# Delayed temporomandibular joint pain and dysfunction induced by whiplash trauma

## A controlled prospective study

**Hanna Salé, DDS; Annika Isberg, DDS, PhD**

**Background.** The Quebec Task Force on Whiplash-Associated Disorders urged for controlled, prognostic studies of symptoms after whiplash trauma. The authors conducted a study that met the design requirements to enhance knowledge about short-term and long-term temporomandibular joint (TMJ) pain, dysfunction or both induced by whiplash trauma.

**Methods.** The authors studied 60 consecutive patients who had neck symptoms after whiplash trauma and were seen at a hospital emergency department. They followed up 59 subjects one full year later. At the inceptive examination and at follow-up, each subject completed a self-administered questionnaire, followed by a comprehensive interview. Fifty-three frequency-matched control subjects followed the same protocol concurrently.

**Results.** The incidence of new symptoms of TMJ pain, dysfunction or both between the inceptive examination and follow-up was five times higher in subjects (34 percent) than in control subjects (7 percent). The frequency of TMJ pain increased significantly in female subjects, as did the frequency of TMJ symptoms that were reported to be the main complaint. At the follow-up, 20 percent of all subjects reported that TMJ symptoms were their main complaint.

**Conclusions.** Our results suggest that one in three people who are exposed to whiplash trauma is at risk of developing delayed TMJ symptoms that may require clinical management.

**Clinical Implications.** Awareness of a significant risk for delayed onset of TMJ symptoms after whiplash trauma is crucial for making adequate diagnoses, prognoses and medicolegal decisions.

**Key Words.** Prospective; temporomandibular joint; whiplash trauma; asymptomatic; pain; dysfunction.

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The Quebec Task Force on Whiplash-Associated Disorders (WAD) published a systematic review of the literature on whiplash injuries in 1995[1] followed by an updated review in 2001.[2] They considered 24 studies of prognosis to be scientifically admissible, one of which focused on the temporomandibular joint (TMJ) but did not include control subjects.[3] Since the updated review, two TMJ-related studies have been published.[4,5] The first study was a controlled follow-up that investigated TMJ pain and dysfunction.[4] It only included patients between the ages of 20 and 35 with signs and symptoms corresponding to WAD grade 1[1] (that is, a neck complaint of pain, stiffness or tenderness but no physical signs). The patients, therefore, were not representative of the general population that is exposed to whiplash trauma. The second study was population-based and included patients who had been exposed to either an indirect whiplash trauma or a direct trauma to the head.[5] It evaluated the incidence and recovery of reduced or painful jaw movements that began with the car collision but did not account for whether there was TMJ affliction. Impaired and painful jaw movements can be symptoms of TMJ injury, but they also can be associated directly with the neck injury in patients who

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have WAD.[6,7] It remains unclear whether a delayed onset of symptoms can occur in TMJs that appear unaffected directly after whiplash trauma.

We conducted a study to enhance knowledge about short-term and long-term TMJ pain, dysfunction or both induced by whiplash trauma. We hypothesized that delayed symptoms frequently develop in the TMJ after whiplash trauma and that the sex of the patient affects the development of posttraumatic symptoms in the TMJ.

**TABLE 1**

| STUDY SAMPLES | SEX (NO.) | | AGE (YEARS) | | |
|---|---|---|---|---|---|
| | Female | Male | Mean | Median | Range |
| Subjects | 37 | 22 | 33 | 35 | 16-55 |
| Control Subjects | 31 | 22 | 36 | 35 | 15-63 |

## SUBJECTS AND METHODS

**Subjects.** We examined 60 consecutive patients directly after they were involved in a rear-end car collision and followed up with them one full year later. Inclusion criteria at the inceptive examination were exposure to a well-defined cervical extension-flexion trauma, without any direct trauma to the head or neck, and signs and symptoms corresponding to WAD grades 1 through 3 (implying neck complaint with no physical signs, with musculoskeletal signs and with neurological signs, respectively). The only exclusion criterion was subjects' having signs and symptoms corresponding to WAD grade 4 (implying fracture or dislocation of the cervical spine). One subject declined to participate in the follow-up. The subjects' demographic data can be seen in Table 1.

**Control subjects.** We frequency matched 53 control subjects by age and sex (Table 1). We selected the control subjects from a pool of volunteers from the same geographic region as the subjects. They had various social and work-related backgrounds, and we recruited them by word of mouth and a poster asking for volunteers to participate in a research project that included magnetic resonance (MR) imaging of the head and neck. The volunteers had no history of trauma to the head or neck, and we made no attempt to either attract or reject volunteers who had TMJ symptoms in an attempt to have the control subjects reflect a general population that might be exposed to a rear-end car collision. All control subjects participated in the follow-up study.

**Inceptive examination after the accident.** In the emergency department (Sundsvall, Sweden) directly after the accident, an orthopedic surgeon graded the subjects' neck symptoms and other trauma-related symptoms according to the Quebec classification of WAD.[1]

At the same visit at which they underwent MR imaging,[8] which was done between three and 15 days after the accident with a mean of nine days (an optimal time for MR depiction of bleeding and edema in the soft tissues), the subjects completed a self-administered 38-item questionnaire regarding their health history, medication history, current medication use, head and neck symptoms, duration of symptoms, history of trauma and main complaint. The questionnaire was composed of both multiple-choice questions and questions that required an answer in free writing. When the subjects reported having pretraumatic TMJ symptoms, posttraumatic TMJ symptoms or both, we assessed more specific information regarding the type of symptoms, including clicking, crepitations, transient locking, locking with restricted mandibular movements, mandibular deflection and TMJ pain. We assessed subjects' pain intensity at rest, during chewing and when opening the mouth wide by having them mark the appropriate point on three numerical rating scales, ranging from 0 to 5 and anchored on each end by the words "no pain" and "extreme pain." In a separate questionnaire section, we also assessed pain intensity on a 0 to 5 descriptive scale in which the choices were "no pain," "mild," "moderate," "rather severe," "severe" or "extreme pain," respectively. We asked the subjects to report the degree of symptoms' interference with daily life given a choice among the answers "no interference," "disturbs my sleep," "interferes with my private life/studies/work," "must use analgesics" and "sick leave due to my symptoms."

After the subjects completed and returned their questionnaires, a thoroughly calibrated examiner met with each subject and scrutinized the subject's answers on the questionnaire during

**ABBREVIATION KEY. MR:** Magnetic resonance. **TMJ:** Temporomandibular joint. **WAD:** Whiplash-associated disorders.

an interview to enhance the validity of the self-reported answers. Hence, the interview ascertained that the reported TMJ symptoms emanated from the joint, that clicking referred to a distinct snapping joint sound emitted from the joint during opening or closing jaw movements, and that clicking was distinguished from crepitations (multiple grinding or scraping joint sounds). The same examiner carried out all interviews. The control subjects concurrently followed the same protocol as the subjects.

**Follow-up.** Follow-up took place one full year after the inceptive examinations, with a mean of 16 months for subjects (median, 15 months; range, 13-21 months) and a mean of 14 months for control subjects (median, 14 months; range, 12-17 months). Both the subjects and control subjects once again completed and returned the self-administered questionnaire. A thoroughly calibrated interviewer conducted a telephone interview with each subject and control subject to scrutinize his or her answers as was done at the inceptive examination. In addition, the interviewer asked the subject to identify the external ear canal and the tragus and then describe the location of the symptoms relative to the tragus; the subjects and control subjects performed this part of the interview first without visual feedback and then in front of a mirror. When subjects and control subjects reported in the questionnaire that they had joint symptoms, we found that they consistently referred to them at the site immediately in front of the ear canal and tragus (that is, over the TMJ). We did not include symptoms other than those felt in the joint to avoid an overestimation of TMJ symptoms.

**During the inceptive examination and at the follow-up, subjects often spontaneously disclosed that they had been involved in a whiplash-causing accident.**

The interviewer was a different person than the examiner from the inceptive examination and was blinded to the results from the inceptive examination; however, during the inceptive examination and at the follow-up, subjects often spontaneously disclosed that they had been involved in a whiplash-causing accident.

**Outcome variables.** We defined a delayed TMJ symptom as a new TMJ symptom that did not occur in association with the accident, but evolved sometime during the follow-up period. The TMJ symptom variables that we compared between the inceptive examination and the follow-up were incidence of new symptoms, main complaint, frequency of pain and pain intensity. We noted development of new symptoms when a TMJ that was asymptomatic at the inceptive examination was reported to be symptomatic at the follow-up. The symptoms noted were clicking, crepitations, transient locking, locking with restricted mandibular movements, mandibular deflection and pain. In the questionnaire, we asked the subjects if they had a main complaint, and they could list one or several symptoms or they could leave the question unanswered if they were asymptomatic. We used the highest intensity score from any of the pain scales to evaluate changes in TMJ pain intensity between the inceptive examination and the follow-up.

**Statistics.** We assessed the differences in outcome proportions (incidence of new TMJ symptoms, main complaint, TMJ pain) between subjects and control subjects by score test (statistical test for a null hypothesis) in conditional logistic regression, stratified by each combination of age group (≤ 24 years, 25-34 years, 35-44 years, ≥ 45 years) and sex. We estimated relative risks for TMJ symptoms by using odds ratios computed under the conditional logistic regression described above. We used the McNemar test to test for differences in outcome proportions within groups between examinations. We evaluated differences in proportions within groups between sexes using the Fisher exact test. We based all reported $P$ values (significance level = .05) on two-sided tests. With a development of symptoms in one of three TMJs in subjects and in one of 15 of TMJs in control subjects, 59 subjects and 53 control subjects would yield a statistical power more than 0.80.

The Regional Committee on Ethics at Umeå University, Sweden, approved the study (registration 96-037). We obtained informed consent from the subjects and control subjects.

## RESULTS

**Medical status.** None of the subjects had been unconscious as a result of the car accident. During the inceptive examination directly after the whiplash trauma, 25 subjects (42 percent) reported using analgesics daily, and six subjects

(10 percent) reported using analgesics occasionally. At follow-up, six subjects (10 percent) still were taking analgesics daily, and 16 subjects (27 percent) used analgesics occasionally. At the inceptive examination and at follow-up, we found that three control subjects (6 percent) used analgesics occasionally. At follow-up, one subject was receiving psychopharmacological medication owing to depression. One subject's systemic lupus erythematosus and one control subject's rheumatoid arthritis had been diagnosed before the inceptive examination; neither condition caused TMJ affliction. No other subject or control subject used medication or had a disease that could influence the evaluation of TMJ pain and dysfunction.

No subject or control subject received TMJ treatment during the follow-up period, but during the follow-up, seven subjects (12 percent) spontaneously expressed a need for treatment of TMJ pain, dysfunction or both, and four (7 percent) expressed a need for treatment of ear-related symptoms. These subjects reported that they had complained about TMJ symptoms to their orthopedic surgeons, physical therapists or dentists, but treatment for their posttraumatic symptoms had been focused only on their neck symptoms, regardless of the severity of the TMJ symptoms. Their reasons for requesting treatment were TMJ pain associated with clicking or locking, impaired hearing and blocked ears. At the inceptive examination, 26 subjects (44 percent) and one control subject (2 percent) reported experiencing disturbed sleep, and, at follow-up, 24 subjects (41 percent) and zero control subjects (0 percent) reported experiencing disturbed sleep. Thirty-one subjects (53 percent) and one control subject (2 percent) reported a negative impact on their daily lives owing to symptoms at the inceptive examination, and 24 subjects (41 percent) and two control subjects (4 percent) reported the same at follow-up.

**TMJ symptoms.** Frequencies of TMJ symptoms before the accident, at the inceptive examination and at follow-up are shown in Figure 1, Figure 2 and Table 2. There was no statistically significant difference in frequency of TMJ symptoms reported by the subjects before the accident compared with those reported by the control subjects (18 [31 percent] versus 10 [19 percent], respectively; $P = .13$). TMJ symptoms began with the accident in nine subjects (15 percent). Subjects with asymptomatic TMJs at the inceptive examination developed joint symptoms significantly more often during the follow-up period than did the control subjects with asymptomatic TMJs ($P = .009$). Thirty-two subjects (54 percent) and 43 control subjects (81 percent) had no TMJ symptoms at the inceptive examination. The number of asymptomatic joints in subjects was 79 (67 percent), and the number of asymptomatic joints in control subjects was 91 (86 percent). Of the subjects who were asymptomatic at the inceptive examination, 11 (34 percent) developed TMJ symptoms during the follow-up period compared with the natural course, which was demonstrated

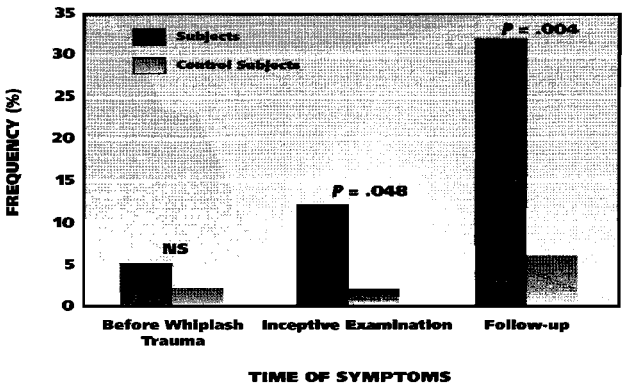


**Figure 1.** Frequency of temporomandibular joint pain before the rear-end car collision, at the inceptive examination and at follow-up in subjects (n = 59) compared with frequency-matched control subjects (n = 53). The frequency in subjects increased significantly during the follow-up period ($P = .008$) in contrast to the control subjects. NS: Not significant.

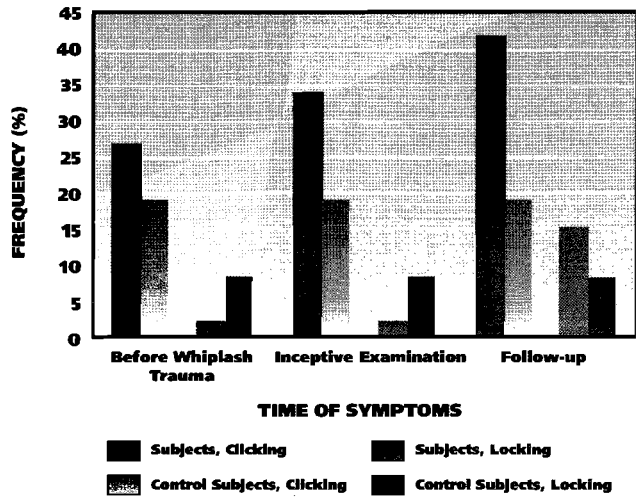


**Figure 2.** Frequency of temporomandibular joint clicking and locking before the rear-end car collision, at the inceptive examination and at follow-up in subjects (n = 59) compared with frequency-matched control subjects (n = 53).

**TABLE 2**

| STUDY SAMPLES | INCEPTIVE EXAMINATION | | FOLLOW-UP | | SUBJECTS VERSUS CONTROL SUBJECTS† (*P* VALUE) | OR‡ | 95% CI§ |
|---|---|---|---|---|---|---|---|
| | Asymptomatic (No.) | | Symptomatic (No. [% of Asymptomatic Subjects]) | | | | |
| | Subjects | Control subjects | Subjects | Control subjects | | | |
| **Subjects** | 32¶ | 43¶ | 11 (34) | 3 (7) | .009 | 6.6 | 1.6 to 27.2 |
| **Joints** | 79# | 91# | 27 (34) | 6 (7) | < .001 | 7.2 | 2.7 to 19.1 |

* The symptoms included joint pain and painful or nonpainful clicking, transient locking, locking with limited mouth opening and crepitations.
† *P* values based on score test in conditional logistic regression.
‡ OR: Odds ratio.
§ CI: Confidence interval.
¶ Bilaterally asymptomatic subjects.
# Two joints per asymptomatic subject and one joint per subject with unilateral symptoms.

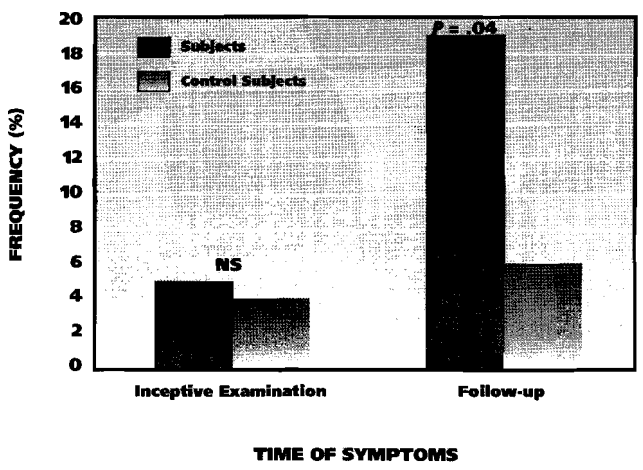


**Figure 3.** Frequency of temporomandibular joint symptoms constituting the main complaint in subjects (n = 59) compared with control subjects (n = 53) at the inceptive examination and at follow-up. The frequency in subjects increased significantly during the follow-up period (*P* = .04) in contrast to the control subjects. NS: Not significant.

by the onset of new TMJ symptoms in three of the control subjects (7 percent). This difference between subjects and control subjects was accentuated further when we compared the number of joints that developed symptoms during the follow-up period between groups (27 [34 percent] versus six [7 percent], respectively; $P < .001$). An analysis of the combination of symptoms accounted for in Figures 1 and 2 showed that the number of subjects with nonpainful clicking decreased from 18 (31 percent) to 13 (22 percent) during the follow-up period, while 11 subjects (19 percent) developed painful TMJ clicking. At follow-up, one subject (2 percent) had painful clicking that persisted from before the car accident. Painful TMJ locking developed in eight subjects (14 percent). One subject (2 percent) had painful locking that persisted from before the accident.

**TMJ symptoms as main complaint.** The number of subjects reporting TMJ symptoms to be their main complaint increased significantly from the inceptive examination to follow-up (three [5 percent] versus 11 [19 percent], respectively; $P = .04$) (Figure 3). We found no significant increase among the control subjects between the inceptive examination and follow-up (two [4 percent] versus three [6 percent], respectively; $P = 1.00$). This implied a significant difference between subjects and control subjects at follow-up ($P = .04$). There was a difference between the sexes in that the number of female subjects' reporting TMJ symptoms to be their main complaint increased significantly from the inceptive examination to follow-up ($P = .02$), while there was no statistically significant increase for male subjects. Scrutiny of the type of TMJ symptoms in subjects with the TMJ as the site of main complaint at follow-up revealed the evolution of TMJ locking and pain in eight of the 11 subjects.

**TMJ pain.** Frequency of TMJ pain before the accident, at the inceptive examination and at follow-up is shown in Figure 1. TMJ pain began with the trauma in four subjects (7 percent), implying a significant difference between subjects and control subjects at the inceptive examination (seven [12 percent] versus one [2 percent], respectively; $P = .048$). The number of subjects with painful TMJs increased significantly during the follow-up period ($P = .008$) compared with the control subjects ($P = .5$). This implied a significant

difference between subjects and control subjects at follow-up (19 [32 percent] versus three [6 percent]; $P = .004$). In the subject group, we observed that women, but not men, reported having TMJ pain significantly more often at follow-up than at the inceptive examination ($P = .012$). Subjects' pain intensity reported at the inceptive examination and at follow-up is shown in Figure 4.

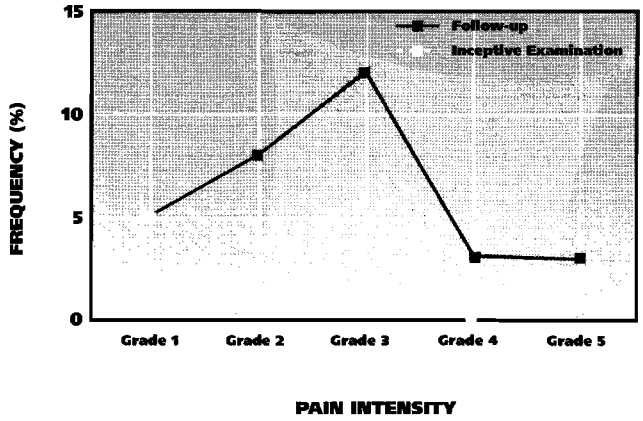


**Figure 4.** Frequency of subjects (n = 59) who reported having temporomandibular joint pain plotted against a numerical scale for intensity of pain. The rating scale was from 0 = "no pain" to 5 = "extreme pain." Comparison between the inceptive examination and the follow-up.

## DISCUSSION

The most important requirement of any study of disease progression is that an inception cohort must be assembled at the outset.[9] We recruited the subjects in our prospective cohort study from a hospital at the time of their whiplash trauma, which constituted the most representative sample.[9] A retrospective design presupposes that patients will accurately remember the time of onset of their symptoms months or years after whiplash trauma, and patients may incorrectly refer spontaneous symptoms to the trauma.[10] Our prospective study considerably diminishes these problems, since we assessed preaccident TMJ symptoms and symptoms induced by the whiplash trauma three to 15 days after the accident. Assessing additional data regarding the TMJ status of each subject shortly before the whiplash trauma would have been ideal, but it is not possible.

The national health insurance in Sweden covers health care costs for patients with whiplash injury, and litigation concerning whiplash-related injuries is rare. If damages are paid, they are small. Hence, damages do not constitute an economic incentive for patients in Sweden to overestimate symptoms after whiplash trauma. This adds credibility to our results, because recovery from whiplash tends to be much faster in jurisdictions operating under a system that does not compensate for pain and suffering. This was demonstrated in a study that found a 54 percent reduction in median time to claim closure after a tort-compensation system for traffic injuries, which included payments for pain and suffering, was changed to a no-fault system, which did not include such payments.[11]

We did not attempt to either attract or reject people with TMJ symptoms, and it is reasonable to consider that our subjects and control subjects reflect a general population that might be exposed to whiplash trauma. This conclusion was supported by the results of a recent population-based study[5] in which the frequency of reported precollision jaw pain equaled the frequency of TMJ pain before the accident in our subjects and control subjects. The conformity in TMJ symptomatology between our subjects before the accident and control subjects was crucial. It was a prerequisite for the long-term comparison between incidence of new posttraumatic TMJ symptoms in the subjects after whiplash trauma and concurrent development of TMJ symptoms (that is, the natural course) in the control subjects. We also noted conformity between groups in that neither subjects nor control subjects had received TMJ treatment, although it was spontaneously requested by 12 percent of the subjects at follow-up. The true number of patients in need of TMJ treatment most likely was higher, considering the increase in pain intensity and the increase of TMJ symptoms, mostly painful locking, which they reported to be the main complaint.

It is plausible that the subjects' estimations of pain and pain intensity would have been even higher had there not been a more extensive use of analgesics in the subject's group than in the control subjects' group. Conversely, pain's adverse effect on sleep and daily activities might enhance a patient's perception of pain and pain intensity. Other factors that might have influenced the outcome of TMJ pain and pain intensity are psychosocial dysfunction and psychological factors such as depression and anxiety. Depression symptoms are common after whiplash trauma,[12] and neck pain intensity directly after whiplash trauma is a prognostic factor for depression and

anxiety within the two following years.[13] We have not assessed psychological and psychosocial illnesses in our study, and further research is needed to evaluate their prognostic impact on TMJ symptoms after whiplash trauma.

**Incidence of posttraumatic TMJ symptoms.** Our hypothesis that delayed TMJ symptoms frequently appear after whiplash trauma was verified. After one full year, we found a significant difference between subjects and control subjects in that one in three of the primarily asymptomatic subjects but only one in 14 matched control subjects had developed TMJ symptoms including dysfunction, pain or both. This contradicts the results of a controlled, prospective study that reported no significant difference in the frequency of TMJ symptoms between subjects and control subjects directly after the accident or after six months.[4] The disparity in results between studies can be explained by their inclusion of patients with signs and symptoms corresponding to only WAD grade 1, while our subjects had signs and symptoms corresponding to WAD grades 1 through 3. Furthermore, they excluded patients younger than 20 years and older than 35 years from their study, while we did not have an age-related exclusion criterion. The resulting age range of 17 to 56 years in our study represented a typical population exposed to whiplash trauma.

Our follow-up findings also contradicted the results of a prospective, but uncontrolled, study that reported no increase of joint symptoms one year after trauma compared with the symptoms after the accident.[3] The difference likely can be explained by a deviant range of symptoms in their patient population compared with the general population. The authors found TMJ clicking in only 1 percent of their patients, while there are studies that reported a prevalence between 15 and 44 percent in general populations with various age ranges.[14-17] At the inceptive examination, the frequencies of TMJ clicking in our subjects and control subjects were in line with those in general populations.

**TMJ symptoms as main complaint.** One in five subjects reported that TMJ symptoms were their main complaint one full year after the accident. This was quadruple the number of subjects reporting TMJ symptoms as their main complaint directly after the accident, and the increase was found in female subjects. Neck-related symptoms after whiplash trauma are more common in women than in men.[1] One hypothesis for this is that given the same head size, women have less neck musculature mass than do men, which makes them more susceptible to this type of trauma.[18] As with the neck, our results point to the TMJ being more vulnerable in women than in men because the significant increase in the number of patients reporting TMJ symptoms as the main complaint was attributed to women.

**TMJ pain.** In our study at the inceptive examination, subjects reported having TMJ pain significantly more frequently than did control subjects, which is in line with a study conducted two weeks after whiplash trauma.[19] At follow-up in our study, one in three subjects reported having TMJ pain, which was five times more frequent than in control subjects and was contrary to the reported frequency of pain before the inceptive examination (no difference between subjects and control subjects). TMJ pain intensity increased in subjects from the inceptive examination to follow-up, but the number of subjects was not large enough to yield sufficient statistical power. Frequency of TMJ pain increased significantly from the inceptive examination to follow-up for female subjects, which also was the case for TMJ symptoms' being the main complaint. The majority of subjects with TMJ symptoms as their main complaint at follow-up reported the onset of new symptoms that were consistent with painful nonreducing TMJ disk displacement.

## CONCLUSIONS

One in three people who are exposed to whiplash trauma, which induces neck symptoms, is at risk of developing delayed TMJ pain and dysfunction with onset during the year after the accident. ■

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