An Orthodontic Challenge. Juvenile Rheumatoid Arthritis: Examination Protocol

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Aim: *Juvenile rheumatoid arthritis is a chronic systemic disease with poorly understood treatment. This article suggests a specific examination protocol for the assessment of the disease status and for the treatment management when unloading the temporomandibular joints.* **Methods**: *Depending on the onset and the exacerbation and remission periods that occur during growth, a great number of signs and symptoms are found in the stomatognathic system, including functional limitation, anterior open bite, and broken downward protrusion of the jaw pathway caused by articular and/or occlusal interference. These signs and symptoms are discussed and analyzed in this article.* **Conclusion**: *Treatment management and a specific examination protocol are provided.* World J Orthod 2001;2:56–68.

From the pathologic, we learn much about the normal. (Graber)

Data identification with respect to the chronic joint childhood illness called juvenile rheumatoid arthritis (JRA) is extremely important for treatment outcome. JRA is an autoimmune and systemic joint disease marked by inflammation, degeneration, or metabolic derangement of connective tissue. Its etiology is unknown and the onset occurs in children and adolescents less than 16 years of age.[1-6]

Anterior open bite is a JRA consequence, usually treated by selective grinding and provisional prosthetic rehabilitation.[7] Sometimes, a stabilization splint is indicated to prevent parafunctional activity during sleep and physical therapy. Such treatment provides temporomandibular joint (TMJ) stability and more comfortable mandibular dynamics during the day.

However, functional orthopedics is an excellent option for relieving pain and stiffness and enhancing morphofunctional considerations in properly chosen patients. It is a proper early treatment alternative for reducing open bite, eliminating compensatory tongue and perioral habits, improving chewing performance, and achieving a satisfactory esthetic appearance. Functional appliances, particularly the bioelastic type,[8] can be an indispensable tool in the therapeutic armamentaria. With these appliances it is possible to change the posture and growth direction of the mandible without any sagittal translation.[8]

Posterior morphologic growth rotation, retrognathism, micrognathia, and microgenia are common JRA sequelae, depending on the age of onset and the spontaneous exacerbation and remission periods.[1-3,6] After functional orthopedic treatment, geneoplasty may satisfy a patient's esthetic demands without the need for orthognathic surgical mandibular advancement.

Initial diagnostic criteria for JRA are persistent morning stiffness, pain and limitation on motion, tenderness, joint warmth, swelling, and effusion in one or more joints for at least 6 to 12 weeks.[1,7] Before making a JRA diagnosis, more than 100 other causes of chronic arthritis in children and adolescents under 16 years of age must be excluded.[4] The results of anamnesis, physical examination, and laboratory findings, the main bases for JRA diagnosis,[1] must be readily available in an easy-to-read format. In addition, the findings should include data essential for functional appliance selection, fabrication, and control of the effects of JRA orofacial signs and symptoms.

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Since JRA is an organic disease, that is, "an illness caused or accompanied by structural changes in a body organ or tissue,"[9] the examination protocol must provide a means for continuous observation and interpretation of relevant changes.

The purpose of this paper is to present a JRA examination protocol, illustrated by a case report. The patient was treated with functional orthopedics and geneoplasty (Figs 1 to 9). Some specific details will be highlighted to stimulate further research.

JRA EXAMINATION PROTOCOL

The examination protocol consists of three areas. The first focuses on the general rheumatoid arthritis status. This is furnished by a multidisciplinary diagnostic group of rheumatology, ophthalmology, otolaryngology, orthopedics, endocrinology, physiotherapy, etc. The classification of five groups seen within this area is optimal in correlating JRA with the TMJ, muscles, and dental area involvement.[2]

The second area of the protocol focuses on head and neck signs and symptoms regarding the TMJ and muscles. A finding of four of the following signs and symptoms indicates TMJ local involvement in a patient who has been diagnosed with JRA[7]: bilateral involvement; posterior or lateral joint tenderness; crepitus or cortical bone erosion, identified by imaging, swelling, warmth in or over the TMJ in the acute phase, and temperature reduction in the chronic phase; anterior open bite; and polymorphonuclear or mononuclear leukocytosis in the TMJ fluid, corresponding to acute and chronic phases, respectively.

Signs of painful TMJ degenerative arthritis often parallel lateral pterygoid tenderness on the same side. However, the anatomically deep location of lateral pterygoid muscles makes palpation impossible. Functional manipulation of the mandible can facilitate assessment of the lateral pterygoid muscles.[10] Place the thumb on the chin in protusive movement; if pain results beneath and deep in the zygomatic arch, the finding is positive.

Another test can be performed to diagnose atlantoaxial subluxation.[4] Place the thumb on the axis spinous process in the suboccipital region with the head in the flexion posture, and with the other hand, push the forehead backward. In the JRA patient, it is possible to feel at least a 3-mm gap,[4] which can be seen clearly on lateral radiographs in flexion and extension positions.

The rich synovial fluid at C1 and C2 is strongly affected by JRA. As a rheumatic disease, JRA causes upper cervical instability when it is active for a long period. Atlantoaxial dislocation is present in 40% of JRA patients.[11] The cricoarytenoid joint may also be affected, causing swallowing, throat, and voice problems as well as referred otalgia.[12]

The third area of the protocol is related specifically to the dental area, including imaging and coordination of different ages.

Interocclusal distance measurement.[13] Occlusograms or bite registrations are periodically taken with thermoplastic impression material. The material is placed consecutively between posterior and anterior dental arch segments in forced occlusion and maximal intercuspation. A caliper is used to measure the lateral and anterior open bite on the occlusograms at different dental levels.

Masticatory functional angle of Planas (MFAP)[14] evaluation. The lateroprotrusive movements are recorded in a manner similar to a Gothic arch tracing except on a frontovertical instead of a horizontal plane. This tracing is easily taken and clinically useful. While the patient describes these movements, a pencil positioned between the maxillary and the mandibular central incisors produces the MFAP tracings. Harmonious tracings have equal right and left inclination and size marked on the mandibular central incisors.

Simões protrusion movement analysis.[8] Physiological protrusion is a symmetrical, straightforward movement with incisors in contact until edge-to-edge protrusion. Basically, this is free protrusion. Although incisor contact may exist, it alone does not prove a physiologically free protrusion; a straightforward trajectory after edge-to-edge position is also necessary. Protrusion beyond edge-to-edge should take a slightly oblique upward vector. In short, physiological free protrusion approximately follows the Posselt envelope.[15]

Abnormal protrusion movement is downward, deviated from physiological trajectory, and the space between the anterior teeth is increased. There are five types of abnormal or "broken" protrusion (Fig 10):

1. *Compound:* Initially straightforward movement becomes downward movement.
2. *Simple tumbled:* The "break" occurs from the beginning.
3. *Double tumbled:* There is a "break" at the beginning, which is interrupted by a straightforward path and again "breaks" in a tumbled manner.
4. *Stepped:* Movement is normal at the beginning and at the end. It is initially straightforward but changes to a downward vector in between.
5. *Broken L:* Protrusion begins as tumbled and continues as horizontal. It resembles part of the double tumbled broken protrusion category.

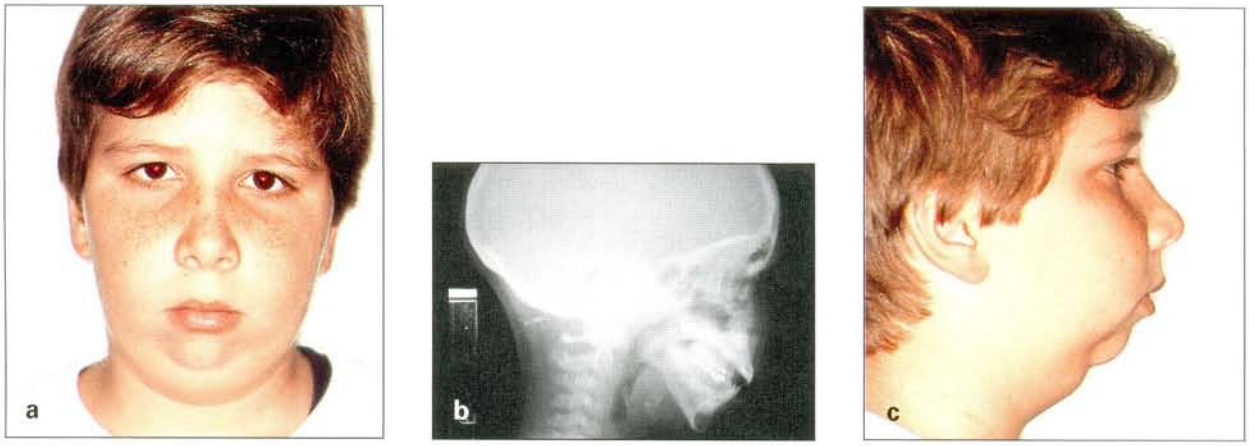

Fig 1 July 24, 1991 (age 13 years, 2 months): **(a)** Frontal view. **(b)** Radiograph. **(c)** Profile view.

Fig 2 Intraoral views of patient at age 13 years, 2 months.

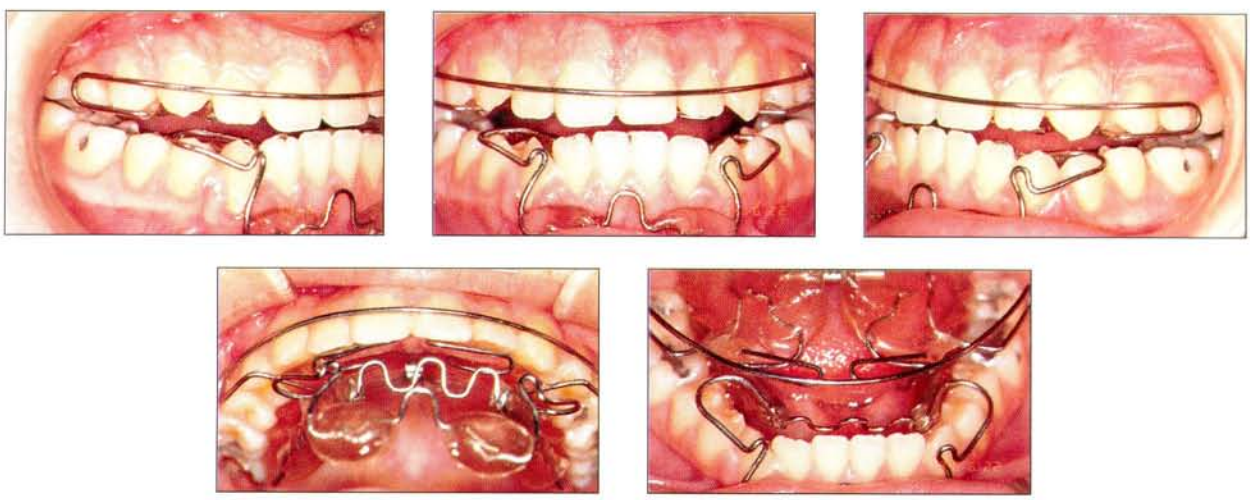

Fig 3 Intraoral views with the appliance placed. Patient age was 16 years, 2 months.

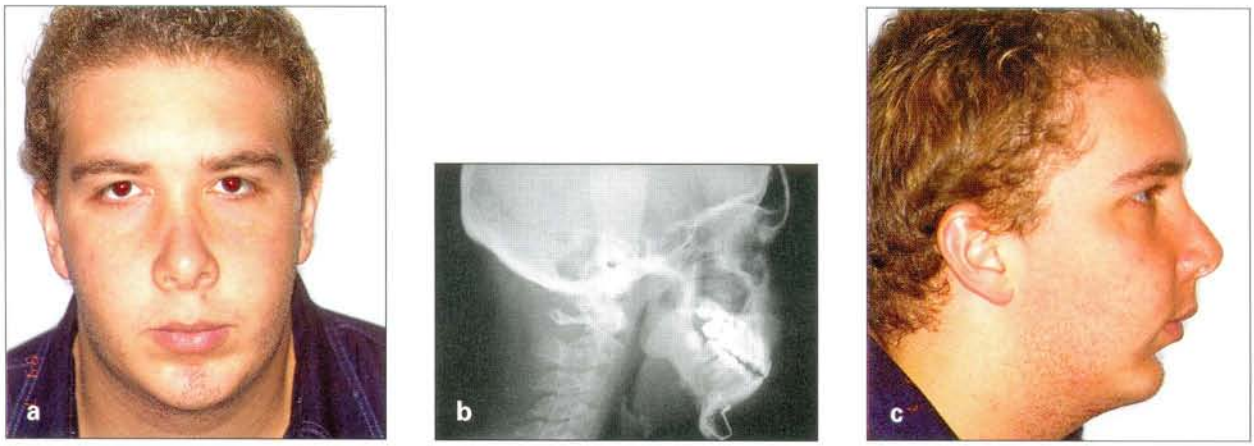

Fig 4 July 1, 1999 (age 21 years, 3 months): **(a)** Frontal view. **(b)** Radiograph. **(c)** Profile view.

Fig 5 Intraoral views of patient at age 21 years, 3 months.

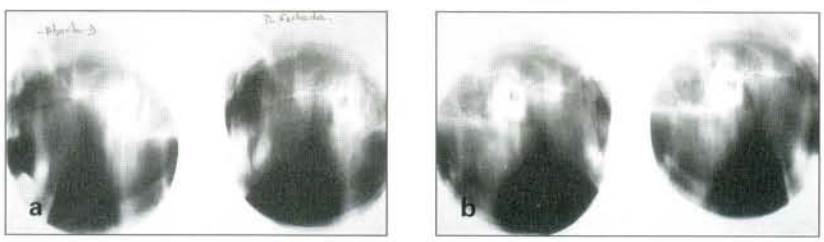

Fig 6 **(a)** Transcranial imaging of right side with open and closed mouth. **(b)** Transcranial imaging of left side with open and closed mouth.

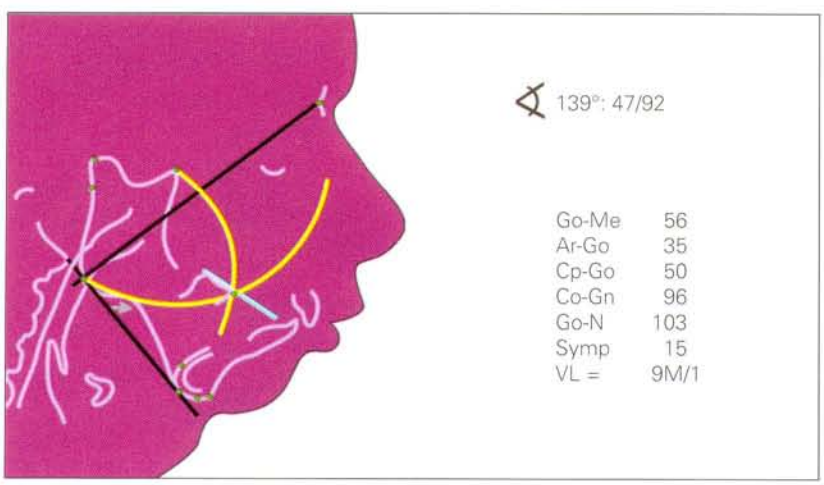

Fig 7 Articular compass tracing. Morphological age analysis was 13 years, 1 month.

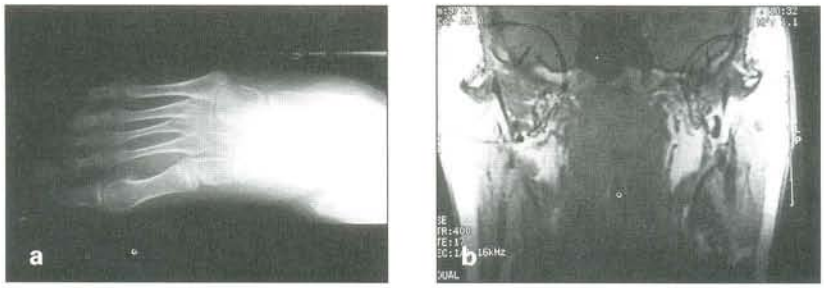

Fig 8 **(a)** Foot radiograph. **(b)** MRI showing the disc replaced by fat.

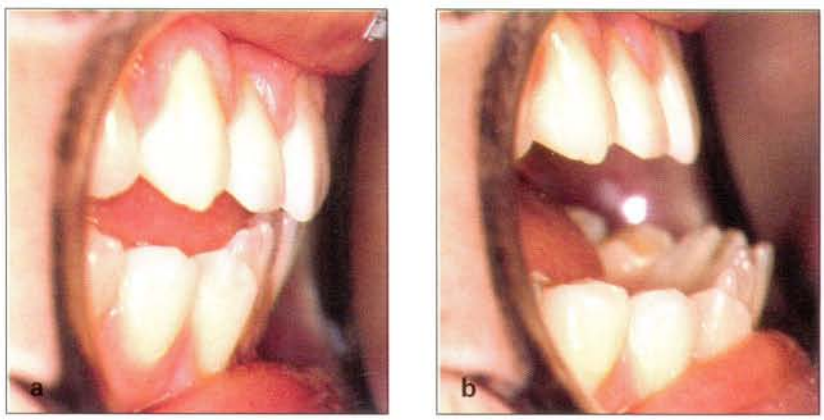

Fig 9 July 1, 1999: **(a)** Mouth profile. **(b)** Maximal protusion movement of simple tumbled type of broken protrusion.

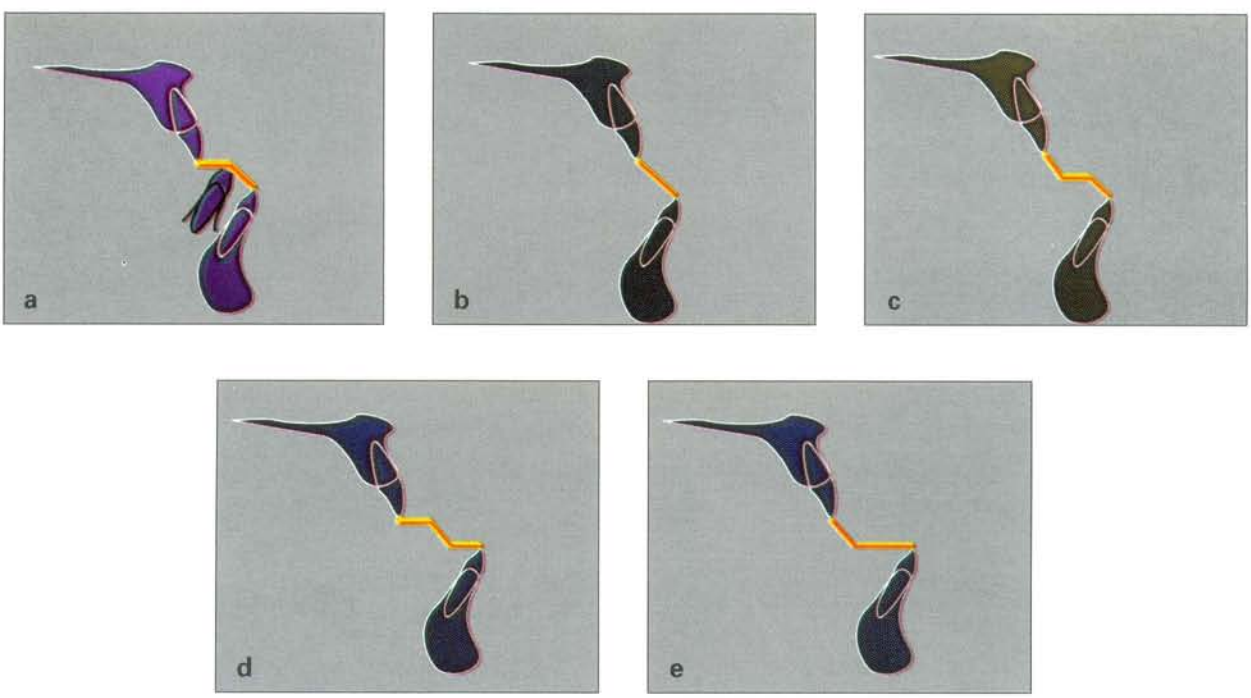

Fig 10 Types of broken protrusion: **(a)** compound, **(b)** simple tumbled, **(c)** double tumbled, **(d)** stepped, **(e)** broken L.

Patient Case Report

Name: *O. B. N.*
Address:
Zip Code: City/State: Country: *Brazil*
Phone: Fax: E-mail:
Birth date: *24/03/78* City/State: */São Paulo* Nationality: *Brazilian*

PART I

Age: *13 y 4 mo* Sex: ☒ M ☐ F Race: *white* Ethnic group:
Age of JRA onset: *5 y 6 mo* Since: 6 mo ☐ 1 y ☐ within first 5 y ☐ more than 5 y ☒
JRA stage: I early ☐ II moderate ☐ III severe ☒ IV terminal ☐
Westergren erythrocyte sedimentation rate (ESR): above 20 mm/h ☒ *39 mm* below 20 mm/h ☐
Lymphadenopathy ☐ Y ☒ N Nodes: *No* Nodules: *No*
Leukocytosis ☐ Y ☒ N Leukopenia ☐ Y ☒ N White blood cell count: *7.000/mm³*
Anemia ☐ Y ☒ N Antinuclear antibodies (ANA) ☐ Y ☒ N
RFp: *No* RFn: *Yes* HLA-DR5: DR8:
Endocrine diseases: *No* Metabolic diseases: *No*
Exocrine diseases: Eyes: Lungs:
Joint deformities: fingers ☒ hands ☒ feet ☒ wrists ☐ elbows ☒
shoulders ☒ hips ☐ knees ☒ ankles ☒ TMJ ☒
TMJ deformities: after other joints ☐ Y ☐ N before other joints ☐ Y ☐ N all together ☒ Y ☐ N
Joint warmth:
Ankylosing spondylitis ☐ Y ☒ N Cricoarytenoid joint changes ☐ Y ☒ N
Others: *Medicinal gastric hemorrhage 10 y of age; GI bleeding; loose stools (about every 2 mo)*
General physical examination: *Normal*
Observations: *Anisocytosis; initially JRA involved knees (5 y 6 mo); has spread to involve TMJ, fingers, left elbow, neck, ankles and feet; tarsal osseous fusions in the left ankle; moderate knock-knee deformity; swelling in both knees*

Subtype group

1º Polyarticular: (PO, seropositive for RF) ☐ Y ☐ N TMJ ☐ Y ☐ N symmetric ☐ Y ☐ N ANA ☐ Y ☐ N
2º Polyarticular: (PO, seronegative for RF) ☐ Y ☐ N TMJ ☐ Y ☐ N symmetric ☐ Y ☐ N ANA ☐ Y ☐ N
3º Polyarticular Type I: iridocyclitis ☐ Y ☐ N TMJ ☐ Y ☐ N symmetric ☐ Y ☐ N ANA ☐ Y ☐ N
4º Periarticular Type II: iridocyclitis ☐ Y ☐ N sacroiliitis ☐ Y ☐ N TMJ ☐ Y ☐ N symmetric ☐ Y ☐ N
5º Systemic-onset JRA or Still's disease: *Knees, hands, feet, left elbow, ankles, neck, TMJs; until 7 y: pharyngitis, amygdalitis, otitis, staphylococcus infection. At 7 y of age, it was noted the micrognathia, anterior open bite and opening limitation*

History & time related

Family inflammatory diseases occurrence: *Sacroiliitis and arthritis*
Pericarditis:
Systemic infection: *1 y 4 mo dehydration followed by intestine, blood, and throat infection*
Trauma: *No*
Psychological stress: *Occasional*
Sleep disturbances: *Body position difficulties*

Persistent arthritis of 6 weeks duration in one or more joints: [Y] [N]

When diagnosed with JRA: *5 y 8 mo*

Start of JRA treatment: *5 y 8 mo*

JRA onset subtypes: early childhood [X] childhood [ ] late childhood [ ]
prepubertal [ ] pubertal [ ]

Associated diseases: *It seems quite possible psoriatic arthritis given the nail pits and somewhat suspicious lesion in the umbilicus*

Exacerbation periods: _____ mild [ ] moderate [ ] severe [ ]

Remission periods: _____ partial [ ] complete [ ]

Treatment

Medicines: *Naprosyn, Trolovol (penicillin), Flagil, Anador, Ridaura (Au), AAS; currently Methotrexate orally 7 mg/wk plus nonsteroidal agents*

Physiotherapy: *For hands; ankle and knee stretching exercises*

Psychology: *No*

Surgery: *No*

Chief complaints & time related

Fever: *Often present with high infections*

Fatigue: general [Y] [N] when: *Mainly walking* jaws [Y] [N] when: *Chewing*

Daily behavior limitations: *Sports, except swimming*

Disability: *Trouble with hand function, particularly in writing; often unable to make a fist*

Weight loss: [Y] [N] since: _____ periods: _____

Growth disturbances: *Lumbar khyphosis and striking micrognathia*

Sore throat: [Y] [N] Rash: [Y] [N] trunk [X] upper arms [ ] others: _____

Headache: _____

Tooth pain: _____ Neck pain, rash [Y] [N]

Face pain: *Zygomatic and gonial angle region* Myalgia, rash [Y] [N]

Otalgia [Y] [N] Ear noises [R] [L] Odynophagia [Y] [N] Throat fullness feeling [Y] [N]

Athralgia: [Y] [N] 4 or fewer joints [Y] [N] pauciarticular onset [Y] [N]
5 or more joints [Y] [N] polyarticular onset [Y] [N]
Morning stiffness: [Y] [N] greater than 30 min [Y] [N] *3 hours*

Visceral pain: [Y] [N] hepatomegaly [Y] [N] splenomegaly [Y] [N]

Others: *Anterior chest pain, not related to breathing*

Exacerbation: mild [ ] moderate [X] severe [ ] with: *Stress, walking, writing*

Remission: not always [X] always [ ] partial [X] complete [ ] with: *Medicines and physiotherapy*

Observations: *Stiffness, by evening has loosened up enough so that he can run*

PART II: SPECIFIC TMJ CRITERIA (RECORDED BY CLINICIAN)

Auricular region pain: front [X] back [X] upper [ ] lower [ ]

Palpatory joint tenderness: laterally [R] [L] posteriorly [R] [L]

Crepitus: palpable R L audible R L swelling Y N - R L rash Y N - R L
Clicking: Y N opening R L closing R L early R L middle R L end R L
Pain occurrence: on waking X late in the day ☐ at night ☐ when eating X
before eating ☐ after eating X stress X opening R L jaw resting pain X
Pain frequency: constant Y N Pain intermittence: _____
Pain duration: _____
Pain sensation: sharp ☐ throbbing X burning ☐ dull X
Pain intensity: mild ☐ moderate X severe ☐ visual analog scale (VAS): 6
Referred pain: *Mainly temporal region*
Irradiating pain: _____
Morning stiffness: Y N more than 30 min Y N _____ Ankylosis: Y N - R L
Loss of function: Y N which one: *Impaired chewing*
Surrounding muscle ache: *Masticatory muscles*
Observations: *Able to chew only soft food and soup*

Specific muscles tenderness criteria

Temporal insertion X	Anterior X	Posterior ☐	SCM X
Trapezius X	Lateral pterygoid X	Medial pterygoid X	Superficial MSS X
Deep portion X	Posterior digastric X		

Pain behavior

Worse in the morning and diminishes throughout the day Y N
Worse as the day progresses Y N *May also occur depending on the activity*
Pain: temporal region X angle of jaw X

Specific neck criteria

Symptomatic Y N Neck pain Y N - R L Back pain Y N - R L
Neck pain location: front ☐ back X upper X lower X
Pain occurrence: on waking X late in the day ☐ at night ☐ when eating X
before eating ☐ after eating X stress contributes X
Neck stiffness Y N
Pain frequency: constant Y N; intermittence: _____
Duration: _____ Use-associated pain: *Position maintenance; walking more than 1 block*
Pain intensity: mild ☐ moderate X severe ☐ visual analogue scale (VAS): 6
Pain sensation: tight X sharp ☐ dull ☐ throbbing ☐ burning ☐
Night sweats: Y N Pain abruptness onset: Y N
Pain relief with: *Medicines and physiotherapy*
Occipital or suboccipital headache Y N Deep suboccipital area tenderness Y N
Movements of neck that produce headaches Y N and alter headaches Y N
FHP Y N LHP asymmetry Y N - R L Restriction in motion Y N
Pain and limitation in neck range of motion Y N
Diminished sensation, pain, or numbness radiating to the neck, suboccipital head, shoulder, or arm:
No
Head flexion produces sharp pain Y N Transverse ligament weakening Y N

Flexion does occur between 45 and 55 degrees [Y] [N] smaller [ ] larger [ ]
Extension does occur around 70 degrees [Y] [N] - [R] [L] smaller [X] larger [ ]
Rotation does occur between 80 and 85 degrees [Y] [N] - [R] [L] smaller [X] larger [ ]
Lateroflexion does occur around 45 degrees [Y] [N] - [R] [L] smaller [X] larger [ ]
Gap between atlas and odontoid process clinical examination: [Y] [N]
Bony fusion: _____
Shoulders: *Severe forward posture*
Observations: *Slight limitation of external rotation of the left shoulder*

PART III: SPECIFIC DENTAL AREA CRITERIA

Open bite: *5 mm* Overbite: _____ Overjet: *5 mm* Backward chin [Y] [N]
IOD-L side: incisive: *3* mm; canine: _____ mm; premolar: *3* mm; molar: _____ mm
IOD-R side: incisive: *2* mm; canine: _____ mm; premolar: *2* mm; molar: _____ mm
Opening according to age [Y] [N] Opening: *Increased pain at 27-33 mm*
Range of jaw motion: RL decreased [R] [N] LL decreased [Y] [N]
Masticatory functional angle: [R] [L] smaller [X] larger [ ]
Physiological free protrusion: [Y] [N] _____ mm pain [Y] [N]
Broken protrusion type: [1] [2] [3] [4] [5] *7* mm pain [Y] [N]
Dental size: *SI 7997* *Si 65, 55, 56* *Ls 19* *Li 15* $\frac{4\ 4}{4\ 4}$ *34* $\frac{6\ 6}{6\ 6}$ $\frac{4\ 4}{4\ 4}$
Shape: _____ Number: _____
Sn-O: *6.8 cm* Sn-Gn: *6.3 cm* T-O: *7.9 cm* T-Sn: *9.4 cm* T-Td: *13 cm* T-Te: *12 cm*
MIC achievement difficulty [Y] [N] Pain [Y] [N] Yawning opening pain [Y] [N]
Talking difficulty [Y] [N] Talking pain [Y] [N] Hoarseness [Y] [N]
Opening deviation occurrence at _____ mm; to [R] [L] side MLD [Y] [N]
Dental deviation: _____ Jaw deviation: *To left* Asymmetric growth [S] [M] [I]
Closing pain [Y] [N] Missing teeth: *No* Molar key: [R] *I* [L] *I*
Grinding [Y] [N] Clenching [Y] [N] Unilateral chewing [R] [L]
Biting on: cheek [Y] [N] lip [Y] [N] tongue [Y] [N]
Abrasion: [Y] [N] Periodontal health status: poor [ ] good [X] optimum [ ]
Dental health: poor [ ] good [X] optimum [ ]
Observation: *Upper canine lack of space; lower crowding; no eruption curve problems; jaw occasionally locks on the right side, during opening and closing*

Legend: Sn = subnasal; Gn = gnathion; O = ofrion; T = tragus; Td = right side tragus; Te = left side tragus; MLD = medial line deviation.

Imaging modality selection

Orthopantomography [X] Transcranial [X] Transmaxillary [ ] Transpharyngeal [ ]
Periapical [X] Tomography [ ] CT [ ] MRI [X] Scintigraphy [ ]
Cephalometric radiographs: lateral projection [X] frontal projection [X]

JRA imaging profile

Micrognathia [Y] [N] Accentuated notch [Y] [N] Symmetric [Y] [N]
Deepened antigonial notching side [R] [L] Articular space: [R] [L] increased [ ] decreased [ ]
Condyle irregular surfaces: anterior [ ] medial [ ] Condyle erosion: complete [X] partial [ ]
Subchondral cyst [ ] Bony sclerosis [ ] Osteophytes [ ]

Condyle form: mouthpiece of the flute ☐

Glenoid fossa irregular surface ☐ Glenoid fossa erosion: complete ☒ partial ☐

Articular eminence flattening ☐ Articular eminence irregular surfaces ☐

Articular eminence erosion ☐ Disc: Y ☒ replaced by fat or proliferating tissue ☒ N

Cephalometric radiographs lateral projection: *13 y 1 mo*

Gonial angle (Ar-Go-Me): *139 degrees*

Upper/Lower gonial angle (Ar-Go-N/N-Go-Me): *47/92 degrees*

Mandibular corpus length (Go-Me): *56 mm*

Posterior ramus length (Ar-Go): *35 mm*

Ramus diagonal length (Cp-Go): *50 mm*

Mandible diagonal (Co-Gn): *96 mm*

Symphyseal width (Symp-Po): *15 mm*

Articular compass - VL: *9M/1 (13 y 1 mo)*

Biotypological relation analysis: *AI 5/8 8/8 D/L L +c −r*

Facial soft tissue: Po'-SNV: *−28.9* mm; mean: *−3.5* mm

Observations: *Throat angle: 142.6 degrees and mean = 106.0 degrees; Po-NV: −24.1 mm and mean = −7.0 mm; disc replaced by fat tissue*

Legend: M = mesial; AI = gnathostatic profile A large; D = dolichoprosopic; L = leptoprosopic; c = cooperation; r = reaction to treatment.

Age coordination

Chronological: *13 y 4 mo* Height: *1.47 m* Weight: *52 kg* Skeletal: *13 y*

Vertebral (10 to 15 y): harmonious ☐ _____ retarded ☒ *10 y* accelerated ☐ _____

Vertebrae concavities: 2 3 4 5 6 ☒ N ☐ I

Taper: ☒ rectangular (horizontal) ☐ nearly square ☐ rectangular (vertical) ☐

Pubertal (9 to 18 y): harmonious ☐ _____ retarded ☒ accelerated ☐ _____

Mandibular dynamics maturity: *9th* stage of development Mental age: *Normal*

Dental age x calcification (Nolla): *9*

Observations: *He is somewhat plump and has buffalo hump. LH=1.3 UI/L; SFH=1.6 UI/L; Testosterone = 250 ng/dL (8.8 nmol/L)*

Dates	Height (m)	Weight (kg)
27/01/87	1.27	36.0
06/01/88	1.32	28.6
01/03/91	1.45	48.0
17/05/91	1.45	51.5

Protocol symbol legends:

M = male; F = female; Y = yes; N = no; R = right side; L = left side; B = beginning; D = deep; S = severe; M = moderate; I = incipient

Skeletal open bites and posterior crossbites may have aberrant protrusion patterns caused by occlusal and/or TMJ morphology or muscular interferences.[8] Trauma may cause vascular impairment that temporarily provokes an avoidance type of protrusion. Protrusive occlusal posterior interference can produce painful muscles and parafunctional activity. Many severe skeletal crossbites have compound or stepped broken protrusion. Simple or double tumbled protrusions are frequently seen in mesiocclusion, with posterior skeletal crossbite.

JRA patients with complete or partial advanced condyle destruction usually have simple tumbled broken protrusion. JRA patients commonly have a shorter protrusive motion in remission periods and may not protrude in active periods when fibrosis and condylar destruction are being exacerbated.

Simões deviation in form (DIF) and deviation in position (DIP) analysis.[13,14,16] Dental and jaw position deviation, plus incipient or advanced asymmetric growth identification, are obtained from the orthopantomographs, chewing side test, and gnathostatic and calcographic tracings. These exams are related to the presence or absence of clinical midline deviation.

JRA imaging profile and age coordination

Age coordination is detected on radiographs, along with other diagnostic criteria such as the hormone laboratory analysis for pubertal age assessment commonly provided by the physicians responsible for the JRA patient. Physical examination provides height and weight curves used to evaluate height age. The other three age categories—skeletal, vertebral, and dental—require radiographic examination. Skeletal age is analyzed by hand-wrist radiographs; vertebral age by the lateral cephalometric radiograph; and dental age by orthopantomography.

Dental age may be assessed according to tooth formation and eruption and mandibular dynamics maturity.[13,16] For JRA patients, assessment of the latter is especially important at the active peaks,[6] that is, between ages 2 to 4 and 8 to 12 years.

Although the patient may recover from the disease satisfactorily during puberty, the ultimate consequences of irreversible structural changes on the patient's functional processes may determine treatment limitations.

Simões structural articular compass analysis.[8] Visualize the proportionality of the ramus-corpus. This is a cephalometric analysis (see Fig 7) to diagnose skeletal or nonskeletal malocclusions with accentuated vertical growth. Clinically, these malocclusions are related to type of protrusion. Other complementary cephalometric analyses can also be useful.

It has been shown that skeletal open bite patients with a broken protrusion have a less favorable prognosis than do patients with other types of protrusion. They also have a gonial angle (articulare-gonion-menton) greater than or equal to 135 degrees. Also present in these patients is a lower part of the gonial angle, nasion-gonion-menton, greater than or equal to 76 degrees.

Constructed gonion is the most distal point of the tangent to the lower border of mandible corpus. JRA patients can have severe antigonial notching or a pronounced lower border curvature, which results in even smaller body length measurements.

This measurement criterion describes a shorter corpus and a longer ramus, which consequently leads to a greater gonial angle concern. When these proportions are found, it is important to check for the beginning or the aggravating conditions of jaw deformity. As the disease progresses, one of the crippling effects is a loss of condylar height. Near-total bilateral destruction of the condylar processes can occur.

The important consideration is not the high gonial angle but the compensatory growth and structural disposition of the parts that should be proportional to the whole craniofacial complex. Harmonious growth is not based on size but on proportion, which allows optimal function of the stomatognathic system. The upper part of the gonial angle indicates ramus obliquity and the lower indicates corpus obliquity. Both have an influence on the downward and forward symphysis projection.

In JRA patients, symphysis width can still have favorable dimensions in relation to the distocclusion. However, mandible morphology is not favorably responsive, as it may be in other cases, because the rules are different. Downward symphysis deviation and increased antigonial notching aggravates the lack of proportionality.

A shorter ramus indicates the likelihood of a poorer prognosis for open bite correction. Therapeutic efforts are severely compromised in cases of JRA where condylar structure is jeopardized by partial or complete destruction.

Another valuable cephalometric criterion is the ramus diagonal. The ramus diagonal measurement is between the superior point on the outline of the coronoid process and the gonion (Cp-Go) (see Fig 7). The vestibular-lingual (VL), so called because it signifies both the surfaces of teeth or of mandibular bone, is a landmark at the crossing lines of the circles of the arches, with the center on Cp and Go, one at a time, and the distance Cp-Go as the radius.

These two cephalometric constructions seem to enclose the measurement that may represent one of the keys to understanding the mandible proportionality between the ramus and corpus relationship. Proportionality is independent of condylar morphology but may relate the ramus morphology with the occlusal plane. Cp is related with temporal muscle and Go with the medial pterygoid masseteric sling.

In control cases with skeletal open bites, similar cephalometric values and free protrusive function from age 6 or 7 to adulthood showed that the VL position changes from the deciduous molar and/or premolar region to the symphysis and incisor region. The relationship between the occlusal plane and VL could be useful to check for possible differences or similarities achieved with treatment. Chances of modifications increase with early treatment. In JRA cases, it is common to find a negative VL above the occlusal line because of jaw deformity, even if it can be centered on the dental or mandible bone area during some periods. A negative VL is often coincident with exacerbation periods, especially in children younger than 12 years of age.

Simões location articular compass analysis.[8] This cephalometric analysis is helpful in the construction of bioelastic appliances, which offer a better design for anterior accessories that may be used as a tongue crib. These accessories provide superior control of the aberrant tongue posture and function. The likelihood of success, using this analysis, is significant.[9]

By 6 to 8 years of age, the jaw structure of the JRA patient can be markedly affected.[1,6,7] It may make bioelastic appliance anchorage difficult. The Simões location articular compass analysis[8] can be used to achieve better appliance adaptation and use.

Vertebral age assessment.[17] This organized analysis provides cervical vertebrae visualization on the lateral cephalometric radiograph. Females reach each maturity stage sooner than males. The reader is referred to the research by Lamparsky for a detailed study of vertebral morphology development.[17]

With this analysis it is possible to evaluate the skeletal age of JRA patients even if the hands and wrists show morphologic deformities. While it is uncommon to find retarded skeletal age, it is not uncommon to find a retarded vertebral age, even when no cervical deformity is present.

Dental age assessment by mandibular dynamics maturity.[13,16] This assessment depends on the vertical dental support zones on which the closing movements stop and also on the anterior tooth guidance for protrusion and lateroprotrusive movement maturation.

Mandibular positions and movements significantly improve the value of dental age assessment. Tooth formation and emergence are of limited value if considered alone. Vertical dental support zones are associated with intercuspation.

Functional orthopedic JRA treatment is not indicated before the fourth or fifth dental development stages, at 6 to 7 years of age, when the first permanent molars are fully erupted and deciduous anterior teeth shedding is occurring.

The sixth mandibular dynamic development stage, at 7 to 8 years of age or later, is mainly characterized by the permanent incisor eruption. In the seventh stage, around 9 to 10 years, the main maturity indicator is mandibular incisors contacting antagonists. This vertical dental support zone is reinforced by the support on the first permanent molars. The deciduous canine and molar shedding allows the first permanent molars to migrate mesially. Anterior open bite in JRA patients may be present at this time, and therefore proper jaw motion cannot be established, including the anterior protrusive guidance physiological pattern.

The eruption of the premolars and permanent canines during the eighth stage, combined with the permanent second molar eruption, brings an active period. This occurs after patients reach 12 years of age. JRA patients usually show heavy nonphysiological attrition on the first permanent molars.

In the ninth stage, when patients are around 13 to 14 years of age, all teeth except the third molars have erupted. In the tenth stage, at approximately 16 to 17 years of age, the number of dental antagonist contacts normally increase at maximal intercuspation, but this does not occur in JRA patients. Depending on the disease activity, an open bite may become worse.

Although coincident with a remission period, the neuroendocrinological character of puberty is not favorable.[13] During puberty, JRA has a long activity period beyond the initial assault, enough to cause many growth aberrations. If the condyles are destroyed, it is even more difficult to obtain any maxillomandibular growth adjustment. Growth compensation that normally happens in puberty is not sufficient to cover the devastating effects of JRA.

The eleventh stage of development, at 18 to 19 years of age, is of utmost importance for the maturation of lateroprotrusive movements. The range of motion normally reaches stability, based on more amplified mature occlusal antagonistic contacts and on a better anterior guidance disposition.

At approximately 20 years of age, the twelfth stage, all dimensional resultants in transverse, vertical, and sagittal vectors have produced a circular

morphological growth movement. This is known as the growth rotational phenomenon, making up part of the natural growth in sagittal and transverse dimensions. In JRA, the result of rotational growth in a downward and backward posterior direction, without the proper maturation of lateroprotrusive and protrusion movements, can be aggravated.

CONCLUSION

Surprisingly, response to treatment may be more favorable with bioelastic functional appliances. They have smaller areas in contact with oral structures, inducing the most convenient change of posture. This provides some relief of symptoms as well as TMJ unloading.

Performing an examination every 6 months following this protocol is advisable for documenting structural changes, the disease status, and treatment outcome. While reading the examination protocol, refer to the case report illustrations. Note, in Fig 4, the structural changes in cervical vertebrae; in Figs 6a and 6b, the condylar destruction at 13.1 years of age; in Fig 8a, the foot deformities; and in Fig 8b, the disc replaced by fat at 18.3 years of age. A blank JRA examination protocol form is included in the online version of this journal (http://www.quintpub.com).

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