

CHAPTER

7

Carotid Sinus Massage in Clinical Practice: the Six-Step-Method

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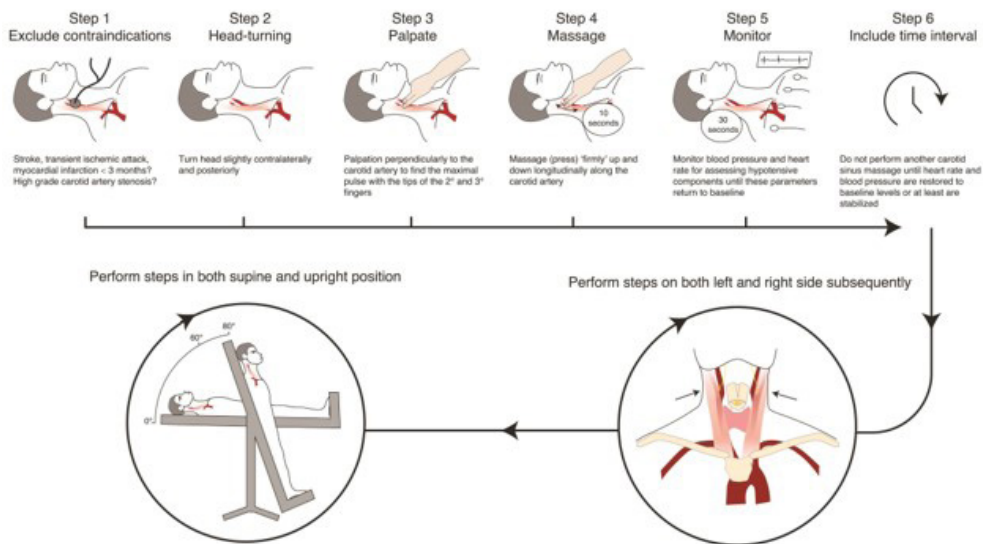
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WHAT'S NEW?

- The Six-Step-Method as standardized protocol to perform carotid sinus massage properly and safely for all physicians and allied professionals
- Equipment and personnel to perform carotid sinus massage
- Complication rate of carotid sinus massage before the year 2000 compared to the modern syncope unit
- Explanatory video and poster of the Six-Step-Method as supplementary material

Graphical Abstract

Six step method for carotid sinus massage



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Carotid Sinus Massage is safe and needed: the Six-Step-Method. Europace 2024. Illustrations by Jelle SY de Jong.

INTRODUCTION

Patients presenting after a syncopal episode are often asymptomatic upon evaluation as the event has already passed. To identify the cause of syncope, first the initial syncope evaluation is performed,¹ often yielding a diagnosis. However, when no diagnosis can be made using history taking, an active standing test and an electrocardiogram, further investigation is warranted. One specific cause of syncope, carotid sinus hypersensitivity, can be triggered manually by the physician. This is done by massaging the carotid sinus. Carotid sinus massage (CSM) is the only diagnostic tool for carotid sinus hypersensitivity (CSH), an exaggerated response to external stimulation of carotid sinus baroreceptors. CSH is defined as a fall in systolic blood pressure of at least 50 mmHg and/or three or more seconds asystole upon applying a firm pressure to the carotid sinus (**Figure 1,2**).¹ When asymptomatic, CSH is largely unrelated to syncope and has a low diagnostic value. For this reason, the diagnosis of carotid sinus syndrome (CSS) requires the presence of CSH and reproduction of symptoms (syncope or near-syncope) during massage.¹ In the case that the patient does not remember the circumstances before fainting circumstances then we must rely on symptom recognition during CSM. According to the 2018 European Society of Cardiology (ESC) syncope guidelines,¹ CSS is confirmed if CSM causes asystole (>3e seconds) and/or hypotension (> 50 mmHg) with reproduction of spontaneous symptoms, and patients have clinical features compatible with a reflex mechanism of syncope.¹ With increasing age, CSH becomes more prevalent.² In patients younger than 40 years old CSH is very rare.³⁻⁵ Therefore, CSM is indicated in all patients >40 years of age with syncope of unknown origin and compatible with a reflex mechanism.⁶ However, CSM may also be considered in younger patients who had undergone neck surgery or radiation, especially close to the locus of carotid sinus. A positive response to CSM demands a class I indication for therapy.¹

Nevertheless, CSM is largely underutilized in clinical practice and, when performed, its methodology of execution varies as also is the interpretation of its CSM results (see next section). Here we explore the reasons for the high variability of CSM execution across different countries and diagnostic centres and offer practical instruction on how to perform CSM and how to interpret its results.

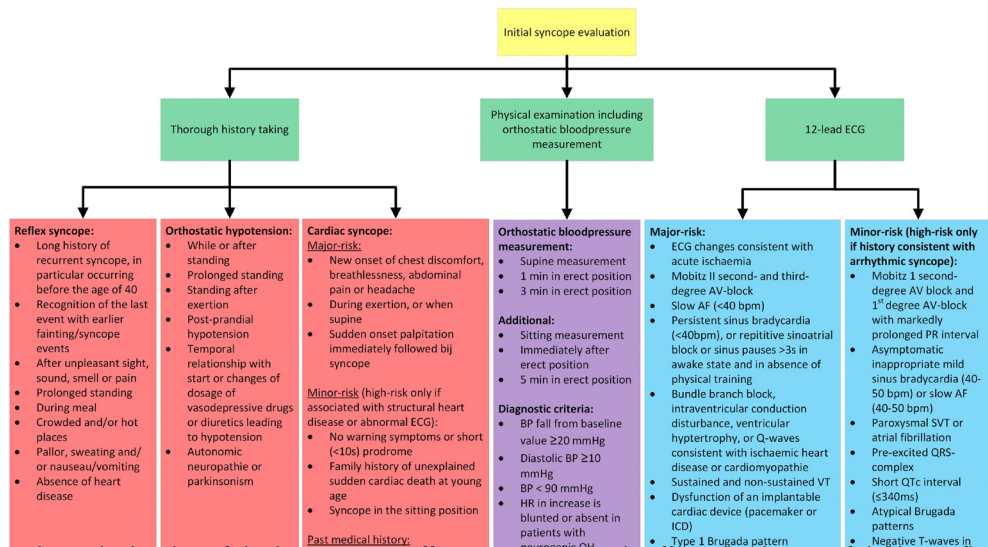
Barriers to a proper utilization of CSM in the diagnosis of syncope

Inter-operator and inter-centre variability in indications and interpretation of positive responses

The frequency of CSS diagnosed in syncope clinics vary widely in literature, owing to differences in indications, methods of execution of CSM,⁷ the definition of CSS^{8,9} and fear of possible complications caused by the procedure itself.¹⁰⁻¹² This results in large practice variation in execution of CSM across different countries and diagnostic centers and makes many physicians skeptical about the real usefulness of the test and reluctant to perform it.^{2,13}

Consequently, CSM is largely underused in clinical practice outside highly specialized syncope facilities, especially in United States of America, being performed in 0.07% to 8% among patients investigated for unexplained syncope above 40 years of age.¹⁴⁻¹⁹ In a recent survey on syncope units in the Netherlands,

Figure 1



Schematic drawing of the baroreceptor afferent and autonomic efferent pathways of the baroreflex arc. The afferent signals are transferred to the cardiovascular (CV) centre in medulla oblongata by the glossopharyngeal nerve (IX). When activated, the centre acts through efferents on effector organs via the vagus nerve (X) to the heart, causing bradycardia or asystole, and via sympathetic ganglia, leading to profound vasodilation and hypotension. CSM, carotid sinus massage.

CSM is usually not performed at all in 20% of the reporting centres and performed incomplete in 50% of the remaining centres. Among centres that perform CSM, one-fourth of them do this without continuous blood pressure monitoring.²⁰ In Sweden, two out of nine academic centres perform CSM according to the ESC guideline on syncope, and two others perform CSM only in selected cases (national unpublished survey data provided by AF).

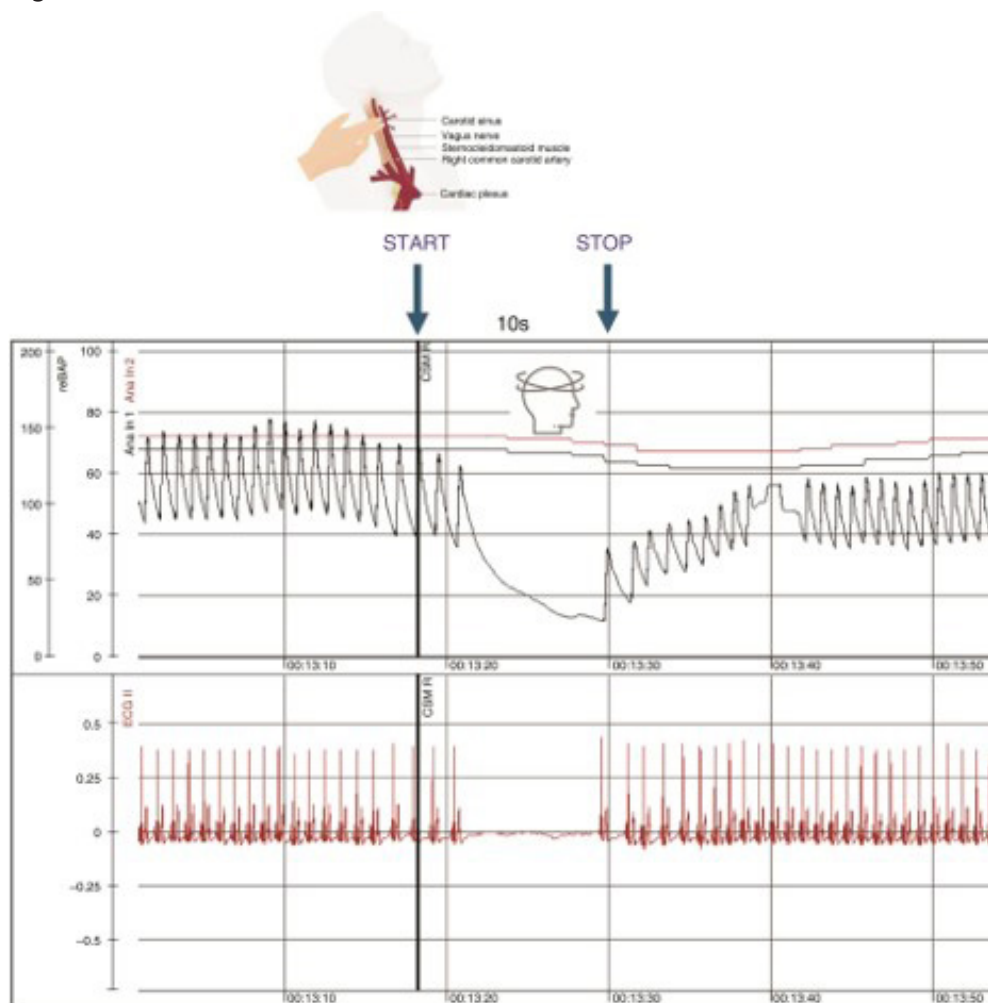
Even when CSM is performed in both supine and upright position and on both left and right carotid arteries, the positive diagnostic yield of CSM varies between 4-14.6% of examined patients in different settings.²¹⁻²³ A great inter-operator variability exists. For example, in a recent study²³ the positivity rate varied greatly from 0% to 36% among eight syncope centres with trained staff.

False perception of the risks

It is commonly believed that CSM may in some cases lead to cerebral ischemic attacks and caution should be taken before performing such procedure.²⁴ This belief comes from the reports of the old literature of the last century. In a pooled analysis of published studies (**Table 1**) an ischemic attack had occurred in 30 out of 8319 patients, i.e., 3.6 events per 1000 patients. In most cases, the event was transient with complete rapid recovery. For the above reasons, it is likely that some physicians refrain from performing CSM because of the fear of causing an irreversible damage to the patient and the risk of subsequent liability issues.

Factually, the complication rate has greatly decreased in the last two decades, being two out of 6328 patients, i.e., one case per 10,000 patients in a pooled

Figure 2



Carotid sinus massage performed on the right side in supine position in 50-year-old woman with recurrent syncopal attacks occurring in different body positions, including lying in the bed. A profound cardioinhibitory response with sinus arrest of 10 s, syncope, and total reproduction of spontaneous attacks. Please note that the slight deceleration of heart rate in the two beats preceding the marker ('START') was due to a gentle pressure to the neck when looking for the maximal pulsation, like we describe in step 3 of the Six-Step-Method. The patient was effectively treated with pacemaker and without recurrences over a period of five years. CSM, carotid sinus massage.

analysis of three large series of modern syncope units (**Table 2**), a significant decrease when compared with the old studies of the last century ($p < 0.0001$). Thus, CSM is a very safe procedure even if we must be aware of reporting bias of outcomes in this pooled analysis of published studies. There, are several possible explanations for this great decrease. Over the past two decades, a shift of epidemiology has occurred that might be responsible for the observed

persistently lower complication rate by: 1) better risk assessment in the current practice for older patients with unexplained syncope¹⁰; 2) better preventive- and treatment strategies against stroke²⁵; 3) better selection of patients with unexplained syncope > 40 years of age in whom CSM is indicated and performed; 4) the standardization of the method of performing the massage, due to the implementation of the guidelines in current medical practice that recommend the complete initial syncope evaluation in every patient with syncope.¹

Table 1: Complication rate of carotid sinus massage before the year 2000.

	Inclusion period	N	Age, mean $\pm$ SD	Males, %	TIA/stroke (%)	Specification of complication
Puggioni et al. Am J Cardiol 2002 (3)	1996-2000	1719	63 $\pm$ 16	56%	3 (0.17%)	TIA's <24 hour in 3
Davies et al Am J Cardiol 1998 (26)	1993-1998	4000	74 $\pm$ 14	na	11 (0.27%) (*)	TIA's <24 hour in 9, Persistent hemiparesis in 1, visual field loss in 1
Munro et al, JAGS 1994 (27)	na	1600	na	na	7 (0.44%) (**)	TIA's <24 hours in 4, stroke from 1 to 7 days in 3
Richardson et al Age ageing 2000 (28)	na	1000	69 $\pm$ 10	31%	9 (0.9%) (***)	TIA's <24 hour in 8, mild weakness of right hand >24 hour
Total		8319			30 (0.36%)	
					3.6/1,000	

(*) Davies: 2 pts had had previous TIA/stroke beyond 6 months. Carotid Doppler normal in 9, stenosis 70% in 2.

(**) 1 pt had 70% carotid artery stenosis,

(***) Doppler ultrasound normal in 8, carotid stenosis 50% in one

TIA's: transient ischemic attacks; na: not available; SD: standard deviation

Table 2: Complication rate of carotid sinus massage in a modern syncope unit.

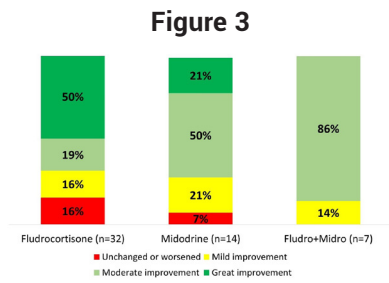
	Inclusion period	N	Age, mean±SD or median (IQR)	Males, %	TIA/stroke (%)	Specification of complication
Torabi et al. Europace (21)	2008-2021	1634	64±13	39%	0	0
Brignole et al. Europace (22)	2003-2019	3293	73 (64-80)	48%	2 (0.06%)	TIA's <24 hour in 2
Ungar et al. Age and Ageing (11)	na	1401	72±16	41%	0	0
Total		6328			2/6328 (0.03%)	0
						3 /10,000

TIA's: transient ischemic attacks; SD: standard deviation; na: not available; IQR: interquartile range

How to perform CSM in supine and upright position: The Six-Step-Method according to the method of symptoms

During CSM instant and rapid changes in blood pressure may occur that makes sphygmomanometer method inadequate. To measure these rapid changes, continuous blood pressure measurements are needed. For the assessment of syncope this is preferably done using a non-invasive-beat-to-beat (NIBTB) blood pressure monitor (e.g. Finapres NOVA® or Task Force®)(Table 3). In this way instant variations in both blood pressure and heart rate (HR) can be observed during CSM.^{7,29-31} Continuous blood pressure monitoring is necessary for a precise assessment of the magnitude of the vasodepressor component of the reflex, which can be missed by intermittent measurement traditional blood pressure recording using standard cuff. Nevertheless, we recognize the need to perform CSM also in those settings in which an instrument for continuous non-invasive blood pressure monitoring is not available. In such circumstances, CSM may identify a significant number of patients with cardioinhibitory responses to CSM who may be candidates for pacing or other interventions, however the assessment of an associated hypotensive reflex should be performed by means of other tests, e.g., tilt testing.

CSM should be performed on both the right and left side, with the patient in both supine and upright position (in head-up tilt (HUT) between 60 to 80 degrees), resulting in a total of four separate carotid sinus massages per patient (Figure 3). explanatory video and poster provided as supplementary material in this paper).



Performing CSM in both supine and upright position is important since CSM can, in some patients be positive in one position only, and in some cases the positive response is cardioinhibitory in supine but vasodepressive in standing position.²³ To prevent injury of the patient caused by a fall due to syncope during CSM in the upright position, CSM should be performed when patients are fixed by straps as is done during regular head-up tilt testing (HUTT).^{29,30} In order to perform CSM in the upright position one must take into account that also in the upright position both the patient and the hemodynamic parameters should be visible for the operator during and after CSM. CSM can be easily combined with HUTT during short autonomic cardiovascular assessment as recently described and shown in our explanatory video that is included in this paper as supplementary material (**Table 3, Figure 4**).³²⁻³⁴ The Atropine test is useful to unmask an underlying vasodepressor response in patients with cardioinhibitory response. Since the CSM

is performed on a tilt table and it is followed by a tilt testing, atropine test is no longer needed because the vasodepressor response can already be revealed by tilt testing.

Table 3: Equipment and personnel to perform Carotid Sinus Massage

Equipment / Personnel		Explanation
1	Tilt table	In order to perform CSM in the upright position after performing CSM in supine position without the risk of injury (see also explanatory video as supplementary).
2	Continuous blood pressure monitor or cardiac monitor*	Non-invasive beat to beat monitoring order for detection instant changes in HR and blood pressure
3	Two persons	One that performs the CSM and one that controls the marker on continuous blood pressure monitor

** In some hospitals, CSM is performed without access to continuous blood pressure monitoring, which is a suboptimal approach as the investigator can miss an important vasodepressive reflex component with negative therapeutic consequences. Thus, the authors encourage applying the most optimal methodology as presented below.*

CSM: carotid sinus massage; HR: heart rate

Here we describe the Six-Step-Method according to the 'methods of symptoms' (**Table 4, Figure 3 and Supplementary file**).

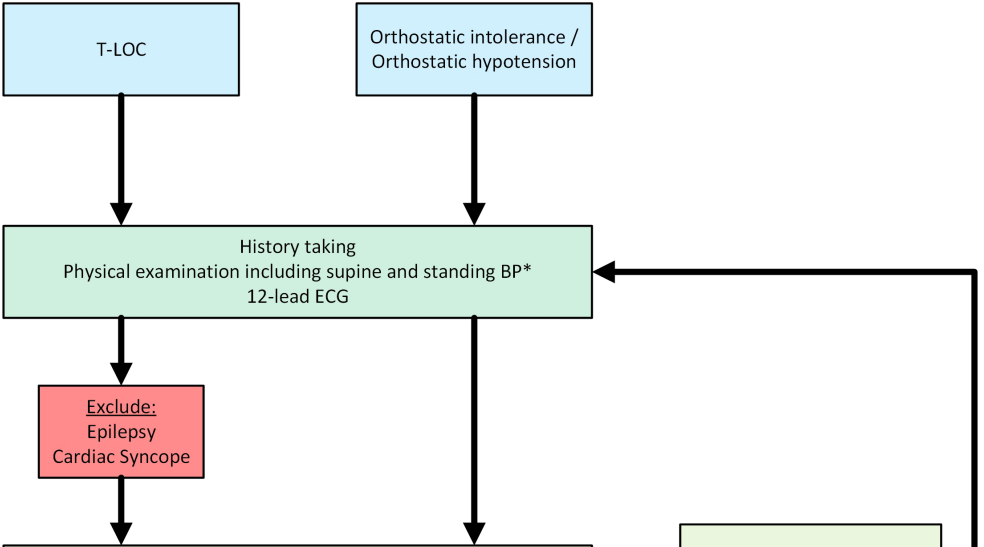
The first step is to exclude any contraindication to CSM (**Table 4 and Figure 3**). It is a common sense to refrain from CSM in patients with a previous transient ischemic Attack (TIA)/stroke in the last three months and/or confirmed high-grade carotid stenosis.³⁵ To obtain this information the medical history of patient is sufficient, effective and easily available in most cases prior to performing CSM. However, in unresolved cases or when the clinical suspicion of carotid stenosis is high, carotid auscultation might be performed followed by optional carotid ultrasound if carotid bruits are present.^{26,36} Although it should be kept in mind that cerebral complications may occur in absence of a significant carotid stenosis. Indeed, as shown in **Table 1**, embolic complications occurred in most patients with normal carotid arteries. Probably, the best criterium for the proper selection of patients is an assessment of the risk/benefit ratio. In general, the benefit of performing CSM is greater in those patients who may benefit from a specific effective therapy derived by the diagnosis of CSS, such as pacemaker implantation in cardioinhibitory CSS. For the second step the patient is asked to turn the head slightly contralaterally posteriorly for a gentle and careful palpation to search for and detect the location of the carotid sinus and where is the exact location of maximal pulsation. When the exact location of the maximal pulsation is confirmed, the CSM may be started (the second person applies the marker available on the monitor for exact labelling of the duration of CSM). We continue with step 3: the massage of the carotid sinus should be applied at the site of the maximum carotid pulse, located between the angle of the jaw and the cricoid cartilage on the anterior margin of the sternocleidomastoid muscle with the neck rotated contra-laterally and posterior (step 3) and applied firmly and deeply using two fingers moving up and down along the carotid artery (step 4). Moving up and down during massage is important since the location of the carotid sinus may vary in its location due to anatomic variation.³⁷ According to the ESC guidelines instructions,⁶ the CSM should be performed for 10 seconds to allow symptoms to develop and the vasodepressor component to become evident.^{3,38} Additionally, just before commencing CSM make sure the marker is running, this will allow measurement of the RR interval prior to CSM. After the massage is terminated, the HR and blood pressure should be monitored until the hemodynamic parameters have been restored to the baseline level. Usually this is within 30 seconds, but the observation may be prolonged in the severe vasodepressor forms (step 5). This longer monitoring period is important to detect the magnitude of the vasodepressor component of the carotid sinus reflex, which occurs later than the cardioinhibitory component and may have important implication for the therapy. Make sure the period of the actual massage is properly marked/indicated. The next CSM should not be performed until heart rate and blood pressure are restored or stabilized at baseline levels (step 6). Record if the patient experiences either a presyncopal or syncopal episode. Ascertain if these symptoms were the same as the spontaneous symptoms (is there recognition?).

Table 4: Six-step-method for Carotid Sinus Massage

Steps	Action	Explanation
1	Check history for exclusion CSM	CSM is contra-indicated in case of TIA/stroke/ myocardial infarction in the past 3 months, high grade carotid stenosis. Auscultation should be performed in unresolved cases or high suspicion of carotid stenosis
2	Head turning	Turn head slightly contralaterally and posterior
3	Palpate to orientate	Palpation perpendicularly to the carotid artery to find the maximal pulse with the tips of the 2nd and 3rd fingers
4	Massage for 10s	Massage (press) 'firmly' up and down longitudinally along the carotid artery
5	Monitor HR and blood pressure after the CSM	Monitor blood pressure and HR for assessing hypotensive components until these parameters return to baseline
6	Include time interval to another massage	Do not perform another carotid sinus massage or start CSM in the upright position after achieving CSM in supine position, until heart rate and blood pressure are restored to baseline levels or at least are stabilized (see also explanatory video as supplementary).

TIA: transient ischemic attack; HR: heart rate; CSM: carotid sinus massage

Figure 4



The Six-Step-Method for carotid sinus massage. Carotid sinus massage should be performed in supine position on both left and right sides followed by both the left and right sides in upright position. For this, a tilt table is required to perform CSM in standing position (see also explanatory video as Supplementary file). This figure is also available as a poster provided as Supplementary material.

Limitations

CSM may be a fatigable reflex such that the order in which is carried out (right-left, supine-upright) may impact outcome. Little is known in the literature at the regard. The merit of this study is that we have standardized the sequence of execution. The impact of the sequence of execution on the results of CSM is outside the scope of this study and should be the aim of another study.

Practical implications

Here we propose the Six-Step-Method for CSM that can be applied easily and safely in syncope units as part of the short cardiovascular autonomic function assessment (23). When performed during such comprehensive autonomic assessment in appropriate patients in the setting of a specialized syncope unit, the diagnostic yield of CSM is as high as 25%, (of which 20% are asystolic forms) (23).

CONCLUSION

The Six-Step-Method for CSM is a safe procedure and should be performed, after the initial work-up, in every patient above 40 years, with unexplained syncope which is compatible with a reflex mechanism.

Conflict of interest statement

All authors have declared no conflicts of interests.

Data availability statement

The data underlying this article are available in the article and in its online supplementary material.

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