Brain Disorders & Therapy

Klingner et al., Brain Disord Ther 2015, 4:1
DOI: 10.4172/2168-975X.1000153

Case Report Open Access

A Case with 7 Min Door-To-Needle-Time and an Outline of Ultrarapid Stroke Management

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Rec date: Nov 20, 2014, **Acc date:** Nov 25, 2014, **Pub date:** Nov 30, 2014

Abstract

Tissue plasminogen activator (t-PA) is the only approved thrombolytic therapy for the treatment of stroke patients. Its effectiveness is highly time dependent due to the sensitivity of brain tissue to ischemia. Therefore, it is crucial to minimize the time between the onset of symptoms and the initiation of an effective thrombolytic treatment. Here we describe a case that received an ultrarapid thrombolytic therapy. A 72-year-old woman was presented at our emergency department with a sudden occurrence of severe left sided hemiparesis. After exclusion of intracranial hemorrhage, the patient received intravenous thrombolysis therapy 7 min after arrival at our hospital. The patient showed a fast, nearly complete improvement of symptoms, and a minor infarction was detected in a follow up MRI. We describe this case and the general stroke management in our emergency department that led to this rapid door-to-needle time.

Keywords: Stroke management; Thrombolysis; Case report

Introduction

Stroke is the second most frequent cause of death worldwide, accounting for ~11% of the total deaths. In the United States, stroke declined from the second to the fourth leading cause of death in the last 80 years [1]. Particularly, mortality rates after stroke decreased in the last 20 years [2]. The reason for this success was multifactorial and included improved prevention and improved care [3]. It has been established that the rapid initiation of a thrombolytic treatment is strongly beneficial to stroke patients (45). The sensitivity of brain tissue to ischemia causes the time dependence of the effectiveness of tissue plasminogen activator (t-PA). Accordingly, the number needed to treat (NNT) for one patient to recover increases with increasing time (<1.5 h NNT=5; 1.5-3 h NNT=9; 3-4.5 h NNT=15) [4-6]. Therefore, it is crucial to minimize the time between the onset of symptoms and the initiation of an effective thrombolytic treatment. This time can be divided in the time between onset of symptoms and the arrival at an emergency department and the time between arrival the application of thrombolytic therapy (door-to-needle-time). In order to optimize the door-to-needle-time, the development of a standardized protocol for stroke management is strongly suggested [7]. The effectivness is generally measured by the mean door-to-needle-time across multiple patients. However, also the peek performance (minmal door-to-needle-time) might be a valueable parameter for the effectiveness of an implemented stroke management. Here we describe a case with a door-to-needle-time of 7 minutes along with the general stroke management in our emergency department that led to this rapid door-to-needle time.

Case Report

A 72 years old right-handed woman, with treated arterial hypertension, developed an acute onset of left hemiparesis and dysarthria. The emergency medical service (EMS) was called immediately and the paramedics arrived 8 min later at the patient. After further 9 min the EMS physician arrived and after again 9 min the transport to the hospital started. After a total time of 36min the patient was admitted to our emergency department. Neurological examination showed a left sided hemiparesis including a facial palsy, no residual movement of the left arm and minor movements of the left leg, a sensory loss of tactile and pain perception, anosognosia, and left spatial neglect. The National Institutes of Health Stroke Scale (NIHSS) was 17. Emergency cranial computer tomography (cCT) showed no sign of intracranial hemorrhage, early infarction or edema apart from a hyperdense middle cerebral artery (MCA) in the insular fissure (Figure 1). A medication plan was acquired by the paramedics that did not show any medication potentially affecting the coagulation status. Following current guidelines [7], a total dose of 72 mg t-PA, with a bolus of 7 mg, was administered 7 min after her arrival in our emergency department (43 min after symptom onset). A cCT angiography and a cCT perfusion were performed after the start of the thrombolysis therapy. In cCT perfusion, the cerebral blood flow (CBF) and time to peak (TTP) images showed a broad perfusion deficit in the right MCA territory (Figure 1). The blood volume chart, however, showed a clearly less significant defect in this region, consistent with the presence of large ischemic penumbra in the cortical cerebral tissue within the MCA territory (Figure 1). CCT angiography showed a thrombus in the M2 segment of the right MCA (Figure 1) with signs of blood flow distally of the thrombus in the right MCA. After the cCT, the patient was transferred from the emergency department to our neurological stroke unit. NIHSS improved rapidly. After 4 hours the

NIHSS was 3. After 24 hours only a slight instability in walking tests was seen.

The follow-up magnetic resonance imaging on the next day showed the presence of multiple small infarcts in the right MCA region (Figure 2). The ultrasound investigation showed a recanalization of the MCA without any abnormalities in flow dynamics. Transthoracic and transesophageal echocardiography were also normal. During the 72 hour stroke monitoring period no other abnormalities were found particularly no sign of cardiac arrhythmias. An additionally recorded 24 hour electrocardiography was also rated as normal.

The patient received acetylsalicylic acid (100 mg) and simvastatin (80mg) for secondary prevention. Three days after arrival at our emergency department the patient was discharged home without any neurological deficits (NIHSS = 0). An outpatient neurological rehabilitation was initiated for occupational therapy training resulting in complete neurological recovery within the following two weeks.

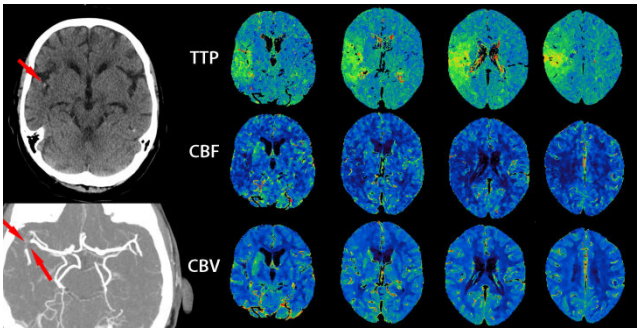

Figure 1: The cranial computer tomography (cCT) scan without contrast agent (upper left) showed no signs of intracranial hemorrhage, early infarction or edema. A hyperdense MCA in the insular fissure was seen (arrow). The cCT angiography (lower left) showed a thrombus in the M2 segment of the right MCA (marked by arrows). Abnormal perfusion was demonstrated in the right MCA region, characterized by increases in time to peak (TTP; upper row) and decreases in cerebral blood flow (CBF; middle row). The cerebral blood volume (CBV; lower row) seemed less affected.

Hyperacute management of stroke patients / in house hypermanagement of stroke patients

The current stroke protocol is based on the Helsinki protocol [8]. To attain minimal door-to-needle-times, we have created internal processes and protocols for acute stroke management prior to admission and in the emergency department. After arrival at the patient's location, the EMS personal perform a short clinical examination including the FAST test to identify potential stoke patients [9,10]. If the clinical symptoms suggest a stroke, the patient must be immediately transported to the emergency department. If possible, the paramedics acquire a medication plan for the patient, the phone number of near relatives and the family doctor. The emergency department is informed by phone about the impending arrival of a suspected stroke, with additional information on the time of onset of symptoms.

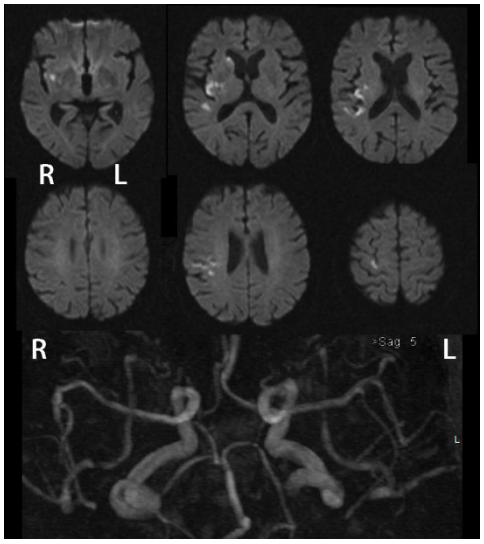

Figure 2: Magnetic resonance imaging 24 hours after the onset of symptoms. Diffusion-weighted imaging showed multiple infarcts in the right MCA region. Magnetic resonance angiography (lower part of the image) showed the recanalization of the right MCA.

The doctor in charge in the emergency department then informs the neurologist, who must be present in the emergency department prior to the arrival of the patient. Furthermore, the emergency physician blocks the cCT for routine investigations, preparing full monitoring including continuous intraarterial blood pressure management and airwaymanagement, if necessary. During transport, blood samples are taken by the EMS if possible and forwarded at their arrival. If a medication plan and information about the past medical history is available, there is no need to wait for for INR and platlet values before initiating thrombolysis.

On arrival at the emergency department, the patient is transferred from the rescue stretcher directly onto the table of the cCT scanner. The EMS reports to the neurologist and the in-hospital emergency physician about the patient. During EMS handover the nurses check the patient's monitoring equipment, supplemental oxygen supply, temperature and venous catheter. The neurologist performs a fast examination sufficient to determine the NIHSS and a short medical history including only facts that are necessary for the decision about thrombolysis. At the same time, the emergency physician also examines the patient, concentrating on airway, breathing, circulation and inserting intraarterial line for continuous intraarterial pressure management. However, the placement of the catheter must not delay the start of the cCT and must be cancelled if not successful completed within two attempts. While performing the cCT, the neurologist checks whether all necessary information (excluding cCT results) is present for a thrombolysis decision. If necessary, additional information is acquired (e.g., by calling relatives or the family doctor of the patient).

If clinical symptoms strongly suggest an ischemic and not a hemorrhagic origin of the symptoms we premix t-PA before the cCT-scan to save time, in case a thrombolysis will be indicated. Based on native cCT results, thrombolysis therapy was decided. If thrombolysis is approved, the drug is administered immediately (the t-PA has

already been prepared in the CT room). While the emergency physician administers the drug bolus, the nurse prepares the perfusor that is connected after the bolus. Now, if indicated, additional cCT-angiography and cCT-perfusion tests are performed. Afterwards, the emergency physician nad nurse observe and care for the patient next door (e.g. airway and blood pressure management). The neurologist stays with the radiologist to evaluate and discuss the cCT angiography and cCT perfusion. Based on all of the data now available, the subsequent treatment plan is decided, particularly whether a thrombectomy (e.g., in case of a long thrombus in the proximal MCA) has to be performed or whether the patient should be immediately transferred to the stroke unit.

Discussion

Until now, a door-to-needle time of 60 minutes is the official goal for treatment of ischemic stroke [7,11]. In the current case reports, we demonstrate that our structured stroke management strategy is able to greatly reduce this time.

It is beyond doubt that the fast initiation of treatment is strongly beneficial to stroke patients (45). The sensitivity of brain tissue to ischemia causes this time dependence of the effectiveness of tissue plasminogen activator (t-PA) [4-6]. Therefore, it is crucial to minimize the time between onset of symptoms and treatment. This requires the optimization of prehospital [12] and in-hospital stroke management.

To facilitate the recognition of strokes by the rescue services and to provide adequate prehospital stroke care, education programs for paramedics by experienced neurologists can be generally recommended [13]. Such education programs have to include the dispatchers so that they can improve their skills in recognizing the signs and symptoms of stroke [14].

It remains unknown whether appropriately educated paramedics need an additional EMS physician or if this delays the intake process. In our case, the EMS physician arrived 9 min after the paramedics and another 9 min elapsed until transport to the hospital started. However, in this time, the medication plan, phone numbers and medical history were acquired. The absence of this information would have delayed the door-to-needle time. Although the acquiring of information was exemplary, it could be questioned whether appropriately educated paramedics might be able to perform similarly without the EMS physician. After arrival at the emergency department, the patient should be further diagnosed and treated with the highest priority in the framework of predefined door-to-needle stroke management.

For every 15-minute reduction of door-to-needle time, there is a 5% lower chance of in-hospital mortality (45). In the United States, only 26.6% of patients who arrive in time to be treated with t-PA are treated within an hour after arrival, demonstrating the significance of in-hospital delays [15]. These data highlight that the door-to-needle time still has a high potential for optimization. Factors that improve door-to-needle time include advanced hospital notification by emergency medical services, fast access to a cCT, storing and administering t-PA in the emergency department, and the full-time availability of an in-house stroke expert [16].

To ensure a constant high quality of acute stroke management, hospitals should implement standardized processes and protocols for acute strokes to guide immediate patient assessment, brain imaging, drug administration and post-thrombolysis care.

Although the current case demonstrates the feasibility of very short door-to-needle times under the described in-hospital stroke procedures, there could be multiple reasons that might delay the door-to-needle time, for example missing information about prior medications or uncontrolled arterial hypertension. However, one has to keep an eye on the balance between speed to treatment and diagnostic accuracy to minimize the thrombolytic treatment of stroke mimics which is suggested to be below 3% [17,18].

Therefore, the described door-to-needle time cannot be suggested as a target time for thrombolysis, but demonstrates the potential of the Helsinki protocol under optimal circumstances [8]. Moreover, this case allows each hospital to compare door-to-needle-times under optimal circumstances. We suggest that not only the mean- but also the minmal door-to-needle-time is an important parameter for evaluating the effectiveness of a local stroke protocol. Particulary, the mean door-to-needle time might be negatively affected by different additional parameters independent from the quality of the stroke protocol. For example, the use of MRI-based thrombolysis in patients with unclear onset time of stroke symptoms might worsen the mean door-to-needle-time compared to hospitals that does not use/or have an MRI of this indication. Although it is beyond doubt that the implementation of the Helsinki protocol improves door-to-needle-times, the importance of individual measures (out of the twelve recommended measures) are not known and should be investigated in further studies (e.g. what time improvement are caused by premixing of t-PA).

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