MJoSHT
Malaysian Journal of Science, Health & Technology
[mjosht.usim.edu.my]

Article

Association of Periodontitis Severity and Rheumatoid Arthritis Functional Disability: A Narrative Review

Nurul Amysya Liyana Mohd Yusri, Haslina Taib, Wan Suriana Wan Ab Rahman, and Wan Majdiah Wan Mohamad

School of Dental Sciences, Universiti Sains Malaysia Health Campus, 16150 Kubang Kerian, Kelantan, Malaysia

Correspondence should be addressed to:
Wan Majdiah Wan Mohamad; wmajdiah@usm.my

Article Info
Article history:
Received:1 April 2024
Accepted: 23 December 2024
Published: 18 February 2025

Academic Editor:
Nazefah Abdul Hamid

Malaysian Journal of Science, Health & Technology

MJoSHT2025, Volume 11, Issue No. 1
eISSN: 2601-0003

https://doi.org/10.33102/mjosht.v11i1.409

***Abstract*— Numerous studies have demonstrated a relationship between rheumatoid arthritis (RA) and periodontitis. In addition to the shared inflammatory pathways between both conditions, it has been proposed that the joint inflammation and deformity associated with RA causes inability of patients to perform good oral hygiene. This contributes to periodontal and other oral health issues. This review aims to identify common oral manifestations in RA as well as to evaluate the association between periodontitis severity and RA functional disability. A literature search was performed using Google Scholars, Mendeley, and accessible USM-subscribed databases including Springer Link, Science Direct, and Nature to identify related articles published from 1990 until 2021 using research interest and keywords combination. Thirty articles that fit in research interest and fulfilled the objectives were selected. We found that the most common oral manifestations in RA patients discovered in previous studies were increased severity of periodontitis, TMJ problems as well as oral dryness. Inconsistent results were found between the relationship of periodontitis severity and RA functional disability in most studies.**

***Keywords*— rheumatoid arthritis, periodontitis, oral manifestations, periodontitis severity, functional disability**

I. INTRODUCTION

Rheumatoid Arthritis (RA) is a common autoimmune disease primarily affecting the synovial joint lining, leading to progressive disability, early mortality, and socioeconomic burdens [1]. At the rate of 0.5% to 1.0% [2] worldwide, it predominantly occurs in females aged 30 to 50 years old with an incidence of 1 in 150. Progressive destruction of the joint causes pain, swelling, and stiffness, which subsequently leads to deformation and irreversible physical dysfunction of the affected joints [3].

Abnormalities in the humoral and cellular immune responses were hypothesized to occur in RA. Rheumatoid Factors (RF), Anti-cyclic Citrullinated Protein Antibodies (ACPA), anti-Carbamylated Protein (aCarP), and Anti-Acetylated Protein Antibodies (AAPA) are amongst autoantibodies that have been found in the serum of RA patients [4]. The accumulation of autoreactive T and B cells have been discovered in the synovial tissues. The failure of self-tolerance leads to activation of these autoreactive T cells, subsequently stimulating B cells to produce autoantibodies. Meanwhile, the binding of autoantibodies with antigens leads

to the formation of immune complexes which deposited in tissues, subsequently causing tissue damage [3].

On the other hand, periodontitis is a chronic inflammatory disease causing the destruction of teeth-supporting tissues such as gingiva, cementum, periodontal ligament, and alveolar bone. The primary features of periodontitis include gingival bleeding on probing (BOP), the presence of periodontal pocketing, Clinical attachment loss (CAL), and alveolar bone loss [5]. The National Oral Health Survey of Adults (NOHSA) in Malaysia, 2010 [6] reported that 94.0% of dentate adults have some form of periodontal disease (PD). PD is a chronic disease which includes gingivitis and periodontitis. This figure has remained constant for the past 20 years, indicating that the condition is relatively common in our country. The severe form of periodontitis may lead to loss of teeth if left untreated and impair oral functions such as eating, speaking, and smiling.

Several investigations have demonstrated the link between RA and periodontitis. Some researchers hypothesized that the relationship occurs due to periodontal bacteria's citrullination, while others asserted that the link exists due to inflammatory pathways. There are also studies reporting that pharmacological treatment for one of the disorders affects one another. According to Wolff *et al.* (2014) [7], patients with early RA had increased loss of periodontal attachment and alveolar bone, which was also supported by later studies [4,8]. The prevalence of moderate or severe periodontitis was found to be higher in RA patients compared to non-RA patients [8]. It was reported that periodontal parameters such as plaque index, BOP, probing pocket depth, and clinical attachment levels were significantly worse in RA patients than in healthy controls. This indicates that periodontitis severity was associated with RA disease activity [4].

Patients with RA may present with several oral manifestations, including angular cheilitis, candida infection, temporomandibular joint (TMJ) disorder, oral ulceration, and xerostomia [9]. The common incidence of oral dryness in RA patients is most probably due to the effect of pro-inflammatory cytokines such as TNF-*α,* which plays a main role in the pathophysiology of Sjogren Syndrome (SS) and the destruction of the salivary gland [10]. Oral dryness may affect the cleansing effect in the oral cavity, therefore promoting plaque accumulation, which may lead to periodontal disease. Although immunosuppressive drugs may help to reduce the inflammatory effects of RA and periodontitis, several studies reported worsening periodontal status due to prolonged immunosuppression as well as reduced salivary flow [11]. Additionally, irreversible damage of the cartilage and joint in RA leads to loss of functions that can impair the ability to perform routine oral hygiene measures such as tooth brushing and flossing [12]. According to research performed by Lertpimonchai *et al*. in 2017 [13], the risk of periodontitis increases by two to five-fold in individuals with unsatisfactory oral hygiene.

The Health Assessment Questionnaire (HAQ) is a simple instrument used to monitor the functional ability of RA patients. It comprised 20 items which were easy to score and extensively investigated, proved to have good sensitivity when patients' therapy was modified [14]. The HAQ was then modified to only eight items, known as the Modified Health Assessment Questionnaires (mHAQ) by Theodore et al. (1983) [15], in which each one of the items represents each category. According to Evo et al. in 2018 [16], the use of mHAQ effectively compared with the calculation of change scores, reflecting the significant clinical changes in RA patients over time. As compared to laboratory tests or radiographs, assessing patients' comfort levels and capacity to engage in daily activities is proven to be very cost-effective. The Malay version of the mHAQ has been validated in Malaysia as a viable approach for assessing functional status in RA patients [17]. Using this method, patients were requested to assess their normal functioning abilities during the previous week. This review aims to identify common oral manifestations in RA and to evaluate the association between periodontitis severity and functional status in RA patients.

II. METHODS

This study is a narrative review of previously published studies from 1990 until 2021. The information was acquired from research articles published online and accessible on USM-subscribed websites, including Springer Link, Science Direct, and Nature. Additionally, the data was gathered from cost-free websites like Google Scholars and Mendeley. 'Rheumatoid arthritis,' 'periodontitis,' 'periodontitis severity,' and 'functional disability' are key terms used to identify the relevant articles. The publications must be published in English, contain the relevant keywords, and highlight the relationship between periodontitis and RA. The exclusion criteria are editorials and articles published in other languages. All duplicates were removed for the final review of the included papers.

III. RESULTS

Sixty-five articles were retrieved based on the keywords entered. Twelve duplicates, two editorials, and four other types of articles were excluded. Further selection discovered that seven articles had limited information, and ten were unrelated to the aim of the study. Thus, they were omitted from the review. The selection process of the articles is displayed in Figure 1.

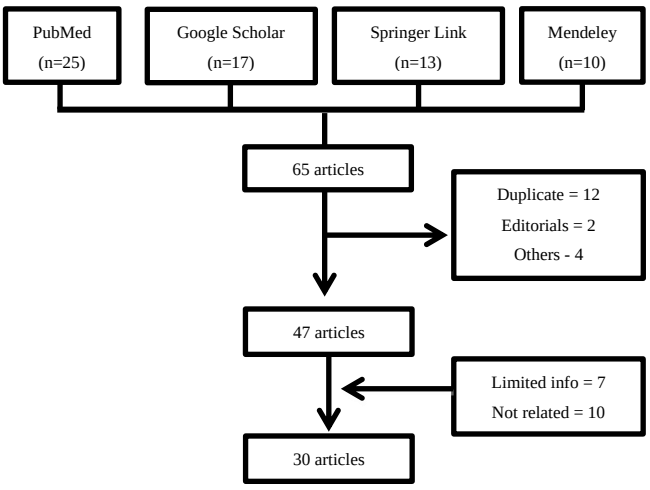

Fig. 1 Flow chart of article search and selection process

.

TABLE I. SELECTED STUDIES TO ASSESS THE COMMON ORAL MANIFESTATIONS IN RA PATIENTS

No.	Source	Authors	Title	General study design and characteristics	Geographical region	Findings	Oral manifestations
1.	PubMed	[18]	Functional Impairment and Periodontitis in Rheumatoid Arthritis	Cross-sectional study involving 93 patients with RA	Nagoya, Japan	Patients with increased rheumatoid arthritis (RA) severity had significantly higher PD than those with less severe disease. A significant relationship between functional class and PD was observed. Patients with RA severity class III and IV had deeper Periodontal Pocket Depth (PPD) and greater Clinical Attachment Loss (CAL) compared to class I and II.	1. Periodontitis
2.	PubMed	[19]	Temporomandibular and Odontological Abnormalities in Patients with Rheumatoid Arthritis	Case-control study involving: a. 30 RA patients b. 30 control subjects	Chihuahua, Mexico	Patients with RA showed a higher prevalence of temporomandibular abnormalities, both clinical (100.0% vs. 60.0%, $P < 0.001$) and radiographic, including erosions (50.0% vs. 16.0%, $P = 0.010$), compared with individuals in the control group. Likewise, patients with RA had a greater number of missing teeth (6.9 ± 5.7 vs. 3.0 ± 2.0, P = 0.001), more caries (13.4 ± 5.4 vs. 4.9 ± 6.5, $P = 0.001$), periodontitis (1.3 ± 0.9 vs. 0.8 ± 0.8, $P = 0.015$), poorer oral hygiene (43.3% vs. 13.3%, $P = 0.005$) and greater facial pain (66.7% vs. 20.0%, $P < 0.001$).	1.Temporomandibular abnormalities 2. Caries 3. Periodontitis 4. Poorer oral hygiene 5. Facial pain
3.	PubMed	[20]	Associations of periodontal status in periodontitis and rheumatoid arthritis patients	Cross-sectional study involving: a. 64 RA-PD patients b. 84 PD only patients	Vilnius, Lithuania	This study demonstrated that RA-PD subjects had higher readings than the PD-only group despite the fact that the stages of PD were not significantly different between the PD+RA and PD-only groups. These periodontal parameters include CAL, PPD, Bone Loss (BL), and Bleeding on Probing (BOP).	1. Periodontitis
4.	Google Scholar	[21]	The association between rheumatoid arthritis and periodontal disease in a population-based cross-sectional case-control study	Cross-sectional case-control study involving 126 RA subjects and 219 healthy controls	Blekinge, Sweden	This study found that diagnosis of periodontitis was more common in the RA group (61.1%) than in the control group (33.7%) ($p = 0.001$). RA group also shows higher data	1. Periodontitis

						regarding BOP, PPD (≥ 5 mm) and alveolar BL (≥ 5 mm).	
5.	Springer Link	[22]	Oral Health and Orofacial Function in Patients with Rheumatoid Arthritis	Cross-sectional study involving 62 RA patients	Chihuahua, Mexico	In this study, it was discovered that only 15.3% of the 62 RA patients had healthy periodontal status, whereas 98.3% had caries. Early periodontitis symptoms are present in the majority of the individuals (28.8%), followed by mild periodontitis (22%) and severe periodontitis (5.1%). Additionally, 98.4% of the patients had temporomandibular joint (TMJ) disorders, and 75.8% of the participants reported having TMJ pain.	1. Caries 2. Periodontitis 3. TMJ disorders 4. TMJ pain
6.	Mendeley	[23]	Periodontal Health and Oral Microbiota in Patients with Rheumatoid Arthritis	Cohort study involving 40 chronic RA patients	Stockholm, Sweden	Results from this study showed that moderate/severe periodontitis is common in patients with RA, especially in ACPA-positive RA.	1. Periodontitis
7.	Google Scholar	[24]	Rheumatoid arthritis patients' oral health and disease activity	Cross-sectional study involving 164 RA patients	Hjørring, Denmark	3.5% of the subjects experienced frequent dry mouth. Although most of the subjects (46%) estimate their oral hygiene as good, 15% experienced spontaneous gingival bleeding, while 49% complained of gingival bleeding during toothbrushing. Additionally, 14% of the subjects also complained of mobile teeth.	1. Gingival bleeding
8.	Springer Link	[25]	Oral manifestations of rheumatoid arthritis. A cross-sectional study of 73 patients	Cross-sectional study involving: 73 RA patients 73 control subjects	Valencia, Spain	The patients with RA had greater periodontal pocket depths, greater attachment loss, and more bacterial plaque. The resting whole saliva and stimulated parotid saliva rates were also clearly decreased in the RA group compared with the controls.	1. Periodontitis 2. Plaque 3. Decrease saliva rates
9.	Mendeley	[10]	Correlation Between the Oral Manifestations of Rheumatoid Arthritis Patients on Different Treatment with The Clinical Disease Activity	Cross-sectional study involving 85 RA patients (25 were on Methotrexate, 30 on Etanercept, and 30 were on a combination of	Baghdad, Iraq	In this investigation, 30% of the patients did not exhibit any oral findings. Oral dryness and TMJ issues were the predominant oral findings. A large proportion of patients with oral findings displayed higher disease activity. Additionally, medications	1. Oral dryness 2. TMJ problems 3. Lichenoid drug response 4. Angular cheilitis 5. Geographical tongue 6. Glossitis

				Methotrexate and Etanercept)		used to treat the illness (methotrexate and etanercept) may potentially be a factor in the patients' oral symptoms, including oral dryness, lichenoid drug response, angular cheilitis, geographical tongue, glossitis, and aphthous ulcerations.	7. Aphthous ulcerations
10.	PubMed	[26]	Oro-facial evaluation of women with rheumatoid arthritis	A cross-sectional study involving: a. 75 RA patients b. 75 healthy controls	Sao Paulo, Brazil	The RA patients presented more signs and symptoms in the orofacial region (difficulty/tiredness in chewing, TMJ morning stiffness, TMJ clicking and crepitations) than the women in the control group, and statistically significant differences were found between the groups: Difficulty/tiredness in chewing: $p = 0.037$ TMJ morning stiffness: $p = 0.013$ Clicking: $p = 0.009$ Crepitations: $p < 0.001$	1. Difficulty/tiredness in chewing 2. TMJ morning stiffness 3. Clicking 4. Crepitations
11.	PubMed	[27]	Evaluation of the TMJ by means of Clinical TMD Examination and MRI Diagnostics in Patients with Rheumatoid Arthritis	Case-control study involving: a. 30 RA patients b. 30 control subjects	Rostock, Germany	The study discovered that the RA group had TMJ tenderness more frequently than the control group did. Additionally, only the RA group experienced crepitus noises, even if TMJ sounds were present in both groups. Maximum unassisted mandibular opening values were similarly lower in the RA group than in the control group. The RA group also had considerably more condyle deformations, osteophyte formations, erosions in the condylar compacta, and degenerative alterations in the spongiosa than the control group, according to an analysis of the MRI images for that group.	1. TMJ tenderness 2. Crepitus 3. Lower maximum unassisted mandibular opening 5. Condyle deformations 6. Osteophyte formations and erosions in the condylar compacta 7. Degenerative alterations in the spongiosa

12.	PubMed	[28]	Rheumatoid arthritis patients with xerostomia have reduced production of key salivary constituents	Cross-sectional study involving: a.16 xerostomic RA patients (RAX) b.16 non-xerostomic RA c.16 healthy control	Bialystok, Poland	The salivary flow in the RAX (xerostomia RA patient) group was significantly lower than the salivary secretion rate in the RA and healthy control groups ($P < .001$)	1. Xerostomia
13.	Google Scholar	[29]	Impact of temporomandibular joint pain in rheumatoid arthritis	Cross-sectional study involving 33 RA patients	Jeddah, Saudi Arabia	Only 9% of subjects reported not experiencing any TMJ pain. Others reported experiencing pain on the TMJ either at rest, during chewing, movement or opening the mouth.	1. TMJ pain
14.	PubMed	[30]	Association between chronic periodontitis and rheumatoid arthritis: a hospital-based case-control study	Cross-sectional study involving: a. 75 RA patients b. 75 healthy controls	Kerala, India	Comparing the periodontal health of the RA group and the non-RA group revealed that all (100%) of the RA individuals had periodontitis. Of the 112 non-RA subjects, only 92 (82%) had periodontitis. This showed that the prevalence of periodontitis was higher in the RA group than in the non-RA group.	1. Periodontitis
15.	PubMed	[31]	Periodontitis in established rheumatoid arthritis patients: a cross-sectional clinical, microbiological and serological study	Cross-sectional study involving: 95 RA patients 80 control subjects	Groningen, Netherlands	43% of the RA subjects had moderate periodontitis, and 27% had severe periodontitis. These numbers are significantly higher than, respectively, the 18% and 12% found in the control population ($P < 0.001$).	1. Periodontitis
16.	PubMed	[32]	Clinical, radiographic and MRI findings of the temporomandibular joint in patients with different rheumatic diseases	67 patients were divided into four groups: 16 with rheumatoid arthritis (RA), 15 with mixed connective tissue disease (MCTD), 18 with ankylosing spondylitis (AS) and 18 with spondyloarthropathy (SPA).	Helsinki, Finland	This study showed that clinically, RA patients can be presented with tenderness of masticatory muscles and TMJ as well as TMJ crepitation. The MRI findings of the RA patients also showed disc perforation, narrowing of the joint space and osteophytes of the condyle.	1. Tenderness of masticatory muscle and 2.TMJ TMJ crepitation
17.	PubMed	[33]	Salivary gland and temporomandibular joint involvement in rheumatoid arthritis: relation to disease activity	Cross-sectional study involving: 50 RA patients 30 control subjects	Bergen, Norway	Thirty-eight (77.6%) of the RA patients, compared with four (8.0%) of the controls, reported symptoms of TMJ pain or dysfunction during the course of the disease. The mean RWS (resting whole saliva) secretion was 2.6 (s.d. 2.4) ml per 15 min for the RA patients compared with 4.5 (s.d. 3.0) for the controls, P= 0.003.	1. TMJ pain or dysfunction 2. Hyposalivation

TABLE II. STUDIES TO ASSESS THE ASSOCIATION BETWEEN PERIODONTITIS SEVERITY AND RHEUMATOID ARTHRITIS FUNCTIONAL DISABILITY

No.	Source	Authors	Title	General study design and characteristics	Geographical region	Findings	Conclusion	*p*-value
1.	Mendeley	[34]	Oral Hygiene Status in Rheumatoid Arthritis Patients and Related Factors	Cross-sectional study involving 100 RA patients	Rabat, Morocco	In this study, no association was found between regular brushing, RA disease activity, and functional status, which was assessed using the HAQ score.	The relationship is statistically not significant.	0.500
2.	PubMed	[8]	Association Between Rheumatoid Arthritis and Population in An Adult Population – A Cross-Sectional	Cross-sectional study involving 55 RA patients and 55 non-RA patients	New Delhi, India	The mean HAQ score was found to be higher in patients with CAL ≥ 2 mm when compared to CAL< 2 mm and this difference was statistically significant.	The relationship is statistically significant.	0.0415
3.	PubMed	[35]	Impact of Periodontitis on Quality of Life among Subjects with Rheumatoid Arthritis: a cross-sectional study	Cross-sectional study involving 187 (29 RA-PD, 58 RA, 43 PD and 57 HC)	Kuala Lumpur, Malaysia	The Oral Health-Related Quality of Life (OHRQoL) measured using the Malaysian version of the oral health impact questionnaire (OHIP-14 (M)) was the poorest in PD groups compared to the RA-PD, RA, and control groups. However, the data were not statistically significant.	The relationship is statistically not significant.	RA only: 0.094 PD only: 0.170 RA-PD: 0.019
4.	PubMed	[36]	Association between severity of periodontitis and clinical activity in rheumatoid arthritis patients: a case-control study	Case-control study involving: 187 RA patients diagnosed 157 control patients without inflammatory joint disease	La Laguna, Spain	There was a statistically significant higher clinical attachment loss, tooth loss, and number of pockets with depth ≥ 5 mm in RA patients with moderate-high activity compared to controls. However, this study found that there was no association between functional disability, as measured by the HAQ score, and the presence of periodontitis in RA patients.	The relationship is statistically not significant.	> 0.05 (no exact *p*-value stated)
5.	Google Scholar	[37]	Impact of Rheumatoid Arthritis Functional Status on Oral and Periodontal Health in a Multi-Ethnic Population	Cross-sectional study involving 63 RA patients	Kuala Lumpur, Malaysia	In this study, the early hypothesis was that as the duration of the RA increases, there will be a decrease in manual dexterity, leading to an impaired ability to perform oral hygiene care. However, the final results showed no association between the functional status	The relationship is statistically not significant.	0.326

						(measured by HAQ-DI scores) and the oral hygiene of the patients.		
6.	PubMed	[38]	Periodontal Disease in Chinese Patients with Rheumatoid Arthritis: A Case-Control Study	Cross-sectional study included 128 RA and 109 healthy controls	Nantong, China	The study discovered that there was no association between functional disability (measured by Health Assessment Questionnaire (HAQ)) and the periodontal disease in RA patients.	The relationship is statistically not significant.	0.114
7.	Google Scholar	[23]	Periodontal Health and Oral Microbiota in Patients with Rheumatoid Arthritis	Cohort study involving 40 RA patients	Stockholm, Sweden	The study did not observe any association between periodontitis severity and RA disease activity in terms of DAS28 and also the self-assessed health (HAQ-score)	The relationship is statistically not significant.	0.380
8.	Google Scholar	[39]	Clinical Significance of Periodontitis in Rheumatoid Arthritis Patients: Association with Disease Activity and Functional Status	Case-control study involving 60 RA patients and 30 controls	Cairo, Egypt	The mean score of the HAQ disability index significantly correlated with the increase in CAL level.	The relationship is statistically significant.	0.0415
9.	Google Scholar	[40]	Periodontal disease in Thai patients with rheumatoid arthritis	196 RA patients are involved	Chiang Mai, Thailand	In this study, the average oral hygiene level of the patients was fair, and it was in concordance with the upper extremity HAQ score, as only 9.7% of the patients had upper extremity HAQ scores > 2. Therefore, the ability of the patients in this study group to perform oral hygiene practices might not be impaired by their RA disease severity. Thus, oral hygiene might not play a vital role in developing periodontitis in this patient group.	The relationship is statistically not significant.	0.834
10.	Google Scholar	[41]	Inter-Relationship Between Rheumatoid Arthritis and Periodontitis	A total of 100 patients were included in the present study, which was divided into two groups: 50 RA patients and 50 healthy controls	Kathmandu, Nepal	A health assessment questionnaire was used in this study. Out of 24 patients with HAQ1 (less functional debilitation), 16 patients had none to mild periodontitis compared to 8 patients with moderate to severe periodontitis. In 23 patients with HAQ2	The relationship is statistically not significant.	0.145

						(moderate functional debilitation), 11 patients (36.7%) had none to mild periodontitis as compared to 12 patients (60%) who had moderate to severe periodontitis. Basically, there was no statistically significant association between the degree of functional debilitation due to RA and periodontal disease severity ($p > 0.05$).		
11.	PubMed	[42]	Temporomandibular Joint Problems and Periodontal Condition in Rheumatoid Arthritis Patients in Relation to Their Rheumatologic Status	Cross-sectional study involving 100 patients with PD, 50 with RA and 50 without RA	Kurdistan, Iraq	CAL had a significant correlation with the HAQ score.	The relationship is statistically significant.	The correlation was significant at the 0.01 level (no significant *p*-value was stated).
12.	PubMed	[43]	Association of Periodontitis with Rheumatoid Arthritis: A Pilot Study	Cross-sectional study involving 69 RA patients and 35 OA patients	Dallas, USA and Washington DC, USA	There were no associations between periodontitis and measures of RA disease activity as measured by DAS28(4v), CRP, or multi-dimensional-HAQ.	The relationship is statistically not significant.	> 0.05 (no exact *p*-value was stated).
13.	PubMed	[44]	Risk of Periodontal Disease in Patients with Longstanding Rheumatoid Arthritis	Cross-sectional study involving 153 RA patients	Wiesbaden, Germany	This study found that patients with longstanding active RA have a substantially increased frequency of periodontal disease compared to healthy controls. However, this study was not able to prove the correlation between functional impairment and reduced oral hygiene as dental cleaning devices have only been used by 4 out of 50 subjects, and it seems likely that the RA patients had overcome the functional limitation by increasing the cleaning time or frequency.	There were no significant correlations between functional status or grip strength and CAL or probing depth.	No *p*-value was stated.

III. DISCUSSION

Analyzing the articles, it was observed that the most common oral manifestation in RA patients is an increase in the severity of periodontitis. Hashimoto et al. (2022) [18] reported a positive correlation between periodontitis severity and RA disease activity. Patients with higher RA disease severity, indicated by an increase in Matrix Metalloproteinases-3 (MMP-3) level, were discovered to have higher CAL as compared to healthy controls. MMP-3, an enzyme released by chondrocytes and synovial fibroblasts in joints, can hasten the degeneration of fibronectin, collagen types IV, VII, IX, and XI, aggrecan core protein, and cartilage link protein RA. Serum MMP-3 has been well-studied as an indicator of disease activity in RA. Moreover, it was reported that RA patients had higher serum MMP-3 levels, which correlated favourably with disease activity, histological synovitis, and synovial MMP-3 expression [45].

In this review, we discovered that a number of studies reported that most RA patients experienced TMJ problems, which manifest as pain, morning stiffness, clicking, and crepitations. The possible causes might be due to the destruction of cartilage and bone deformity as a result of the production of RF autoantibodies and ACPA in RA individuals. Interestingly, Magnetic Resonance Imaging (MRI) findings in RA patients demonstrated frequent deformations of the condyle, osteophyte formations, and erosions in the condylar compacta, as well as degenerative changes in the spongiosa [27]. These findings are supported by a study by González-Chávez et al. (2020)[19], who discovered that RA patients demonstrated a higher prevalence of temporomandibular abnormalities, clinically and radiographically as compared to control group. The enlargement of intimal and subintimal layers of the synovium in RA leads to pannus formation. Additionally, presence of interleukin 1 (IL-1) and Tumor Necrosis Factor-alpha (TNF-α) in the synovial fluid of RA are proven to be the primary triggers of cartilage destruction [46]. IL-1 and TNF-α can break down the cartilage by inducing chondrocytes to release cartilage-degrading metalloproteases. Other synovial fluid enzymes subsequently triggered this process resulting in the loss of glycosaminoglycan [47].

Other oral manifestations observed in the literature search include decreased salivary flow or oral dryness. According to Alahmed et al. (2016) [10], most patients complained of cracked lips as well as difficulty in swallowing and speech. The mucosa also appeared dry and stuck to the gloves during smear-taking. The release of TNF-α, a pro-inflammatory cytokine in response to tissue damage, infection, and other environmental factors, may cause injury to the salivary glands, resulting in this disorder. Additionally, TNF-α, either alone or in conjunction with other inflammatory cytokines, synergistically induces apoptosis of human salivary gland cells [48].

The key component in RA pathogenesis includes the presence of periodontal pathogenic bacteria, *Porphyromonas gingivalis*, which is able to release the Peptidylarginine Deiminase (PAD) enzyme (49). This enzyme catalyzes the conversion of arginine residues to citrulline, which then triggers the production of ACPAs in RA. As mentioned earlier, several studies reported RA and periodontitis shared some common aspects in the inflammatory pathways. Release of pro-inflammatory cytokines such as IL-6 and TNF-α, as well as an increase in CRP levels, may have an impact on BOP depth in RA patients with moderate to high disease activity [50].

We also observed that majority of the studies reported that there was no significant association between RA functional disability and periodontitis severity. Afilal et al. (2021) [34] reported that poor oral hygiene, which is one of the risk factors for periodontitis, is more correlated to the patient's knowledge and illiteracy. RA has been proven to have a significant impact in the performance of oral hygiene practices. However, it does not have a significant effect on periodontitis severity. Earlier studies reported that RA patients have to overcome the difficulty in performing oral hygiene practices by increasing the cleaning time and frequency of toothbrushing [44]. It is well known that individuals who brush their teeth frequently will have a lower risk of developing periodontitis [13]. Nevertheless, a study by Varshney et al. (2021) [8] has suggested a contradictory result in which they discovered that there was a significant association between RA functional disability and periodontitis severity. The higher plaque index indicates poor oral hygiene has been observed in the RA group. This may be related to a loss of manual dexterity caused by the presence of swollen and painful joints, as evidenced by the higher DAS 28 and HAQ scores.

IV. CONCLUSION AND LIMITATIONS

According to our reviews, the most common oral manifestations of RA patients discovered in previous studies include increased severity of periodontitis, TMJ problems as well as oral dryness. Inconsistent results are revealed regarding the significance of the interrelationship between RA functional disability and periodontitis severity. Thus, more extensive literature search should be performed in the future to obtain more convincing findings.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

ACKNOWLEDGEMENT

The authors would like to thank the School of Dental Sciences USM for this research

REFERENCES

[1] Guo, Q., Wang, Y., Xu, D., Nossent, J., Pavlos, N. J., Xu. J. "Rheumatoid arthritis: Pathological mechanisms and modern pharmacologic therapies". Bone Research, vol. 6, no. 1, 2018. https://doi.org/10.1038/s41413-018-0016-9.

[2] Aletaha, D., Smolen, J. S. "Diagnosis and management of rheumatoid arthritis: A Review". JAMA, vol. 320, no. 13, 2018. https://doi.org/10.1001/jama.2018.13103.

[3] Tanaka, Y. "Rheumatoid arthritis. Inflammation and regeneration. A Review". BMC, vol. 40, 2020, pp. 20. https://doi.org/10.1186/s41232-020-00133-8.

[4] Rodríguez-Lozano, B., González-Febles, J., Garnier-Rodríguez, J. L., Dadlani, S., Bustabad-Reyes, S., Sanz, M., Sánchez-Alonso, F., et al. "The etiology of rheumatoid arthritis". Journal of Autoimmunity, vol. 110, 2020, pp. 102400.

[5] Laine, M. L., Crielaard, W., Loos. B. G. "Genetic susceptibility to periodontitis". Periodontology 2000, vol. 58, no. 1, 2011, pp. 37-68. https://doi.org/10.1111/j.1600-0757.2011.00415.x

[6] "National Oral Health Survey of Adults". Oral Health Division, Ministry of Health Malaysia. 2010.

[7] Wolff, B., Berger, T., Frese, C., Max, R., Blank, N., Lorenz, H. M., Wolff, D. "Oral status in patients with early rheumatoid arthritis: a prospective, case–control study". Rheumatology, vol. 53, no. 3, 2014, pp. 526-31. https://doi.org/10.1093/rheumatology/ket362.

[8] Varshney, S., Sharma, M., Kapoor, S., Siddharth, M. "Association between rheumatoid arthritis and periodontitis in an adult population – A cross sectional study". Journal of Clinical and Experimental Dentistry, vol. 13, no. 10, 2021, pp. 980-986. https://doi.org/10.4317/jced.57562.

[9] Al-yassiri, A. M. H. "Oral Findings in Rheumatoid Arthritis Patients". Karbala Journal of Medicine, vol. 6, no. 1, 2013, pp. 1584–1590.

[10] Alahmed, A. M., Abdulkareem, K. F., Zaidan, F., Yahya, A. "Correlation Between the Oral Manifestations of Rheumatoid Arthritis Patients on Different Treatments with The Clinical Disease Activity". IOSR Journal of Dental and Medical Sciences, vol. 15, no. 9, 2016, pp. 132–138. https://doi.org/10.9790/0853-150905132138.

[11] De Molon, R. S., Rossa, Jr. C., Thurlings, R. M., Cirelli, J. A., Koenders, M. I. "Linkage of periodontitis and rheumatoid arthritis: Current evidence and potential biological interactions". International Journal of Molecular Sciences, vol. 20, no.18, 2019, pp. 4541. https://doi.org/10.3390/ijms20184541.

[12] Hashimoto, H., Hashimoto, S., Muto, A., Dewake, N., Shimazaki, Y. "Influence of plaque control on the relationship between rheumatoid arthritis and periodontal health status among Japanese rheumatoid arthritis patients". Journal of periodontology, vol. 89, no.9 2018, pp.1033-1042. https://doi.org/10.1002/JPER.17-0575.

[13] Lertpimonchai, A., Rattanasiri, S., Arj-Ong Vallibhakara, S., Attia, J., Thakkinstian, A. "The association between oral hygiene and Periodontitis: A systematic review and meta-analysis". International Dental Journal, vo. 67, no. 6, 2017 pp. 332–343. https://doi.org/ 10.1111/idj.12317.

[14] Graell, E., Vazquez, I., Larrosa, M., Rodríguez-Cros, J. R., Hernández, M. V., Gratacós, J., et al. "Disability measured by the modified health assessment questionnaire in early rheumatoid arthritis: Prognostic factors after two years of follow-up". Clinical and Experimental Rheumatology, vol. 27, no. 2, 2009, pp. 284–91.

[15] Theodore, P., Jane, A. S., Salvatore, A. S., Kenneth, A. W., Norman, P. H. "Assessment of patient satisfaction in activities of daily living using a modified stanford health assessment questionnaire". Arthritis & Rheumatism, vol. 26, no. 11, 1983, pp. 1346–53. https://doi.org/10.1002/art.1780261107.

[16] Alemao, E., Guo, Z., Frits, M. L., Iannaccone, K., Shadick, N. A., Weinblatt, M. E. "Association of anti-cyclic citrullinated protein antibodies, erosions, and rheumatoid factor with disease activity and work productivity: A patient registry study". Seminars in Arthritis and Rheumatism, vol. 47, no. 5, 2018, pp. 630–8. https://doi.org/ 10.1016/j.semarthrit.2017.10.009.

[17] Hussein, H., Mustafa, R., Quek, K. F., Hassanudin, N. S., Shahid, S. "Cross‐cultural adaptation and validation of the Malay health assessment questionnaire for use in rheumatoid arthritis". International Journal of Rheumatic Diseases, vol. 11, no. 3, 2008, pp. 237-40. https://doi.org/10.1111/j.1756-185X.2008.00384.x

[18] Hashimoto, H., Hashimoto, S., Shimazaki, Y. "Functional Impairment and Periodontitis in Rheumatoid Arthritis". International Dental Journal, vol. 72, no. 5, 2022, pp. 641–7. https://doi.org/10.1016/j.identj.2022.01.002

[19] González-Chávez, S. A., Pacheco-Tena, C., Campos Torres, R. M., Quiñonez-Flores, C. M., Reyes-Cordero, G., Caraveo Frescas, T. J. "Temporomandibular and Odontological Abnormalities in Patients with Rheumatoid Arthritis". Reumatologia Clinica, vol. 16, no. 4, 2020, pp. 262–71. https://doi.org/10.1016/j.reuma.2018.07.005.

[20] Rovas, A., Puriene, A., Punceviciene, E., Butrimiene, I., Stuopelyte, K., Jarmalaite, S. "Associations of periodontal status in periodontitis and rheumatoid arthritis patients". Journal of Periodontal & Implant Science, vol. 51, no. 2, 2021, pp. 124-34. https://doi.org/10.5051/jpis.2006060303.

[21] Renvert, S., Berglund, J. S, Persson, G. R, Söderlin, M. K. "The association between rheumatoid arthritis and periodontal disease in a population-based cross-sectional case-control study". BMC Rheumatology, vol 4, no. 31, 2020. https://doi.org/10.1186/s41927-020-00129-4.

[22] González-Chávez, S. A., Pacheco-Tena, C., de Jesús Caraveo-Frescas, T., Quiñonez-Flores, C. M., Reyes-Cordero, G., Campos-Torres, R. M. "Oral health and orofacial function in patients with rheumatoid arthritis". Rheumatology International, vol. 40, no. 3, 2019, pp. 445–53. https://doi.org/10.1007/s00296-019-04440-3.

[23] Eriksson, K., Fei, G., Lundmark, A., Benchimol, D., Lee, L., Hu, Y. O. O., et al. "Periodontal Health and Oral Microbiota in Patients with Rheumatoid Arthritis". Journal of Clinical Medicine, vol. 8, no. 5, 2019, pp. 630. https://doi.org/10.3390/jcm8050630.

[24] Radwan-Oczko, M., Duś-Ilnicka, I., Richards, P., Thomsen, A. M., Rasmussen, C. "Rheumatoid arthritis patients' oral health and disease activity". International Journal of Rheumatic Diseases, vol. 22, no. 8, 2019, pp. 1538–43. https://doi.org/10.1111/1756-185X.13590.

[25] Silvestre-Rangil, J., Bagán, L., Silvestre, F. J., Bagán, J. V. "Oral manifestations of rheumatoid arthritis. A cross-sectional study of 73 patients". Clinical Oral Investigations, vol. 20, no. 9, 2016, pp. 2575–80. https://doi.org/10.1007/s00784-016-1745-z.

[26] Hoyuela, C. P. S., Furtado, R. N. V., Chiari, A., Natour, J. "Oro-facial evaluation of women with rheumatoid arthritis". Journal of Oral Rehabilitation, vol. 42, no. 5, 2015, pp. 370–7. https://doi.org/10.1111/joor.12255.

[27] Witulski, S., Vogl, T. J., Rehart, S., Ottl, P. "Evaluation of the TMJ by means of Clinical TMD Examination and MRI Diagnostics in Patients with Rheumatoid Arthritis". BioMed Research International, 2014. https://doi.org/10.1155/2014/328560.

[28] Zalewska, A., Knas, M., Waszkiewicz, N., Waszkiel, D., Sierakowski, S., Zwierz, K. "Rheumatoid arthritis patients with xerostomia have reduced production of key salivary constituents". Oral Surg Oral Med Oral Pathol Oral Radiol, vol. 115, no. 4, 2013, pp. 483-90. https://doi.org/10.1016/j.oooo.2012.10.013.

[29] Ahmed, N., Mustafa, H. M., Catrina, A. I., Alstergren, P. "Impact of temporomandibular joint pain in rheumatoid arthritis". Mediators of Inflammation, 2013. https://doi.org/10.1155/2013/597419.

[30] Joseph, R., Rajappan, S., Nath, S. G., Paul, B. J. "Association between chronic periodontitis and rheumatoid arthritis: a hospital-based case–control study". Rheumatology International, vol. 33, no. 1, 2012, pp. 103–9. https://doi.org/10.1007/s00296-011-2284-1.

[31] Smit, M. D., Westra, J., Vissink, A., Doornbos-van der Meer, B., Brouwer, E., van Winkelhoff, A. J. "Periodontitis in established rheumatoid arthritis patients: a cross-sectional clinical, microbiological and serological study". Arthritis Research & Therapy, vol. 14, no. 5, 2012, pp. R222. https://doi.org/10.1186/ar4061.

[32] Helenius, L. M. J., Tervahartiala, P., Helenius, I., Al-Sukhun, J., Kivisaari, L., Suuronen, R., et al. "Clinical, radiographic and MRI findings of the temporomandibular joint in patients with different rheumatic diseases". International Journal of Oral and Maxillofacial Surgery, vol. 35, no. 11, 2006, pp. 983–9. https://doi.org/10.1016/j.ijom.2006.08.001.

[33] Moen, K., Bertelsen, L. T., Hellem, S., Jonsson, R., Brun, J. G. "Salivary gland and temporomandibular joint involvement in rheumatoid arthritis: relation to disease activity". Oral Diseases, vol. 11, no. 1, 2005, pp. 27–34. https://doi.org/10.1111/j.1601-0825.2004.01054.x.

[34] Afilal, S., Rkain, H., Allaoui, A., Fellous, S., Berkchi, J. M., Taik, F. Z., et al. "Oral Hygiene Status in Rheumatoid Arthritis Patients and Related Factors". Mediterranean Journal of Rheumatology, vol. 32, no, 3, 2021, pp. 249-55. https://doi.org/10.31138/mjr.32.3.249.

[35] Han, P. S. H, Saub, R., Baharuddin, N. A., Sockalingam, S., Bartold, P. M., Vaithilingam, R. D. "Impact of periodontitis on quality of life among subjects with rheumatoid arthritis: a cross sectional study". BMC Oral Health, vol. 20, no. 1, 2020, pp. 1–9.

[36] Rodríguez-Lozano, B., González-Febles, J., Garnier-Rodríguez, J. L., Dadlani, S., Bustabad-Reyes, S., Sanz M., et al. "Association between severity of periodontitis and clinical activity in rheumatoid arthritis patients: a case-control study". Arthritis Research & Therapy, vol. 21, no. 1, 2019.

[37] Nik-Azis, N. M., Mohd Fadzilah, F., Mohamad Said, M. S., Baharin, B., Mohd, N. "Impact of rheumatoid arthritis functional status on oral and periodontal health in a multi-ethnic population". Sains Malaysiana, vol 48, no. 3, 2019, pp. 645-52. https://doi.org/10.17576/jsm-2019-4803-18.

[38] Zhao, R., Gu, C., Zhang, Q., Zhou, W., Feng, G., Feng, X., Dong, C., Gu, Z. "Periodontal disease in Chinese patients with rheumatoid arthritis: A case–control study". Oral Diseases, vol. 25, no. 8, 2019, pp. 2003–9. https://doi.org/10.1111/odi.13176.

[39] Fathi, H. M., Gheita, T. A., Khairy, N., El-Battawy, W. A., Taha, R. "Clinical Significance of Periodontitis in Rheumatoid Arthritis Patients: Association with Disease Activity and Functional Status". QJM: An International Journal of Medicine, vol. 111, no. 1, 2018. https://doi.org/10.1093/qjmed/hcy200.061.

[40] Khantisopon, N., Louthrenoo, W., Kasitanon, N., Sivasomboon, C., Wangkaew, S., Sang-In, S., Jotikasthira, N., Bandhaya, P. "Periodontal disease in Thai patients with rheumatoid arthritis". International Journal of Rheumatic Diseases, vol. 17, no. 5, 2014, pp. 511–8. https://doi.org/10.1111/1756-185X.12315.

[41] Rajkarnikar, J., Thomas, B. S., Rao, S. K. "Inter-Relationship Between Rheumatoid Arthritis and Periodontitis". Kathmandu University Medical Journal, vol. 11, no. 41, 2013, pp. 22–6. https://doi.org/10.3126/kumj.v11i1.11018.

[42] Garib, B. T., Qaradaxi, S. S. "Temporomandibular Joint Problems and Periodontal Condition in Rheumatoid Arthritis Patients in Relation to Their Rheumatologic Status". Journal of Oral and Maxillofacial Surgery, vol. 69, no. 12, 2011, pp. 2971–8. https://doi.org/10.1016/j.joms.2011.02.131.

[43] Dissick, A., Redman, R. S., Jones, M., Rangan, B. V., Reimold, A., Griffiths, G. R., Mikuls, T. R., Amdur, R. L., Richards, J. S., Kerr, G. S. "Association of periodontitis with rheumatoid arthritis: a pilot study". Journal of Periodontology, vol. 81, no. 2, 2010, pp. 223–30. https://doi.org/10.1902/jop.2009.090309.

[44] Käßer, U. R., Gleissner, C., Dehne, F., Michel, A., Willershausen-Zönnchen, B., Bolten, W. W. "Risk for periodontal disease in patients with longstanding rheumatoid arthritis". Arthritis and Rheumatism, vol. 44, no. 12, 1997, pp. 2248–51. https://doi.org/ 10.1002/art.1780401221.

[45] Ma, J. D., Wei, X. N., Zhang, D. H., Mo, Y. D., Chen, L. F., Zhang, X., Li, J. H., Dai, L. "Continuously elevated serum matrix metalloproteinase-3 for 3 to 6 months predict one-year radiographic progression in rheumatoid arthritis: a prospective cohort study". Arthritis Research & Therapy, vol 17, 2015, pp. 289. https://doi.org/10.1186/s13075-015-0803-2.

[46] Ostrowska, M., Maśliński, W., Prochorec-Sobieszek, M., Nieciecki, M., Sudoł-Szopińska, I. "Cartilage and bone damage in rheumatoid arthritis". Rheumatology, vol. 56, no. 2, 2018, pp. 111–20. https://doi.org/10.5114/reum.2018.75523.

[47] Hollander, A. P., Atkins, R. M., Eastwood, D. M., Dieppe, P. A., Elson, C. J. "Human cartilage is degraded by rheumatoid arthritis synovial fluid but not by recombinant cytokines in vitro". Clinical and experimental immunology, vol. 83, no. 1, 1991, pp. 52–7. https://doi.org/10.1111/j.1365-2249.1991.tb05587.x.

[48] Koski, H., Janin, A., Humphreys-Beher, M. G., Sorsa, T., Malmström, M., Konttinen, Y. T. "Tumor necrosis factor-alpha and receptors for it in labial salivary glands in Sjögren's syndrome". Clinical and experimental rheumatology, vol. 19, no. 2, 2001, pp. 131–7.

[49] Leech, M. T., Bartold, P. M. "The association between rheumatoid arthritis and periodontitis. Best practice & research". Clinical rheumatology, vol. 29, no. 2, 2015, pp. 189–201. https://doi.org/10.1016/j.berh.2015.03.001.

[50] Kobayashi, T., Yokoyama, T., Ishida, K., Abe, A., Yamamoto, K., Yoshie, H. "Serum cytokine and periodontal profiles in relation to disease activity of rheumatoid arthritis in Japanese adults". Journal of periodontology, vol. 81, no. 5, 2010, pp. 650-7. https://doi.org/ 10.1902/jop.2010.090688.