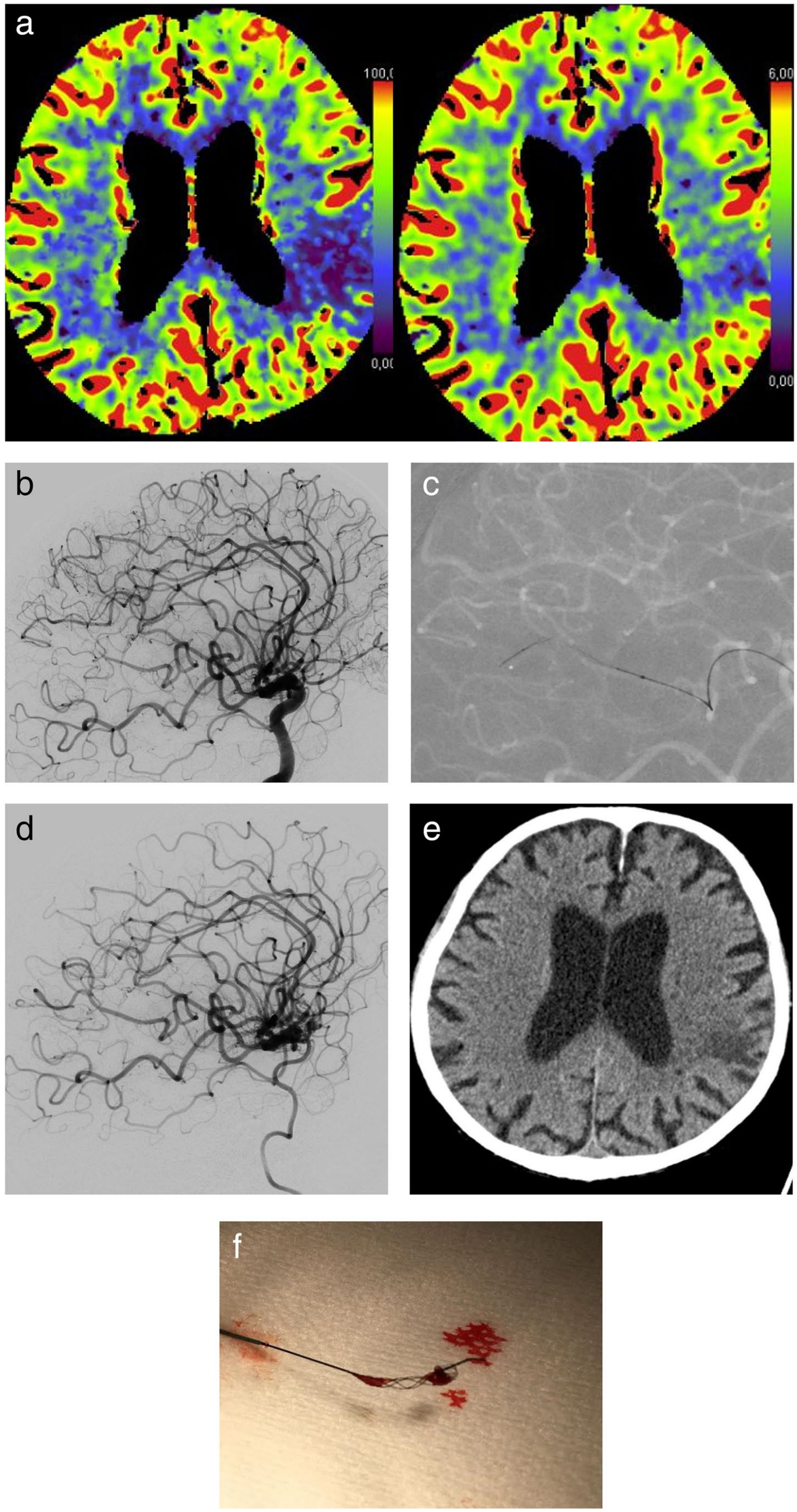

Fig. 2 **a** CT perfusion imaging in a patient with a wake-up stroke (right-sided hemiparesis; NIHSS 8) indicating the infarct core with a surrounding penumbra. **b** angiogram of the left ICA indicates an occlusion of the M3 segment of the left MCA; lateral view. **c** Placement and expansion of the Tigertriever 13 within but mostly distal to the clot; lateral view. **d** Successful reperfusion after two MTE maneuvers using Tigertriever 13; lateral view. **e** Plain CT within 24 h after the procedure indicates the estimated infarct without evidence of SAH (NIHSS 3 at discharge); axial reconstruction. **f** Tigertriever 13 with the clot trapped within the mesh of the device

Table 1 The entire and subgroup angiographic and clinical results including the location of the DMVO treated (group 1, acute stroke due to a primary DMVO; group 2, DMVO treated in the setting of MTE in LVO); for primary DMVOs (group 1), the median NIHSS-shift is given according to the specific location

	[No]	NIHSS	Attempts	Successful recanalization	Unsuccessful recanalization	mRS at discharge 0–2
		Median admission-discharge	Median/range	[%]	[%]	[%]
Entire group						
Total	45	9–3	2/1–7	**84.4** (38/45)	**15.5** (7/45)	**53.5** (23/43)
Localization						
M3	23		2/1–3	**73.9** (17/23)	**26.1** (6/23)	
A2	9		1/1–3	**100.0** (9/9)	**0.0** (0/9)	
A3	3		1/1–1	**100.0** (3/3)	**0.0** (0/3)	
A4	1		3/3–3	**100.0** (1/1)	**0.0** (0/1)	
P2	8		3/2–7	**87.5** (7/8)	**12.5** (1/8)	
SCA	1		1/1–1	**100.0** (1/1)	**0.0** (0/1)	
Group 1						
Total	32	7–3	2/1–7	**81.3** (26/32)	**18.8** (6/32)	**64.5** (20/31)
Localization						
M3	17	8–4	2/1–3	**70.6** (12/17)	**29.4** (5/17)	
A2	4	6–6	1,5/1–3	**100.0**(4/4)	**0.0** (0/4)	
A3	2	12–2	1/1–1	**100.0** (2/2)	**0.0** (0/2)	
P2	8	2–2	3/2–7	**87.5** (7/8)	**12.5** (1/8)	
SCA	1	3–1	1/1–1	**100.0** (1/1)	**0.0** (0/1)	
Group 2						
Total	13	13–7	1/1–3	**92.3** (12/13)	**7.7** (1/13)	**23.1** (3/13)
Localization						
M3	6		1/1–2	**83.3** (5/6)	**16.7** (1/6)	
A2	5		1/1–1	**100.0** (5/5)	**0.0** (0/5)	
A3	1		1/1–1	**100.0** (1/1)	**0.0** (0/1)	
A4	1		3/3–3	**100.0** (1/1)	**0.0** (0/1)	

The spectrum and the rate of complications as well as the optimal procedural setup of MTE in DMVOs are different to that in LVOs and not yet clearly defined [6].

To date only one study focuses on DMVOs exclusively treated with the Tigertriever 13. Rikhtegar et al. presented a series of 115 patients suffering from DMVOs treated with the Tigertriever 13. They subdivided their series into those with a primary and a secondary (following LVO MTE) DMVO as we did in our series [9]. Different to our cases, they defined a third group, which summarized cases of "hyperacute" DMVOs following the treatment of intracranial aneurysms or arteriovenous malformations (AVM). They observed no statistically significant differences regarding the successful recanalization rate between group 1 and 2 (70.5% group 1 versus 73.2% group 2). Even though this rate appears somewhat lower, it is comparable to our successful recanalization rate of 84.8%, since in the mentioned study, the eTICI score (2b 67–89% of the territory) was applied in contrast to our study where the mTICI score (2b < 50% of the territory) was used. The successful recanalization rate of distal vessel occlusions following endovascular aneurysm or AVM treatment (group 3) was 100.0% in the mentioned study, which might be explained by the "hyperacute" status without a "time frame" for thrombus organization.

The comparability within the different studies targeting MTE in distal occlusions is limited by the fact that in most of them, M2 occlusions represent the major proportion of "distal" occlusions treated. We excluded M2 occlusions from our analysis in line with the study by Rikhtegar et al., seeing as MTE techniques/devices needed in these locations do not relevantly differ from those for LVOs.

Furthermore, we made reference to the recently presented definition of medium vessels by Goyal et al., who aside from the M2 segment proposed to exclude the P1 PCA and the A1 ACA as well [18]. However, several authors have already presented their experience in the treatment of distal or small caliber vessel occlusions using devices other than the Tigertriever 13, while the definition of "distal vessel" varies. Hofmeister et al. presented a series of distal vessel occlusions using the Catch Mini stent retriever (Balt, Montmorency, France) in 41 patients, where the majority were M2 occlusions. They observed a successful recanalization rate of 78.0% without hemorrhagic complications related to the procedure [19]. This is in line with the results of comparable studies where different types of self-expandable stent retrievers were applied [20, 21]. There is little experience with low profile stent retrievers in DMVOs following the definition of Goyal et al. Onal et al. as well as Haussen et al. reported a 100.0% successful recanalization rate in DMVOs in their studies using low profile self-expandable stent retrievers [8, 22].

A major issue regarding MTE with stent retrievers especially in DMVOs is the potentially higher risk of vessel injuries that might cause focal SAH. On follow-up CT imaging performed within 24 h following the procedure, the rate of focal SAH was 14.0% in the entire series. All cases of focal SAH without angiographic evidence of active contrast extravasation during the procedure remained clinically silent. This is in accordance with the results of Rikhtegar et al., who defined postoperative subarachnoid contrast extravasations as a benign epiphenomenon induced by the deviation of the distally located vessels during withdrawal of the stent retriever [9]. However, one patient with mild clinical symptoms caused by an M3 occlusion (NIHSS 3) experienced a fatal SAH following MTE with the Tigertriever 13. This underlines that the indication for MTE in DMVOs needs to be carefully weighted against the potential benefit. The prevalence of additional factors that might influence the risk of vessel injuries should be taken into account: additional IVT, underlying coagulation disorders, arterial hypertension, success of recanalization, atherosclerotic disease, vessel tortuosity, thrombus composition, and especially the number of passes with the stent retriever will certainly have an influence on the occurrence of SAH after MTE for DMVOs [23, 24]. Our median number of thrombectomy maneuvers within the entire series was 2, which is comparatively low when compared to MTE in LVOs. This reflects the more defensive strategy in DMVOs.

For MTE in LVOs, stent retrievers are associated with a higher incidence of vessel injuries compared to aspiration alone [25, 26]. It is not proven that this is true DMVOs as well; however, it might favor aspiration alone. On the other, even in distal locations, MTE with stent retrievers may lead to higher rates of reperfusion than aspiration alone [27]. The latter is supported not only by our overall results with the Tigertriever 13 but also by the four failed cases using the Tigertriever 13 that were successfully treated with the Catch Mini stent retriever, while aspiration alone failed in two of four failed cases. In DMVOs of highly tortuous vessels, aspiration might fail due to the impaired navigability of appropriate aspiration catheters with a lumen large enough to aspirate the clot. The compatibility of the Tigertriever 13 with a highly flexible 0.013 inch microcatheter allows for MTE in locations where other strategies may fail.

All cases of sICH with two of the three resulting in a fatal outcome occurred in patients with an underlying LVO, while all of them were wake-up strokes with multiple MTE maneuvers performed. These are well-known predictors of sICHs unrelated to a remaining or preexistent DMVO [28]. Therefore, a causative relation to the MTE performed with Tigertriever 13 remains highly uncertain. It is more plausible that these sICHs were related to an underlying large ischemia caused by the underlying LVO with the above-described conditions.

The concept of the Tigertriever offers the possibility to manipulate the expansion and the radial force of the device. This might help to obtain a higher likelihood of capturing the clot compared to traditional stent retrievers, where the operator cannot alter the expansion [12–14].

Whether a gentle relaxation of the Tigertriever with a reduction of the radial force during withdrawal reduces straightening of the vasculature and with this the risk of vessel injuries remains speculative. This assumption is supported by the results of Katz et al., who, in their experimental study, proved that in smaller vessels (1.5–2.24 mm), the radial force is lower with braided stent retrievers as compared to laser cut devices [29]. They discussed that minimizing the radial force of a stent retriever may reduce the incidence of vessel wall injuries (withdrawal of Tigertriever 13), while on the other hand, a high radial force would be associated with a higher rate of clot removal (expansion of the Tigertriever within the clot). However, the mesh of the Tigertriever can be manually over-expanded, whereas the radial force of conventional stent retrievers is determined by the diameter of the vessel. Over-expansion of the Tigertriever might result in a deformation of the mesh within the vessel, which we described as the "tear-drop-phenomenon" (Fig. 1). The retrieval of the over-expanded device without previous reduction of expansion might increase the risk of vessel wall injuries.

Our study has limitations mainly related to the retrospective design without predefined clinical and anatomical criteria for MTE in DMVOs. Furthermore, it was upon the operator's discretion to apply the Tigertriever 13 and how often to perform MTE maneuvers without fixed criteria or an institutional standard regarding the technical setup in MTE of DMVOs.

Conclusion

MTE in DMVOs using the Tigertriever 13 leads to high recanalization rates. The incidence of clinically asymptomatic hemorrhagic events appears to be higher in comparison with that in MTE procedures in LVOs. The indications for MTE in DMVOs need to be carefully weighted against the potential benefit. Further studies will help to identify anatomical and clinical criteria, which will contribute to establishing a guideline for MTE in DMVOs.

Abbreviations MTE: Mechanical thrombectomy; LVO: Large vessel occlusion; DMVO: Distal medium vessel occlusion; MCA M2: M2 segment of the middle cerebral artery; MCA M3: M3 segment of the middle cerebral artery; MCA M4: M4 segment of the middle cerebral artery; ACA A1: A1 segment of the middle cerebral artery; ACA A2: A2 segment of the middle cerebral artery; ACA A3: A2 segment of the middle cerebral artery; PCA P1: P1 segment of the middle cerebral artery; PCA P2: P2 segment of the middle cerebral artery; PCA P3: P3 segment of the middle cerebral artery; SCA: Superior cerebellar artery; ENT: Embolie in new territory; CT: Computed tomography; CTA: Computed tomography angiography; CTP: Computed tomography perfusion; NIHSS: National Institute of Health Stroke Scale; mRS: Modified Rankin scale; TICI: Thrombolysis in cerebral infarction; ICA: Internal carotid artery; VA: Vertebral artery; SAH: Subarachnoid hemorrhage; ICH: Intracerebral hemorrhage; sICH: Symptomatic intracerebral hemorrhage; IVT: Intravenous therapy; tPA: Tissue plasminogen activator

Declarations

Conflict of interest Author 1—agreement with Rapid Medical for consulting.
Author 2—none.
Author 3—none.
Author 4—none.
Author 5—none.
Author 6—agreement with Rapid Medical for consulting.

Ethical approval All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent A separate informed consent from each patient before inclusion in this study was not required due to the retrospective design of the study.

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