**Review article**

Prevalence of whiplash trauma in TMD patients: a systematic review

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**SUMMARY** The purpose of this systematic review was to describe the prevalence of whiplash trauma in patients with temporomandibular disorders (TMDs) and to describe clinical signs and symptoms in comorbid TMD/whiplash compared with TMD localised to the facial region. A systematic literature search of the PubMed, Cochrane Library and Bandolier databases was carried out for articles published from 1 January 1966 to 31 December 2012. The systematic search identified 129 articles. After the initial screening of abstracts, 32 articles were reviewed in full text applying inclusion and exclusion criteria. Six studies on the prevalence of neck trauma in patients with TMD met the inclusion criteria and were included in the review. Two of the authors evaluated the methodological quality of the included studies. The reported prevalence of whiplash trauma ranged from 8.4% to 70% (median 35%) in TMD populations, compared with 1.7–13% in the non-TMD control groups. Compared with patients with TMD localised to the facial region, TMD patients with a history of whiplash trauma reported more TMD symptoms, such as limited jaw opening and more TMD pain, and also more headaches and stress symptoms. In conclusion, the prevalence of whiplash trauma is higher in patients with TMD compared with non-TMD controls. Furthermore, patients with comorbid TMD/whiplash present with more jaw pain and more severe jaw dysfunction compared with TMD patients without a history of head–neck trauma. These results suggest that whiplash trauma might be an initiating and/or aggravating factor as well as a comorbid condition for TMD.

**KEYWORDS:** facial pain, jaw pain, neck pain, systematic review, temporomandibular joint disorder, whiplash injuries

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**Introduction**

Pain and dysfunction are common in the population and can have a negative effect on health and well-being, especially when the oro-facial region is affected (1). Patients with temporomandibular disorders (TMDs) typically report jaw/face pain, pain on jaw movements, and impaired jaw mobility (2). The perceived treatment need owing to TMD is estimated within the range of 5–15% (3), which means that dentists will frequently meet patients with TMD of varying severity in their daily practice.

The aetiology of TMD is considered to be multifactorial, with factors such as general health, systemic diseases, psychological, psychosocial, and gender factors, together with local factors such as overload due to bruxism, contributing to the overall risk. It has also been reported that indirect trauma caused by a whiplash trauma can be a contributing factor (4). It has been suggested that as many as one of four patients with TMD has a history of head/neck trauma in proximity to the development of their TMD pain (5) and that these patients have a poorer prognosis (6). There is however a limited number of studies reporting on
the prevalence of TMD related to neck trauma, and thus, there is currently a gap in the knowledge in this area.

The term whiplash describes a hyperextension–flexion trauma to the neck. The incidence in Sweden is about 2 per 1000 inhabitants, mostly from traffic accidents but also from other traumas (7). Even though a majority of individuals exposed to a whiplash trauma will recover, about one in three will develop long-lasting problems; whiplash-associated disorders (WADs) (8). These patients report a range of symptoms such as dizziness, sleeping problems, cognitive problems, and a reduced quality of life (9), in addition to the most common symptoms, headaches and neck pain (9, 10).

Neck pain is often also reported in patients with TMD pain and vice versa. Thus, patients with TMD often report pain not only in the jaws and face, but also in the neck region (11–14), and patients with neck pain often report TMD (15, 16). Recent studies have suggested that the relation between symptoms in the trigeminal and spinal regions shows a dose–response-like pattern (17) as well as a reciprocal influence on the incidence of new symptoms in both regions (18). Furthermore, there is a functional integration between the jaw and neck regions (19, 20), and as jaw function rely on linked motor control of the jaw and neck motor systems, pain and dysfunction in the neck may impair jaw function. An association has been shown between neck pain and neck dysfunction and disturbed jaw function following whiplash trauma. The findings include disturbed jaw–neck motor function in terms of decreased movement amplitudes, disturbed coordination, and impaired endurance (21–23) as well as frequent jaw–face pain (24).

Various explanatory models have been presented for the development of TMD after whiplash trauma. An early theory proposed that a whiplash trauma to the head and neck could cause a ‘mandibular whiplash’ by overstretching or compression of the temporomandibular joint (TMJ) (25). Later studies refuted this idea (26) and instead suggested an indirect injury mechanism (27). The notion of a neurobiological basis is supported by prospective studies showing that about a third of individuals develop TMD pain after neck injury, despite not showing any structural damage to the TMJ (28). In a recent systematic review, we reported an increased prevalence of TMD pain in whiplash populations (29). This finding suggests that a whiplash trauma could be a risk factor for the development of TMD. If this is the case, it would be reasonable to assume that among TMD populations, i.e. patients seeking care for jaw pain and dysfunction, a higher prevalence of a history of head/neck trauma would be present compared with healthy control groups without TMD. There is, however, limited knowledge to whether this is the case, and therefore, the aim of this review was to address this research question.

The aim of this study was to assess by systematic review of the literature, (i) the prevalence of whiplash trauma in patients with TMD and (ii) clinical signs and symptoms in comorbid TMD/whiplash compared with TMD localised to the facial region.

Materials and methods

Inclusion and exclusion criteria

Inclusion criteria for this review were clinical studies in adult patients (>18 years) reporting history of whiplash trauma in a TMD population. Articles were excluded if they were not based on a TMD population or if data from the same cohort had been reported in another article (dual publication). Experimental studies and narrative reviews were excluded from the review.

Literature search

The search strategy was designed to identify studies that reported the prevalence of whiplash trauma in patient populations with TMD. The search encompassed all articles that were (i) indexed in PubMed, the Cochrane Library, and Bandolier, (ii) published in English, Swedish, or German, and (iii) published between 1 January 1966 and 31 December 2012.

The search terms used for PubMed were as follows:

- ‘Whiplash injuries’ [MeSH] or ‘Whiplash Associated Disorders’ or ‘Whiplash’ and
- ‘Temporomandibular joint disorder’ [MeSH] or ‘Craniomandibular disorders’ or
- ‘Temporomandibular disorders’ or ‘Temporomandibular Joint Dysfunction’ or
- ‘Jaw pain’ or ‘Facial Pain’.

For the Cochrane Library and Bandolier database, the search terms included the terms ‘Whiplash’ and
‘Craniomandibular disorders’ or ‘TMJ’ or ‘TMD’. After the search of the databases, reference lists in original articles and review articles were hand-searched to identify additional studies.

**Procedure**

After the database search, two of the authors (BH and MR) independently read all titles and abstracts to identify potentially eligible articles for inclusion. All studies identified as potentially eligible by one of the reviewers were retrieved in full text and reviewed by both reviewers applying the inclusion criteria. Disagreement was resolved by discussion among the investigators. Authors were not contacted for missing information.

The data extracted from the studies were study setting, study design, study sample, number of subjects (age and gender), the diagnostic criteria for TMD and whiplash, the prevalence of whiplash trauma, main results, and author’s conclusions.

**Quality assessment**

Two of the authors (BH and TL) independently evaluated the quality of the included studies using a scoring system with a standardised 21-item checklist modified from MacFarlane (30). Each criterion was scored as ‘yes’, ‘no’ or ‘unable to determine’. Only criteria scored as ‘yes’ gave a score, which added up to give the total quality score, and results were presented as percentages of total attainable score for each paper. After the independent assessments of the individual items, which rendered the total quality scores, the interreliability of the two reviewers was calculated with kappa statistics. All articles were discussed to verify appraisal process until consensus was reached. Disagreements on individual item scores were resolved with discussion. The reviewers were experienced oro-facial pain researchers.

**Results**

The systematic search of three databases together with the hand search identified a total of 129 articles (Fig. 1). After the initial screening of abstracts, 32 articles were retrieved and reviewed in full text. Of these, a total of 26 articles were excluded (Table 1). The main reasons for exclusion were that studies were not based on TMD populations (62%), did not report original data (27%), or did not define TMD/trauma groups (11%). Six studies (5, 31–35) on the prevalence of whiplash trauma in patients with TMD met the inclusion criteria and were deemed eligible for inclusion (Table 2).

Two of the authors independently evaluated the methodological quality of each identified study. The quality score for the included studies ranged from 20% to 65% with a median score of 50%. There was a good agreement between the two investigators in the scoring of the individual items (kappa: 0.82), which were used to calculate the total quality score.
For all included studies, the history of whiplash trauma was self-reported. The criteria for TMD diagnosis varied between the studies, with only one study applying the research diagnostic criteria/temporomandibular disorders (RDC/TMDs).

The reported prevalence of whiplash trauma in the TMD groups ranged from 8.4% to 70% (median 35%). Two of the six included studies reported a prevalence of whiplash trauma for non-TMD control groups of 17% (32) and 13% (33).

Compared with TMD patients without a history of neck injury, TMD patients with a history of whiplash trauma reported more TMD pain, more severe jaw dysfunction, and more headaches, stress, dizziness, and sleeping problems (Table 2).

Discussion

This systematic review suggests that the prevalence of whiplash trauma is higher in patients with TMD compared with non-TMD control groups, suggesting that neck trauma is a comorbid condition for TMD. In addition, the data suggest that TMD patients with a history of whiplash trauma have more TMD pain and more severe jaw dysfunction, compared with TMD patients without a history of neck injury.

In the present review, there were large variations between the primary studies in the reported prevalence of whiplash trauma, with the highest prevalence (70% and 54%) reported in two private TMD clinics (33, 34). The other studies based in TMD clinics reported prevalence between 24-5% and 39-7% (5, 31, 32), whereas the only study not based in a TMD clinic reported the lowest prevalence of 8.4% (35). This study also had the lowest quality score of all included studies, and thus there are uncertainties with regard to the reliability of the reported data from this study. It is reasonable to assume that the variation between studies reflects the differences in TMD populations between the clinics, with patients with more severe TMD symptoms being more likely to seek care in, or be referred to, specialist TMD clinics. The reported median prevalence of whiplash trauma was 35%, which compared with the data from the non-TMD control groups in two of the included studies (32, 33) provide some evidence of increased prevalence of neck trauma in TMD. There is no reliable data on the prevalence of whiplash trauma in the general population, but it has been estimated that approximately 6% of the US population have late whiplash syndrome (8).

The data from the present review indicate that TMD patients with a history of whiplash trauma have more TMD pain and more severe jaw dysfunction, compared with TMD patients without a history of neck injury (5, 31–35). These results are in line with previous studies, which suggest that patients with TMD and whiplash comorbidity have more severe TMD pain and dysfunction (36), seem to have a poorer prognosis for recovery, and seek and demand more treatment (37). Taken together, these findings together with reports of a limited effect for this patient group from the treatment modalities conventionally used for TMD (38) support the view that TMD after whiplash trauma has a different patophysiology compared with localised TMD (29).

It has been suggested that TMD after a whiplash trauma may develop over time, rather than being part of an acute syndrome (29, 39). This notion is based on the fact that most studies in acute whiplash patients report a lower prevalence of TMD pain (28, 30).
Table 2. Included studies reporting the prevalence of trauma in patients with TMD (n = 6)

<table>
<thead>
<tr>
<th>Authors, year</th>
<th>Setting/study design</th>
<th>Study sample</th>
<th>Subjects (n) (% females)</th>
<th>TMD and whiplash criteria</th>
<th>Prevalence of trauma</th>
<th>Clinical signs and symptoms</th>
<th>Quality score</th>
<th>Authors’ conclusion</th>
<th>Comments</th>
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<tbody>
<tr>
<td>De Boever &amp; Keersmaekers, 1996</td>
<td>Facial pain unit Case series</td>
<td>TMD only</td>
<td>n = 302 (38 years) n = 98 (36 years)</td>
<td>TMD: Helkimos index Whiplash: self-reported trauma to head/neck</td>
<td>TMD group: 24.5%</td>
<td>Trauma group more: severe jaw pain and dysfunction P &lt; 0.01 limited jaw opening P &lt; 0.01</td>
<td>52%</td>
<td>Trauma to the head and cervical region is relatively common as an initiating factor in TMD. External trauma to the joint or jaw in general is an important initiating factor in the aetiology of TMD, but the prognosis is favourable</td>
<td>Gender of subjects not given</td>
</tr>
<tr>
<td>Grushka et al., 2007</td>
<td>Oro-facial pain centre Treatment outcome study</td>
<td>TMD only</td>
<td>n = 82 (84%) 39 years n = 54 (80%) 41 years</td>
<td>RDC/TMD Whiplash: self-reported trauma to the head/neck, MVA*</td>
<td>TMD group: 39.7%</td>
<td>Trauma group more: headache P &lt; 0.002 jaw tenderness P &lt; 0.03 stress P = 0.001 poor sleep P &lt; 0.001 dizziness P &lt; 0.001</td>
<td>65%</td>
<td>Widespread and persistent pain complaints, including the jaw in post-MVA, despite the fact that many post-MVA patients demonstrate no evidence of jaw injury by bone scan and MRI. Treatment limited to the TMJs in post-traumatic patients with TMD may fail without consideration that pain may originate in structures other than the TMJs</td>
<td>Varying time interval between clinical examination and MRI/bone scan.</td>
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<tr>
<td>Pullinger &amp; Monteiro, 1988</td>
<td>TMD/Oro-facial pain clinic Case-control</td>
<td>TMD</td>
<td>n = 152 (67%) 18-35 years n = 331 (58%) 18-35 years</td>
<td>TMD: criteria not given Whiplash: self-reported trauma to head/neck</td>
<td>TMD group: 30.4%</td>
<td>TMD group vs. controls: more trauma history P &lt; 0.001</td>
<td>50%</td>
<td>History of head-neck trauma characterised the TMD sample compared with age matched student comparison group. Students with mild TMD reported more trauma than asymptomatic students. Women seem at greater risk of responding adversely and irreversibly to trauma</td>
<td>Unclear TMD diagnosis. Inaccuracies in the Results section</td>
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<tr>
<td>Authors, year</td>
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<td>Study sample</td>
<td>Subjects (n)</td>
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<td>Pullinger &amp; Seligman, 1991</td>
<td>Private TMD clinic Case-control</td>
<td>TMD Control 1 (no TMD) Control 2 (mild TMD) Control 3 (general patients)</td>
<td>n = 230 n = 61 n = 161 n = 150</td>
<td>TMD: criteria not given Whiplash: self-reported MVA or other head/neck trauma</td>
<td>TMD group: 55% Control 1: 13% Control 2: 18% Control 3: 11%</td>
<td>More trauma in TMD group</td>
<td>45%</td>
<td>Patients with TMD have a higher prevalence of trauma history. Trauma may be an important cumulative and precipitating factor in TMD</td>
<td>Unclear TMD diagnosis. Age and gender of subjects not given. History of trauma investigated differently in patients (personal interview) and controls (questionnaire)</td>
</tr>
<tr>
<td>Steigerwald et al. 1996</td>
<td>Private TMD clinic Retrospective</td>
<td>TMD</td>
<td>n = 50 (76%) 34 years</td>
<td>TMD: criteria not given Whiplash: self-reported trauma to head/neck</td>
<td>TMD group: 70% Trauma group: more pain Symptoms improved after arthroscopy</td>
<td>50%</td>
<td>Whiplash-induced TMD may differ from insidious TMD and even other onset of TMD by the prevalence of neck pain, intensity of neck pain and concurrence of neck pain, shoulder pain, headache, and jaw pain. These symptoms resolved after surgery, indicating that TMJ pathology was the perpetuating force behind, if not the cause of, these symptoms</td>
<td>Unclear TMD diagnosis. No controls. Questionnaire filled in between 1 and 104 weeks after surgery</td>
<td></td>
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<tr>
<td>Upgaard, 1992</td>
<td>Private clinic Case series</td>
<td>TMD</td>
<td>n = 382 (79%) 10-60+ years</td>
<td>TMD: criteria not given Whiplash: self-reported trauma to head/neck</td>
<td>TMD group: 8.4% Not clearly reported</td>
<td></td>
<td>20%</td>
<td>Successful treatment is dependent on the overall assessment of the patient, understanding the patient’s total problem and treatment options</td>
<td>Unclear TMD diagnosis. No control group. No material and methods, or statistics. Results not clearly presented</td>
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</table>

*MVA, motor vehicle accident.
40) compared with studies based on chronic WAD patient groups (28, 41–44). When comparing different study populations after whiplash injury, it should also be remembered that a majority with an acute whiplash injury will recover and that the individuals who develop long-term symptoms report greater initial pain and disability (45). It is therefore reasonable to assume that these individuals are more at risk of developing pain also in the jaw/face region. The development of pain and dysfunction in the jaw region may reflect spread of pain related to close sensorimotor linkage between the jaw and neck, as well as lowered sensory and pain thresholds due to central sensitisation. There is support, both in experimental (46–49) and clinical (17) studies of spread and referral of pain between the cervical and trigeminal regions. Disturbed jaw motor function has been demonstrated after whiplash injury, both in terms of amplitudes and coordination of head and jaw movements and endurance of chewing (50). Furthermore, a recent study shows that experimental pain in the masseter muscle in healthy individuals can affect jaw–neck motor behaviour (51). Taken together, these findings further underline the tight sensorimotor coupling between the jaw and neck regions.

In the present review, using a scoring system modified from MacFarlane (30), the median score for the study quality was 50%. This is comparable with previous studies using the same scoring system to evaluate the prevalence of oro-facial pain (29, 30) reporting median quality scores ranging from 55% to 70%. However, for the present review, there were considerable variations between the primary studies, not only in the study quality scores, but also with regard to study populations, methodology, and criteria for TMD diagnosis. To improve the diagnosis of TMD, the research diagnostic criteria/temporomandibular disorders (RDC/TMDs) were introduced in 1992 (2) and are now widely used by clinicians and researchers. In the present systematic review, most of the primary studies were carried out before 1992 and only one study (31) used these criteria, which have a proven reliability and validity for the diagnosis of TMD (52). A new evidence-based DC/TMD protocol for use in both clinical and research setting has recently been developed (53). The new DC/TMD is an important step towards the goal of developing a mechanism- and aetiology-based DC/TMD that will more accurately direct the clinicians in providing personalised care for their patients. In the present review, there were also uncertainties with regard to the history of whiplash trauma, as these data were collected with different methods, for example questionnaires versus personal interviews, and for all studies, were based on patients’ self-reports. Only two of the studies included control groups without TMD (32, 33). All these limitations need to be taken into account as it makes it difficult to draw firm conclusions from the present review. More well-designed studies on the development of TMD after whiplash trauma using the DC/TMD criteria in epidemiological population-based studies are needed.

The results from the present review have implications for assessment of patients with TMD. Examination of these patients should include the neck region, which could provide a more individualised rehabilitation regimen. A multidisciplinary rehabilitation programme should be advocated in TMD patients with whiplash-related neck pain. As the aetiology for TMD is multifactorial, further studies on the mechanisms of the association between whiplash trauma and TMD, and to what extent a neck injury can contribute to the development of TMD, are warranted.

**Conclusions**

In conclusion, the prevalence of whiplash trauma is higher in patients with TMD compared with controls. In addition, the data suggest that TMD patients with comorbid TMD/whiplash have more jaw pain and more severe jaw dysfunction, compared with TMD patients without a history of neck injury. These results suggest that whiplash trauma might be an initiating and/or aggravating factor as well as a comorbid condition for TMD.

**Disclosures**

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**References**


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