Utility of Corticosteroid Injection for Temporomandibular Arthritis in Children With Juvenile Idiopathic Arthritis

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Objective. To assess the effects of computed tomography (CT)–guided injection of corticosteroid into the temporomandibular joint (TMJ) in children with juvenile idiopathic arthritis (JIA) and clinical and magnetic resonance imaging (MRI) evidence of TMJ inflammation.

Methods. Twenty-three children ages 4–16 years with JIA and MRI evidence of TMJ inflammation received CT-guided TMJ injections of corticosteroid (triamcinolone acetonide [n = 16] or triamcinolone hexacetonide [n = 7]). Jaw pain or dysfunction and maximal incisal opening (MIO) distance were assessed before and after injection. Fourteen patients had followup MRI studies of the TMJ 6–12 months after injection.

Results. Of the 13 patients with symptoms of jaw pain prior to corticosteroid treatment, 10 (77%) had complete resolution of pain (P < 0.05). Prior to corticosteroid injection, MIO in all 23 patients was below age-matched normal values. After injection, the MIO was improved by at least 0.5 cm in 10 patients (43%) (P = 0.0017). Patients under 6 years of age at the time of injection showed the best response, with a postinjection MIO similar to that in age-matched controls (P = 0.2267). There was involvement of 23 TMJs in the 14 patients who had followup MRI studies; resolution of effusions was observed in 11 (48%) of the TMJs. Other than short-term facial swelling in 2 patients, there were no side effects.

Conclusion. The majority of children with symptomatic TMJ arthritis improved after intraarticular corticosteroid injection. Approximately half the patients experienced significant improvement in MIO and TMJ effusion. These data suggest that corticosteroid injection may be a useful procedure for the prevention and treatment of morbidities associated with TMJ arthritis in JIA.

Juvenile idiopathic arthritis (JIA) occurs in ~1 in 1,000 children worldwide (1). Involvement of the temporomandibular joint (TMJ) in JIA was recognized as early as 1897 (2). The reported prevalence of TMJ arthritis has varied widely (i.e., 17–87%), based on subtype of JIA, methods used for diagnosis, and population studied (3). The worst outcomes are reported in patients with systemic or polyarticular disease, positive antinuclear antibodies (ANAs), and decreased mouth opening (4,5).

Unlike other diarthrodial joints, the mandibular growth plate is located just beneath the fibrocartilage of the condylar head, making it particularly vulnerable to inflammatory damage. Arthritis-induced destruction of this fibrocartilage can lead to significant limitations in mandibular growth and development (6). Resultant abnormalities include micrognathia in up to 30% of children with JIA, and malocclusion in up to 69% (7,8). Other complications include decreased mouth opening, chewing difficulties, and pain with jaw movement (9). Clinical signs associated with TMJ inflammation include
pain with jaw excursion, asymmetric jaw opening, crepitation, and absence of jaw translation (9). Not all children with TMJ arthritis have clinical signs, making clinical examination alone inadequate for detecting condylar degeneration in JIA (10).

Magnetic resonance imaging (MRI) with gadolinium enhancement is currently the gold standard for diagnosing TMJ inflammation (11). Unlike plain film tomography, enhanced MRI can be used to detect early inflammatory changes such as synovial proliferation and joint effusions preceding the development of cartilage destruction and bony erosions (12). Studies using animal models have confirmed the correlation between histologic findings in TMJ arthritis and early inflammatory changes detected by MRI (13). Earlier detection of disease may in turn allow for earlier therapeutic intervention.

Modalities for the treatment of TMJ arthritis in JIA have included systemic drugs such as methotrexate (MTX), as well as local treatments using arthrocentesis, occlusal devices, and intraarticular injections of steroids or sodium hyaluronate (14–18). Among these, intraarticular corticosteroid injections show the most promise for controlling the inflammation with little or no systemic effect. Intraarticular corticosteroids have proven beneficial in prevention of leg-length discrepancy in children with oligoarthritis of the knee (19). By inference, the use of these agents in TMJ arthritis could potentially prevent mandibular growth alterations, which lead to micrognathia and jaw deviation. Studies of TMJ corticosteroid injection in JIA are few (17,18). Horton first reported on this procedure in 1953 (20), but many pediatric rheumatologists have been reluctant to recommend it based on reports of steroid-induced chondrolysis in adults with TMJ pain (21). Preliminary short-term results from Cahill and colleagues suggest a good symptomatic response to intraarticular steroid injection without evidence of complication in children with JIA (22). Long-term studies by 2 groups in Sweden (23,24) also show a favorable prognosis, with condylar remineralization and remodeling, and symptomatic improvement in pain and jaw mobility, 8–12 years following corticosteroid injection.

Our aim in the present study was to investigate the safety and effectiveness of TMJ corticosteroid injections in a cohort of patients with JIA. We used clinical examination, pre- and postinjection MRI, and a postinjection patient questionnaire to assess side effects and response to treatment.

**PATIENTS AND METHODS**

**Patients.** Twenty-three patients ages 4–16 years who attended the pediatric rheumatology clinic at Children’s Hospital of Philadelphia during the years 2000–2004 underwent corticosteroid injection of 1 or more TMJs, based on clinical evidence of TMJ disease that was confirmed by evidence of TMJ inflammation seen on MRI. All children had JIA based on the Durban criteria (25). None had isolated TMJ involvement or cervical spine arthritis. Six to 12 months after intraarticular steroid injection, followup MRIs were obtained in 14 of the 23 patients. All patients had followup measurements of their maximal incisal opening (MIO), and all completed a verbal questionnaire evaluating symptoms of pain, jaw locking, jaw appearance, and side effects following injection.

**Data collection.** Data were collected retrospectively from medical records and prospectively from patient questionnaires. The medical record data collected included the following: demographic characteristics (including sex, race, age at disease onset, duration of disease, and age at the time of corticosteroid injection), type of JIA, concomitant drug use at the time of corticosteroid injection, MIO, jaw deviation/micrognathia, laboratory data, number of joints injected, and MRI findings before and after injection (including presence of joint effusions, bony erosions, flattening of condyles, and disk changes). Severity of TMJ inflammation seen on pre- and postinjection MRI was assessed as follows, based on the grading system developed by Cahill et al (22): grade 1 = normal joint; grade 2 (acute) = presence of joint effusion, synovial thickening, or marrow edema; grade 3 (chronic) = presence of juxtaarticular erosions; and grade 4 (chronic) = condylar sclerosis or loss of articular cartilage. Grades 3a and 4a signify acute findings in the setting of chronic findings, and grade 5 denotes ankylosis of the TMJ. The patient satisfaction questionnaire was administered after the injection to assess the presence of pain, jaw locking, and chewing dysfunction before and after injection, perceived improvement in jaw appearance, and occurrence of side effects from the injection (including erythema, skin atrophy, infection, and facial swelling).

Sixteen of the 23 patients were injected with 1 cc (40 mg) triamcinolone acetonide (Kenalog-40; Bristol-Myers Squibb, New York, NY) in each of the involved TMJs. The remaining 7 patients were injected with 1 cc (20 mg) triamcinolone hexacetonide (Aristospan-20; SAB-Pharma, Lake Forest, IL). The volume of medication injected was chosen empirically based on the general ease of administration of this volume into the potential joint space without resistance. Corticosteroid injections were performed by 3 experienced pediatric interventional radiologists, using a 30-gauge needle under computed tomography (CT) guidance. Patients undergoing injections were sedated intravenously using a combination of fentanyl citrate 1–3 mg/kg, pentobarbital sodium 2–5 mg/kg, and midazolam hydrochloride 0.1–0.3 mg/kg as described (22). Pre- and postinjection MRIs were performed with gadolinium enhancement. Children under 8 years of age were sedated for the MRI using the above agents, and images were obtained in open- and closed-mouth views.

**Statistical analysis.** The following parametric and nonparametric tests were performed to evaluate distribution and variability in measurements: Student’s t-test, analysis of variance, Pearson’s chi-square test, and Fisher’s exact test for
RESULTS

Demographic characteristics. The study population consisted of 20 girls and 3 boys, with a median age of 9 years, median age at disease onset of 5.5 years, and median disease duration of 2 years. Clinical characteristics in relation to age and disease duration are summarized in Table 1. Seventy-four percent of the patients had polyarticular JIA, and 26% had oligoarticular JIA. One patient had oligoarticular JIA that progressed to psoriatic arthritis. The median age was slightly lower in the oligoarticular JIA group, but duration of disease was similar between the 2 groups. Seventy-eight percent of the patients were ANA positive, and 13% were positive for rheumatoid factor. None were positive for HLA–B27. Seventeen percent of the patients were not receiving any medications. Another 17% were taking nonsteroidal antiinflammatory drugs (NSAIDs) (either naproxen or ibuprofen) as monotherapy, 43% were taking NSAIDs plus MTX, and 22% were taking NSAIDs, MTX, and etanercept. The median age at the time of injection, age at disease onset, and duration of disease were similar among the 4 treatment groups.

In general, TMJ corticosteroid injections were performed if initial MRI revealed joint effusion or pannus formation. Based on these criteria, 6 patients (26%) underwent unilateral TMJ corticosteroid injection and 15 (65%) underwent bilateral TMJ corticosteroid injections. Two other patients (9%) underwent bilateral injections based on abnormalities found on MRI of 1 TMJ and the presence of pain in the contralateral TMJ.

Subjective symptoms. Prior to corticosteroid injection, 13 patients (57%) reported having symptoms of pain with either chewing, maximal jaw exertion, or palpation. Of these patients, 77% had complete resolution of their pain after corticosteroid injection ($P < 0.05$). In 2 of 3 patients with jaw locking, this improved postinjection (Table 2). Eighteen patients (78%) had lateral jaw deviation; 2 (9%) had micrognathia, and 3 (13%) had normal jaw size and positioning. There was no significant improvement in jaw deviation or micrognathia following injection.

Objective signs. Prior to corticosteroid injection, 100% of the measured MIOs were below mean values in age-matched normal subjects (26,27). Mean MIO was slightly lower in patients with jaw pain (3.4 cm) than in those without pain (3.8 cm). Postinjection, the mean ±

Table 1. Characteristics of the study population (n = 23)*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%)</th>
<th>Age at injection, median years</th>
<th>Age at JIA onset, median years</th>
<th>Duration of disease, median years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>20 (87)</td>
<td>9</td>
<td>5</td>
<td>2.7</td>
</tr>
<tr>
<td>Male</td>
<td>3 (13)</td>
<td>6</td>
<td>6</td>
<td>0.7</td>
</tr>
<tr>
<td>JIA onset type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oligoarticular</td>
<td>5 (22)</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Polyarticular</td>
<td>17 (74)</td>
<td>9</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Psoriatic</td>
<td>1 (4)</td>
<td>16</td>
<td>12</td>
<td>4.5</td>
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<tr>
<td>Concomitant drugs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>4 (17)</td>
<td>7</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>NSAIDs</td>
<td>4 (17)</td>
<td>9</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>NSAIDs + MTX</td>
<td>10 (43)</td>
<td>9</td>
<td>7</td>
<td>1.5</td>
</tr>
<tr>
<td>NSAIDs + MTX + TNF inhibitor</td>
<td>5 (22)</td>
<td>7</td>
<td>6</td>
<td>0.4</td>
</tr>
<tr>
<td>Positive serologic results</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANA</td>
<td>18 (78)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RF</td>
<td>3 (13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HLA–B27</td>
<td>0 (0)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* JIA = juvenile idiopathic arthritis; NSAIDs = nonsteroidal antiinflammatory drugs; MTX = methotrexate; TNF = tumor necrosis factor; ANA = antinuclear antibody; RF = rheumatoid factor.

Table 2. Improvement in symptoms among 23 patients with JIA, after TMJ corticosteroid injection*

<table>
<thead>
<tr>
<th></th>
<th>Pain</th>
<th>Jaw locking</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%) with symptom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preinjection</td>
<td>13 (57)</td>
<td>3 (13)</td>
</tr>
<tr>
<td>Postinjection</td>
<td>3 (13)</td>
<td>1 (4)</td>
</tr>
<tr>
<td>% with symptom relief</td>
<td>77</td>
<td>67</td>
</tr>
<tr>
<td>$P$</td>
<td>&lt;0.001</td>
<td>0.17</td>
</tr>
</tbody>
</table>

* $P$ values were obtained using Pearson's chi-square test, with a 70% hypothesized probability of improvement based on an estimated 1-sided confidence interval of 50.5–100.0. JIA = juvenile idiopathic arthritis; TMJ = temporomandibular joint.
SD MIO increased from 3.59 ± 0.725 cm to 4.07 ± 0.606 cm (P = 0.0017 by paired t-test). Forty-three percent of the patients had a clinically significant improvement in MIO of >0.5 cm (equal to 1 SD of age-matched normal means). Figure 1 demonstrates the improvement in MIO among the subjects divided into 3 age groups at time of injection; normative MIO data are shown for comparison. Patients of all age groups improved, but patients injected at 0–6 years of age showed the best response, with a postinjection MIO similar to that of age-matched healthy children (P = 0.2267).

Results of statistical tests to evaluate whether clinical response to treatment was associated with various clinical variables (age at disease onset, age at injection, disease duration, JIA type, concomitant medications, serologic findings, corticosteroid preparation injected) were largely unrevealing. The only clinical variable associated with improvement in MIO was young age. Children with disease onset prior to age 5 years had a significantly greater response to injection compared with children older than 5 years at disease onset (P = 0.04). There were no statistically significant associations between MIO improvement and other clinical variables.

Radiographic findings. Figure 2 shows the distribution of TMJ grades (22) before and after corticosteroid injection. Twenty-three TMJs in 14 patients were evaluated by MRI before and after intraarticular steroid injection. Ten TMJs had evidence of condylar sclerosis as well as joint effusions prior to injection (grade IVa). Of these, 8 improved, with resolution of effusions but no change in bony abnormalities (grade IV). Two TMJs (1 grade IV and 1 grade I) progressed to develop an effusion after corticosteroid injection. Bony resorption was seen in 19 of 23 TMJs studied at baseline. Postinjection, bony resorption worsened in 3 TMJs, improved in 1 TMJ, and remained stable in the rest.

Among the 14 patients who underwent followup MRI, 13 (57%) of the 23 TMJs exhibited findings of acute joint effusion at the time of the first injection. Resolution of TMJ effusion was seen in 48% of these TMJs, reflecting improvement in more than two-thirds of the acutely affected joints after corticosteroid injection. An example of a TMJ in which the effusion resolved is shown in Figure 3. Factors that significantly correlated with resolution of MRI effusion included polyarticular subtype of JIA (P = 0.05) and age 7–10 years at the time of injection (P = 0.03). The remaining clinical variables (age at disease onset, disease duration, concomitant medications, serologic findings, corticosteroid preparation injected) were not associated with radiologic improvement as judged by the presence of effusion postinjection. However, this analysis was lim-

Figure 1. Improvement in maximal incisal opening (MIO) post–corticosteroid injection. All groups improved, but patients injected at 0–6 years of age showed the best response, with a postinjection MIO similar to that in age-matched healthy children. Values for patients pre- and postinjection are box plots, where the boxes represent the 25th to 75th percentiles, the lines within the boxes represent the median, and the lines outside the boxes represent the highest and lowest values. Values for normal subjects are the mean ± SD.
ited by the long time elapsed from corticosteroid injection to performance of followup MRI. Comparison of clinical improvement (MIO >0.5 cm) with resolution of MRI effusion did not reveal a significant association (P = 0.5).

Side effects. After corticosteroid injection, 2 patients developed facial swelling consistent with Cushing’s syndrome, lasting 2 days in 1 patient and 2 weeks in the other. There was no incidence of erythema, infection, or subcutaneous atrophy following injection.

DISCUSSION

TMJ arthritis is common in JIA and affects all subtypes of the disease. The majority of patients in this study were ANA-positive girls with polyarticular JIA and decreased MIO; none were positive for HLA-B27. This pattern is consistent with previous descriptions of risk factors in patients with TMJ inflammation (4,5). Bilateral TMJ involvement was seen more commonly than unilateral involvement in our patients; other reports on this have varied (3). Early-onset disease (prior to age 9 years) was also seen more commonly, and could explain the high prevalence of lateral jaw deviation (78%) or micrognathia (9%) observed in our patients. Considering that the majority of mandibular growth occurs in the first decade of life, alterations in the condylar growth plate during this time have a large impact on final mandibular structure. In our observations, the jaw deviated toward the TMJ with the higher degree of inflammation or bony resorption, consistent with decreased growth of the mandible on the involved side.

Although more than half of our patients reported having jaw pain prior to corticosteroid injection, the presence of jaw pain did not significantly correlate with the presence of effusions on MRI (P = 0.96). In fact, effusions were seen more frequently in patients who did not have pain (80%) than in those who were symptomatic (53%). Prior to corticosteroid injection, mean MIO was slightly lower in patients with jaw pain than in those without, perhaps reflecting pain-limited movement of the jaw at the time of MIO measurement. However, this
difference was not statistically significant \((P = 0.24)\). Despite the observation that corticosteroid injections alleviated pain in more than two-thirds of symptomatic patients, one-third of these patients had persistence of effusions on followup MRI. Although the number of symptomatic patients in our study was small, these data suggest that the presence or resolution of pain may not accurately predict the presence of TMJ inflammation. Since the pain assessment questionnaire was administered after the injections, recall bias may play a role in these findings.

Limitations in mouth opening are often not obvious to patients unless they are accompanied by symptoms \((27)\). Nevertheless, based on Sheppard and Sheppard’s analysis of MIO in normal subjects versus those with periodontal or TMJ disease, failure to open \(\geq 3.5-4.0\) cm is indicative of some restraining effect on mandibular function warranting further investigation \((26)\). In our study, 70% of the patients had a preinjection MIO of \(< 4.0\) cm. This decreased to 39% postinjection. The most significant improvements were seen in patients diagnosed before 5 years of age and those injected at 0–6 years of age. This suggests that early intervention, particularly in patients in whom mandibular growth is not completed, results in greater response to treatment.

One of the most objective means of assessing TMJ inflammation in JIA is MRI evaluation. The use of gadolinium enhances synovial proliferation and joint effusions, which precede bony erosions \((28)\). In our patient population, the majority of TMJs studied by followup MRI showed bony erosions at baseline, and therefore had an arthropathy grade of III or higher before administration of corticosteroids. This reflects longstanding TMJ arthritis in most of the children studied. Corticosteroid injections resulted in resolution of effusions in more than two-thirds of TMJs with acute effusions at baseline. One limitation to this finding is that followup MRIs were performed 6–12 months after corticosteroid injection, and it is possible that the TMJs not showing improvement had initially responded to corticosteroid injection but had recurrent disease by the time the MRI was repeated.

In contrast to our expectations, patients with polyarticular JIA had a greater response to corticosteroid injection in terms of effusion resolution \((P = 0.05)\), even though clinical response based on MIO was better in the oligoarticular disease group. As a result, we were not able to demonstrate a significant relationship between clinical and radiologic improvement after corticosteroid injection \((P = 0.5)\). One possible explanation for this discrepancy is that the head coil used during MRI acquisition may be more sensitive in detecting joint effusions in older children, who comprised the majority of the polyarticular disease group. The use of a surface coil during imaging would allow detection of joint effusions in younger patients with greater sensitivity. Additionally, pre- and postinjection MRIs were often not read by the same radiologist, introducing a possible source of assessor bias in the interpretation of MRI results.

In the majority of patients in our study, there were no side effects from TMJ corticosteroid injection. In the 2 patients who experienced facial swelling, the effects were relatively short in duration, and not accompanied by any subcutaneous atrophy or pain. The use of CT guidance to ensure proper needle placement prior to injection was effective in minimizing potential side effects, although ultrasound guidance may be just as effective while allowing both real-time assessment during needle positioning and confirmation of intraarticular injection.

Interestingly, 15 of the 23 children with JIA and TMJ arthritis in this study were being treated with MTX (in general, 1 mg/kg/week subcutaneously). In addition, 5 of these 15 patients were receiving a tumor necrosis factor inhibitor at the time of TMJ corticosteroid injection \((\text{Table 1})\). This provides indirect evidence that the combination of MTX and tumor necrosis factor inhibition, in at least a subset of children with JIA, is inadequate to control the destructive changes seen with TMJ arthritis. This may reflect a slightly different cartilage composition of the TMJ and/or the close proximity of the mandibular growth plate to the thin overlying cartilage. Regardless of the reason, it is instructive and suggests that children with JIA and TMJ arthritis should be treated by intraarticular corticosteroid injection, possibly along with other therapies.

Our study was limited by small sample size, lack of treatment controls, assessor bias, recall bias, and a relatively short followup period. However, the findings illustrate that JIA patients with jaw deviation or limited incisal opening often have advanced TMJ arthritis, which responds best to corticosteroid injection if instituted early. Initiation of an early radiographic and clinical screening program to detect TMJ arthritis in children with JIA would allow earlier intervention to preserve normal jaw structure and function. Future studies on the incidence of TMJ arthritis in JIA and clinical predictors of active disease would aid in this effort and are currently under way at our institution.

This report is dedicated to the memory of Dr. Frida Gudmundsdottir.
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REFERENCES