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Decreasing the Delay to Carotid Endarterectomy in Symptomatic Patients with Carotid Stenosis — Outcome of an Intervention

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WHAT THIS PAPER ADDS

- This study demonstrates how it is possible to shorten the delay to carotid endarterectomy among patients with symptomatic carotid stenosis with quite simple changes made in the surgical and the neurological unit. However, affecting only the in-hospital delay, optimal results are still not achieved, as our study corroborates. At the same time, our study points out the areas where we could and should still focus more carefully in order to minimise the delay and maximise the expected benefit in stroke prevention.

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ABSTRACT

Objectives: Surgical treatment of carotid stenosis after the onset of ischaemic symptoms should be performed within 2 weeks. This aim was accomplished only in 11% during the years 2007–2008 in the Helsinki University Central Hospital (HUCH) region. Since then, special efforts have been made in order to shorten the delay. The aim of this study was to find out how these changes affected the symptom-to-knife time (SKT).
Materials and methods: All symptomatic patients ($n = 144$) who had carotid endarterectomy (CEA, $n = 145$) in HUCH in 2010 were retrospectively analysed and the SKT was determined.
Results: Of the operations, 37% ($n = 53$) were performed within the recommended 2 weeks. The median SKT was 19 days (1–183). Of the patients who came to HUCH on an emergency basis ($n = 80$), 55% ($n = 45$) were operated within 2 weeks and their median SKT was 13 days (1–148).
Conclusions: The changes that were made in 2008–2009 have significantly shortened the delay in the treatment of carotid stenosis, but the desired time frame of 2 weeks was reached far too seldom. The greatest benefit from preventive CEA is achieved when patients are referred emergently to a clinic where neurologist, imaging resources and vascular surgeon are available.

Cerebrovascular events are the fourth leading cause of mortality in Finland causing 8% of deaths in males and 12% in females.[1,2] With the constantly ageing population, stroke prevention is, or at least should be, a major concern for the Finnish society. Baby boom generation is on the verge of retirement and it has been predicted that the share of individuals aged over 65 years in the Finnish population will rise from 17% to 27% by the year 2040.[3]

Internal carotid artery stenosis accounts for 10–16% of ischaemic strokes.[4] Carotid endarterectomy (CEA) is the standard procedure for the treatment of symptomatic carotid stenosis. According to meta-analysis by Rothwell et al. (2003), surgery can be considered to be highly beneficial in patients with a stenosis degree 70–99% with a stroke risk reduction of 16% in 5 years and moderately beneficial in patients with a stenosis degree 50–70% with a risk reduction of 4.6%.[5]

Also gender and the delay from symptoms to surgery have been found to have a major impact on the success of CEA in stroke prevention.[6,7] The risk reduction in stroke prevention declines quickly after 2 weeks, especially among female patients.[8] Thus, if

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surgery is indicated, it should be performed within 2 weeks[9] assuming that the perioperative stroke risk is <6%.[10] It has been shown that early surgery is as safe as delayed.[11,12]

In our previous report, we evaluated the delay and the reasons for the delay in carotid surgery for 100 symptomatic patients in 2007–2008.[13] We found that only 11% of the patients were operated in 2 weeks and the median symptom-to-knife time (SKT) was as high as 47 days.

Surgical delay, the time from consultation of a vascular surgeon to surgery, was the longest part with a median of 25 days. Thus, we conducted an intervention concerning our policy and practice in order to achieve the 2-week target time (Table 1): two additional surgical time slots per week were added in the operating schedule and operations were scheduled on call if the first elective time was considered to be too far away. In addition, efforts were made to shorten the consultation delay of a vascular surgeon. A transient ischaemic attack (TIA) clinic was introduced at the neurological emergency unit of our hospital where all the TIA, amaurosis fugax (AFX) and minor stroke patients were evaluated by an on-call neurologist. Carotid imaging by ultrasound and/or computed tomography (CT) angiography were performed preferably on the same or the next day. This is in line with the national guidelines on the Current Care of Ischemic Brain Infarct patients (2011).[14] Local meetings for primary care physicians, neurologists and vascular surgeons were organised concerning this topic. All of these changes were started in 2009 and were in full practice in 2010.

The purpose of this study was to evaluate the impact of the organisational intervention on the SKT in patients with symptomatic carotid stenosis.

Materials and Methods

All 144 consecutive symptomatic patients with 145 CEAs performed in HUCH in 2010 were included. During the same time period, 35 patients had CEA for asymptomatic stenosis and four patients were treated by carotid artery stenting, These were not included in this study, as were also not the patients whose treatment was decided to be best medical therapy rather than operative treatment. After approval from the local Ethics Committee, the hospital records of the patients were evaluated retrospectively. The medical history was collected from the hospital records and the prospective HUSVASC registry.[15] Age, sex, smoking status as well as the pre-existing conditions of diabetes, hypercholesterolaemia, hypertension and cardiac disease were recorded.

The onset date and the nature of the index symptom were registered. Index symptom was determined as the symptom that led to the patient seeking medical attention and resulted in surgery. Symptoms were categorised as AFX, TIA, minor stroke, major stroke and miscellaneous. Using the modified Ranking Scale (mRS), distinction between minor (mRS 0–2) and major (mRS ≥3) stroke was made by a neurologist (TS).

The degree of carotid stenosis was evaluated usually by ultrasound scanning as the first imaging. Preoperatively, the degree was confirmed by either CT or magnetic resonance imaging (MRI). MRI was mainly used when CT was contraindicated due to patients' poor renal function. The degree of stenosis was recorded as 50–69% and ≥70%. The degree of contralateral stenosis was also recorded.

Table 1
Efforts made in 2009 to shorten the Symptom to Knife Time.

1. Two additional timeslots in the operating schedule per week
2. Operating on call if no elective times available in 2 weeks
3. Carotid imaging by US and/or CT on call
4. Local meetings with the primary care physicians

The urgency classification of the operations and perioperative complications were identified. Postoperative recovery in the surgical ward and the length of stay (LOS) in hospital were analysed. Follow-up was 30 days after surgery, routinely done by a vascular nurse over telephone and only in case of need by a vascular surgeon.

The different delay times that were assessed in this study were patient-related delay (index symptom – first health-care contact), referral delay (first health-care contact – neurologist's evaluation), neurological delay (neurologist – referral to surgeon) and surgical delay (surgeon's evaluation – surgery).

Statistical analyses

Distributions of the continuous variables were studied and tested for normality. Univariate comparison between the groups' SKT below and above 2 weeks was performed with Student's *t*-test when appropriate for continuous variables and with Pearson $\chi 2$ test for discrete variables. SPSS 19.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. Two-sided values of $p < 0.05$ were considered.

Results

The demographics, medical history, medication both at the time of the index symptom and on the day of the surgery, indications for CEA, degree of stenosis and referral pathways are shown in Table 2. The most common index symptom was stroke ($n = 55$, 38%) and 64% of these were minor strokes. In five cases, the indication for surgery was retinal infarction. These patients were counted as

Table 2
The demographics, medical history, indications for CEA, stenosis degree and referral pathways. → represents the change in medication from arrival to hospital to the time of surgery.

Age (years)	69
Sex (male) (%)	64
Smoking (%)	44
Hypertension (%)	67
Dyslipidemia (%)	58
Cardiac disease (%)	32
Diabetes (%)	30
Antihypertensive medication (%)	79→88
Statin treatment (%)	59→93
Anti-platelet treatment (%)	62→93
Presenting symptom (%)	
Afx	24
Tia	37
Stroke	38
Minor (mRs 0–2)	24
Major (mRs >2)	14
Miscellanous	1
Stenosis (%)	
50–69	25
70–99	75
Contralateral occlusion/stenosis (%)	
0–49	69
50–99	26
100	6
First healthcare contact (N)	
Health care center	52
Secondary referral centres	20
Neurologist HUCH	42
Ophthalmologist	16
Private practitioner	2
Neurologist outside HUCH	7
Surgical ward	2
Neurological ward	1
Other university hospital	2
Hospital in Italy	1

minor stroke as all had partial visual impairment at the time of the operation. In two CEAs, index symptom was dizziness rather than a clear carotid symptom. These were categorised as miscellaneous (1%).

Fifty-three operations (37%) took place within the desired 2 weeks (Fig. 1). In 4 weeks, 67% ($n = 97$) had been operated. On the other hand, in 14% ($n = 21$) delay was over 12 weeks. The median time from index symptom to surgery (SKT) was 19 days (range 1–236 days) (Fig. 2). Forty-five of the patients ($n = 53$, 85%) who were operated within 2 weeks came to HUCH on an emergency basis. The median SKT for those who were assessed on call was 13 days (1–148) compared to 36 days (6–236) for the ones referred electively ($p < 0.0001$). The median surgical delay was 8 (0–80) days. In 32 operations, the surgical delay exceeded 2 weeks and the underlying reasons were analysed more closely in order to recognise the situations where improvement would still be possible (Table 3).

Notably, the patient-related delay constituted a significant portion of the total delay in patients with the delay over 12 weeks (Fig. 3). Also, among these patients ($n = 21$), emergency referral to neurologist was done only for 4 (19%). Patients tended to be more often female (48% vs. 34%, ns), the index symptom was more often AFX (33% vs. 23%, ns) and more rarely a stroke (19% vs. 41%, $p = 0.054$) compared to the patients whose delay was less than 12 weeks.

Of the 53 operations that were performed within 2 weeks, 17 (32%) were performed on call. Indications for on-call operations were progression, fluctuation or recurring symptoms ($n = 5$), unavailability of elective operating time within 2 weeks ($n = 9$) or non-specific reasons ($n = 3$). Four patients on the waiting list were operated on call beyond the 2-week target frame, two of them because of recurrent symptoms and two due to lack of an available elective time. The patients who were operated on call due to lack of available time slots ($n = 11$) were analysed more closely. The operating dates were scattered throughout the year and none of the on-call operations were performed on major holidays.

There were 21/144 (14%) patients who had recurrence or progression of the symptoms during the time between the index symptom and the operation. Six of them had recurrent AFX symptoms (29%), eight had recurrent TIAs (38%), five had recurrence or fluctuation of minor stroke symptoms (24%), one minor stroke progressed into a major stroke (<5%) and one had major stroke symptom progression (5%). Their median SKT was 11 days (1–109).

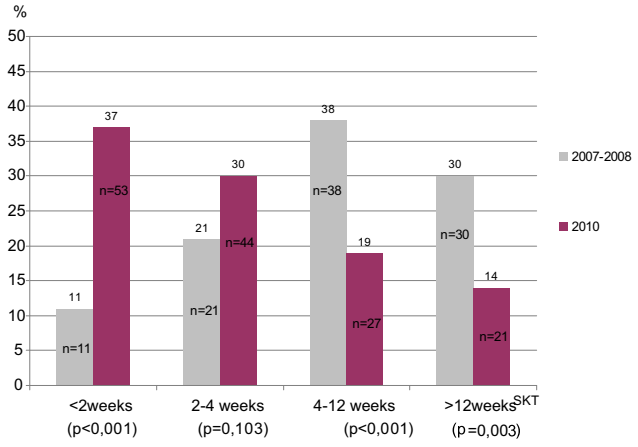

Figure 1. The symptom-to-knife times (SKT) in 2007–2008[13] and 2010. The columns represent the precentage of the patients operated in the different time frames as illustrated on the *x*-axis. n = number of the patients.

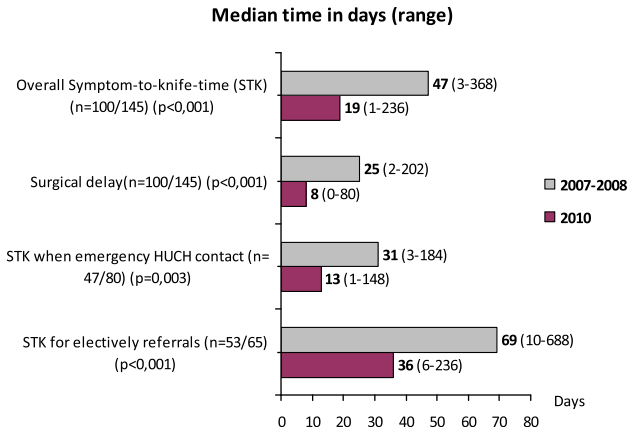

Figure 2. The median Symptom-to-knife times (SKT) in 2007–2008[13] and in 2010.

There were no perioperative deaths. Four patients out of 144 (2.8%) suffered a perioperative major stroke. There were 8/145 (5.5%) haematomas requiring operative evacuation. One (0.7%) patient developed difficulty in swallowing postoperatively, damage to the vagus, hypoglossal and glossopharyngeal nerve were detected by a speech therapist. The patient recovered in 3 months as most patients with major cranial nerve injuries do.[16] Two (1.4%) patients presented speech slurring due to deviation of the tongue resulting from hypoglossal nerve stretching. At 1-month control visit, one had recovered fully, while the other still had some difficulties with speech and was referred to neurological evaluation for rehabilitation. Taken together, there was a 2.8% perioperative combined stroke and/or death risk, 2.1% risk of transient cranial nerve damage and 5.5% risk of wound complications.

The median postoperative LOS was 2 days. In 48 patients (33%), LOS exceeded 2 days, including eight patients who had post-operative complications as described above. The most common reason for extended stay in the ward was hypertension alone ($n = 13$, 9%) or combined with headache ($n = 3$, 2%). All these patients were successfully treated with anti-hypertensive medication. Trans-cranial Doppler (TCD) was performed on patients experiencing headache. None of these patients developed hyperperfusion syndrome. If pre- or postoperative stroke compromised home care ($n = 29$), referrals were made either to a neurological ward or to the primary care centre. These patients' median hospital stay was 3 days (0–11). At discharge, 79% ($n = 116$) went home, 7% ($n = 10$) to a HUCH neurological ward, 8% ($n = 11$) to a secondary neurological ward and 6% ($n = 8$) to a primary care centre ward.

Effectiveness analysis was made by dividing patients into subgroups by sex, degree of stenosis and delay (Fig. 4). Sixty-five percent were operated with a good benefit expectation (NNT < 7) and 22% with a reasonable good benefit expectation (NNT 8–20). Thirteen percent were operated at a point in time when there was no theoretical benefit for the patient due to prolonged SKT.

Table 3
Reasons behind surgical delay exceeding 2 weeks, *n* (%).

Other illness that needed treatment	5 (15%)
Unexpected shortage of surgical staff	5 (15%)
Index symptom >2 weeks at the time of surgical consultation	4 (12%)
Urgency classified as "operation within 1 month"	1 (3%)
Patient's preference	1 (3%)
Showed up for surgery drunk	1 (3%)
No obvious reason for delay	15 (48%)

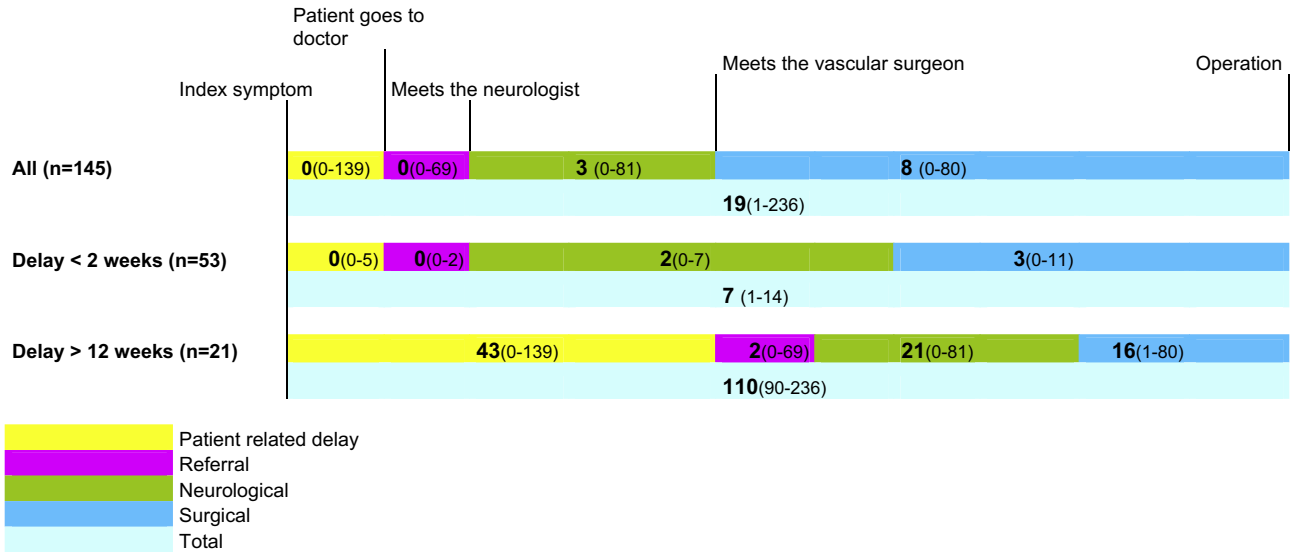

Figure 3. The components of delay shown separately to patients who were operated within two weeks and the ones whose delay exceeded 12 weeks. The numbers are shown as medians (range).

Discussion

Surgery for symptomatic carotid stenosis is highly beneficial in stroke prevention.[17,18] The benefit is associated with symptoms, gender, age, degree and nature of the stenosis, delay from symptom to surgery as well as postoperative complication rate. Delay from symptom to surgery has been proven to be associated strongly with the effectiveness of CEA in stroke prevention.[6,7] The benefit decreases rapidly after 2 weeks from the symptom.[12,13]

In the previous report, we found that the delay in carotid surgery was far too long in our hospital 3 years ago (Vikatmaa et al.).[13] After these concerning results, we made an effort to decrease the delay. Rather, simple changes made in HUCH in 2009 have shortened the delay from symptom to surgery significantly from the median of 49 to 19 days. Especially the surgical delay from 25 to 8 days can be regarded as a substantial improvement. This was expected, since the main focus of the intervention was to decrease the in-hospital delay, that is, the door-to-knife time (DKT). No attempt was made to improve the public awareness. Requesting CT angiogram on an emergency basis and adding 2 weekly time slots in the operating schedule were the most significant changes in our practice. While progress in all delay components is

2010, n=145 (%)

	0-2 weeks	2-4 weeks	4-12 weeks	> 12weeks
70-99 % male	**21 (14)**	**21 (14)**	**16 (11)**	**8 (6)**
50-69% male	**11 (8)**	**8 (6)**	**5 (3)**	**3 (2)**
70-99% female	**17 (12)**	**12 (8)**	**5 (3)**	**9 (6)**
50-69% female	**4 (3)**	**3 (2)**	**1 (0.7)**	**1 (0.7)**

2007-2008, n=100 (%)

	0-2 weeks	2-4 weeks	4-12 weeks	> 12weeks
70-99 % male	**8 (8)**	**11(11)**	**19(19)**	**16(16)**
50-69% male	**0(0)**	**5(5)**	**7(7)**	**8(8)**
70-99% female	**3(3)**	**4(4)**	**10(10)**	**6(6)**
50-69% female	**0(0)**	**1(1)**	**2(2)**	**0(0)**

Figure 4. The effectiveness of CEA in stroke prevention in 2007–2008[13] and in 2010 illustrated in subgroups according to the theoretical number needed to treat (NNT) as described previously. Green: NNT <7, best possible benefit; Yellow: NNT = 8–20, reasonable benefit and Red: NNT cannot be calculated i.e. operation theoretically harmful.

Table 4
Scenario of an ideal situation for the 63 % of the patients (n =92) whose delay exceeded the two weeks target time. The effect is shown as the precentage of all the 145 operations that would take place in two weeks.

What if…	**Operated < 2 weeks**	**What would it require**…
Patient delay (P)= 0	43%(n=62)	Public education
Referral delay (R)= 0	41%(n=59)	Reminding and instructing the referring doctors
Neurological delay (N)= 0	49%(n=71)	Immediate imaging and diagnostics
Surgical delay (S)= 0	63%(n=92)	Operating patients on call and unlimited access to the operating room
P +R = 0	47% (n=68)	Better public and general practitioners awareness COMBINED WITH...
P + R + N = 0	61% (n=89)	... rapid diagnostics by a neurologists
N + S =0	73% (n=106)	An active neurologist and vascular surgeon AND AN PRECEDING...
R + N + S = 0	79%(n=114)	...active general practitioner

indisputable, still only 37% were operated within the 2-week target. These results are still far from those centres where TIA clinics are in practice. After the creation of a rapid access TIA service, 78% of the referred patients were operated in 2 weeks and the median delay was 9 days in Leicester Vascular Surgery Unit.[19] According to Scandinavian vascular registries, the median delay of CEA was as short as 9 days in 2010 in Sweden[20] and 8 days in Denmark, the latter representing the delay from referral to surgery.[21]

In order to further improve our results and to clarify the task at hand, we did an idealising exercise by controlling the different components of delay (Table 4). In the 92 patients whose delay exceeded 2 weeks, we nullified each of the delay components at a time or combined with each other to calculate effectiveness of this to the total delay. The effect on delay is shown as the percentage of all the operations (n = 145) that would have taken place within 2 weeks. It is obvious that correcting only one part of the delay rather meagre results are accomplished. Even a perfect situation in two or three components of delay does not increase the number of patients with a delay of less than 2 weeks to over 80%. The best outcome calculated from this idealising exercise is 79% having the operation in 2 weeks resulting from a combination of 0 days of referral, neurological and surgical delay.

Naturally, just a calculated 0 days of delay does not translate into reality because each component has an influence on the other, thus producing a cumulative delay. For example, if the patient-related delay is long, the first referral is not done on an emergency basis and surgery is not scheduled within the target time since the 2 weeks have already passed at the time of the surgical consultation. In reality, as it was demonstrated in this study, that if there was no patient nor referral delay, 55% (n = 44/80) of the patients were operated in 2 weeks. Therefore, getting the patients on an emergency basis to the hospital and providing the required care is definitely a goal worth aiming at.

The imaging referrals can easily be made without delay in the emergency room, but there will always be days when the imaging just takes longer since it depends on the resources available in radiology as well as the radiologist on call assessing the images. In addition, even if every CEA would be operated on call, they would not all take place on the same day, since not all emergency operations are performed within 24 h. In this study, every third operation that reached the 2-week time limit was performed on call and half of on-call operations were due to the lack of available elective operating times. It is clear that additional resources are needed to meet the growing demand for early CEA keeping in mind that the on-call operating slots are meant for the patients who really need an emergency operation.

No major improvement was seen in the theoretical effectiveness of carotid surgery. A good benefit expected in the current series was 65% versus 57% in 2007–2008, a reasonable benefit expected in 22% versus 24%, respectively, and operation theoretically harmful in 13% versus 19%, respectively. Among patients whose delay was >12 weeks, half were women (10/21) even though in the whole study population 36% were female and it was a known fact during the study time that there is less or no stroke risk reduction expected in operating female patients after 2 weeks. Thus, we did not succeed in selecting the female patients sooner to CEA. In this area, vascular surgeons could still sharpen their focus. When placing a patient on operating lists and after assessing the need for CEA, one should take into account the old saying: “Ladies first.”

The main limitation of the current study is its retrospective nature. Also, the study population consisted of only the patients who underwent CEA, and we did not get hold of the patients whose operation was cancelled due to, for example, major stroke and death after the index symptom. In addition, no comparison was made to the patients treated with best medical therapy as these patients were not identified and analysed. On the other hand, the material was evaluated carefully by both, vascular surgeon and neurologist, and in Finnish case histories, details are traditionally described comprehensively.

Conflict of Interest/Funding

None.

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