Original Article

Effect of depression on attentional network system among rheumatoid arthritis patients—A cross-sectional study

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Abstract

Rheumatoid arthritis (RA) is a chronic, painful and debilitating musculoskeletal condition with depression being its common co-morbidity. It is associated with symptoms of fatigue, pain, and sleep disturbances that can overlap with or mimic symptoms of depression. It may occur with at least mild severity is up to 42% of RA patients. Basically, depression refers to a constellation of experience including not only mood but also physical, mental and behavioral experiences. The fact that rates of depression are higher in samples of patients with RA than in the normal population is well documented. The present study was conducted in order to examine the effect of depression on attentional functioning with diagnosed RA patients. Twenty RA patients out of which 10 patients with depression and 10 patients without depression participated in the study. The Beck Depression Inventory was administered for the assessment of depression and the attentional network task was used to measure the attentional performance of the RA patients. Results revealed that there was a significant difference in depressive symptoms among RA patients on accuracy and reaction time ($P < 0.01$) and orienting effect ($P < 0.05$). The findings would also imply intervention and rehabilitation of depression among RA patients.

Keywords: Depression and attentional functioning, rheumatoid arthritis

Introduction

Rheumatoid Arthritis (RA) is a systemic disease that involves systems/organs other than the bones and joints alone.[1] It is an inflammatory autoimmune disorder that is characterized by joint pain and swelling.[2] According to the World Health Organization (WHO), RA is a chronic systematic disease that affects the joints, connective tissues, muscle, tendons, and fibrous tissue. It tends to strike during the most productive years of adulthood, between the ages of 20 and 40 and is a chronic disabling condition often causing pain and deformity. Women are affected more than men in a ratio of 3:1.[1] Patients feel excess pain, swelling, morning stiffness, and deformity due to the disease progression along with fatigue, weakness, depression, loss of weight fever, disability, and decreased quality of life. It can harm the body as well as reduce the functional potentiality towards work among patients.

People with RA commonly show depressive symptoms during disease. According to WHO, depression is a common mental disorder characterized by persistent sadness and a loss of

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interest in activities that people normally enjoy, accompanied by an inability to carry out daily activities for at least 2 weeks. Pain and depressive symptoms are very common factors in RA, both do exist but the mechanism behind them is not deciphered yet. Depression commonly co-occurs with RA, in the range of 13–20% and above based on clinical assessments.[3,4] Covic *et al.* worked on 169 RA patients using depression, anxiety, and stress scale (DASS) and hospital, anxiety, and depression scale (HADS) and found that comorbidity of depression and anxiety occur in RA.[5] Depression in RA is associated with higher levels of disease activity, pain, fatigue, work disability, health service use but lower treatment compliance and increased suicide risk and mortality.[6-8] The presence of depression shows poor health, impaired mood, increased higher level of pain, and functional disability in RA patients.[3,9,10] Brown *et al.* found that pain was positively related to depression and negatively related to cognitive functioning and that depression mediated the relationship between pain and cognitive functioning suggesting that pain leads to depression which leads to poorer cognitive functioning.[11] A similar study by Shin *et al.* have also worked on the same topic and revealed that the proportion of persons who were classified as cognitively impaired on each test of the neuropsychological test battery, ranged from 8 to 29%. More than 20% of subjects were found to be cognitively impaired in executive function (28% on the design fluency test and 21% on the trail making test).[12] Dickens *et al.* found that depression was significantly more common among RA patients than healthy individuals and was influenced by the level of pain. Pain leads to depression while other researchers suggested that depression leads to pain. Its causal relationship may be bidirectional.[13]

Many studies have reported that executive and attentional functions are affected by chronic pain patients. In a study by Eccleston and Crombez, patients with chronic pain who reported higher levels of both pain and somatic awareness showed significant performance decrements on an attentionally demanding switching task compared with other chronic pain patients.[14] Another study of Oosterman *et al.* used neuropsychological tests of sustained attention, planning ability, inhibition and mental flexibility on 34 participants with chronic pain and 32 control participants and observed that participants with chronic pain perform worse than controls on a test of mental flexibility and sustained attention, but not on inhibition or planning ability.[15]

Attention, a major component of cognition is the process of selecting for active processing specific aspects of the physical environment (e.g., objects) or ideas stand in memory. It is the mental ability to select stimuli, responses, memories, and thoughts that are behaviorally relevant among a host of others that are behaviorally irrelevant.[16] Attention is a key feature of cognitive functioning and essential behavior regulation which is supported by three distinct subsystems: alerting, orienting, and conflict monitoring.[17] More recent theories suggest that attention is a system of disparate networks including alerting, orienting, and selection.[18] The attentional network theory proposes three independent cognitive concepts: (a) alerting involves a change in mental state as well as in the physiological state, and prepare the organism for fast reaction. (b) Orienting involves the selective allocation of attention to a source of signal in space. (c) Executive attention is commonly measured using tasks in which there is an incompatibility between dimensions of the stimulus or response.[19]

On the basis of previous studies, it has been observed that the cognitive functioning of RA patients got affected by RA pain. Comorbid depression has been shown to independently increase functional disability in RA. Several pieces of evidence have suggested that depression increases the risk of cognitive impairment and functional disability.[20,21]

This study was, therefore, undertaken to compare and find the effect of depression on attentional network performances (higher mental activity) in RA patients using attentional network tasks. It is hypothesized that RA patients without depressive symptoms would perform better in terms of reaction time (RT) and accuracy than RA patients with depressive symptoms. It is also predicted that the performance of RA patients would be negatively correlated with their depressive symptoms.

Method

Participants

An experimental study was conducted to examine the depression and attentional performance of RA patients. This study was approved by the institutional research ethics (No. Dean/2019/EC/1795). This study included 20 RA patients diagnosed according to the American College of Rheumatology (ACR) criteria of classification of RA were recruited from an outpatient rheumatology clinic of Sir Sunderlal Hospital, BHU, Varanasi. These 20 patients were further categorized into two groups as RA with depressive symptoms and RA without depressive symptoms on the basis of Beck Depression Inventory's scores. Each group comprised 10 participants. Inclusion criteria included diagnosed patients of RA of age between 25 and 45 years, being able to read and write and willingness to participate in the study. Patients were excluded if they had cognitive impairment or having other types of arthritis other than RA.

Study protocol

Patients fulfilling the inclusion criteria were enrolled after taking consent. Participants were given written and oral instructions. Demographic and socioeconomic details of patients were taken. Mini-mental status examination was used for excluding patients if they found cognitively impaired.[22] They were asked to complete Beck depression inventory-II (BDI) followed by 15–20 min of Attentional Network Task on DELL computer screen, using inquisit millisecond software. After completion of the task, participants were debriefed and thanked for giving their time.

Tools and measures

Mini mental state examination (MMSE)

The mini-mental state examination (MMSE) is a commonly used set of 30-point questionnaire for screening cognitive function.

This examination can be used to indicate the presence of cognitive impairment. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention, and calculation, recall, and language. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment.[22]

Beck depression inventory (BDI)

Beck Depression Inventory (BDI) developed by Beck *et al.* (1961) was used and modified in local language.[23] The psychometric properties of the modified Hindi version of the BDI have found satisfactory. The internal consistency of the Hindi version of BDI was found to be highly satisfactory (Cronbach's alpha = 0.84).

In this research, alerting, orienting, and executive functioning will be assessed independently using the attentional network tasks to examine distinct attentional mechanisms of RA patients.

Experimental task (Attention network task)

The attention network task (ANT) is a combination of a flanker task with arrows[24] and a cued RT task.[25] The ANT examines the effect of cues and targets within a single RT task to provide a means of exploring the efficiency of the alerting, orienting, and executive control networks involved in attention. The ANT was developed as a measure that would allow independent assessment of the efficiency.[18] The ANT provides two measures of performance; response time (RT) and accuracy and three network scores are calculable within each of these measures.

In this task, stimuli consisted of arrowed lines pointing toward rightward or leftward, flanked on their side by side two distracters that could be either in the same direction (congruent flankers) or in the opposite direction (incongruent flankers), neutral lines. Furthermore, four different cues were presented randomly across flankers conditions before the onset of each trial: no cue, a central cue, consisting of an asterisk appearing at the location of the central fixation cross, a double cue, consisting of two asterisks appearing at the two possible target location, and a spatial cue, consisting of an asterisk appearing at the target location.

The experimental task consists of one practice session of 2 min and three blocks of the main trial for 5 min each. The total task was completed in 15–20 min. After 20 trials of the practice session, participants were presented with the main session of three blocks consisting of 96 trials.

Each trial consisted of the following sequence of events: a fixation cross (+) was presented in the middle of the screen for 400–1600 ms, it was immediately followed by one of the types of warning cues for 100 ms, then the warning cue was followed again by the fixation cross (+) for 400 ms, then the central arrow with one of the three types of flankers were presented and remained visible until the participant responded or until 1700 ms had elapsed. Participants were instructed to press the "E" button for the left direction of the central target and press the "I" button for the right direction of the central target. In this task, there were four cue conditions and three target conditions as mentioned in Figure 1.

Statistical analysis

An independent samples *t*-test was conducted to compare the attentional network performance in RA patients with depressive symptoms and RA patients without depressive symptoms. Mean RT in the ANT paradigm was analyzed with two groups (RA patient with depressive symptoms and RA patients without depressive symptoms) × 3 flanker type (congruent, incongruent and neutral) by independent samples *t*-test measures.

Results

Disease duration ranged between 2 months and 5 years with a mean of 1.8 years. It was computed from the disease onset to the time of the questionnaire administering.

Result Table 1 shows that there was a significant difference in the scores of correct detection (accuracy rate) and RT for RA patients without depressive symptoms and RA patients with depressive symptoms conditions ($P < 0.01$). Specifically, our result suggests that a depressive symptom among RA patients has an effect on accuracy and RT and it affects the performance on ANT. Thus, result support the hypothesis that there would be a significant difference in the functioning of attentional networks system among RA patients with depressive symptoms and RA patients without depressive symptoms in terms of accuracy of signals and RT. Figures 2 and 3 also show the graphical presentation of the result.

Result Table 2 shows that there was no significant difference in the scores of alerting effect and executive control effect for RA patients without depressive symptoms and RA patients with depressive symptoms conditions.

The two groups on RTs using independent sample *t*-test revealed significant difference in the scores of orienting effect for RA patients without depressive symptoms (mean = 16.17; SD = 11.2) and RA

Table 1: Showing the mean (M), standard deviation (SD), and *t*-value of correct detection (accuracy rate) and reaction time

	RA with depressive symptoms (*n*=10) Mean (SD)	RA without depressive symptom (*n*=10) Mean (SD)	*t*	Sig. Level
Correct detection	79.65 (19.9)	98.36 (1.3)	2.95	0.008**
Reaction time	749.65 (114.1)	585.7 (112.4)	3.23	0.005**

**Significant at 0.01 level

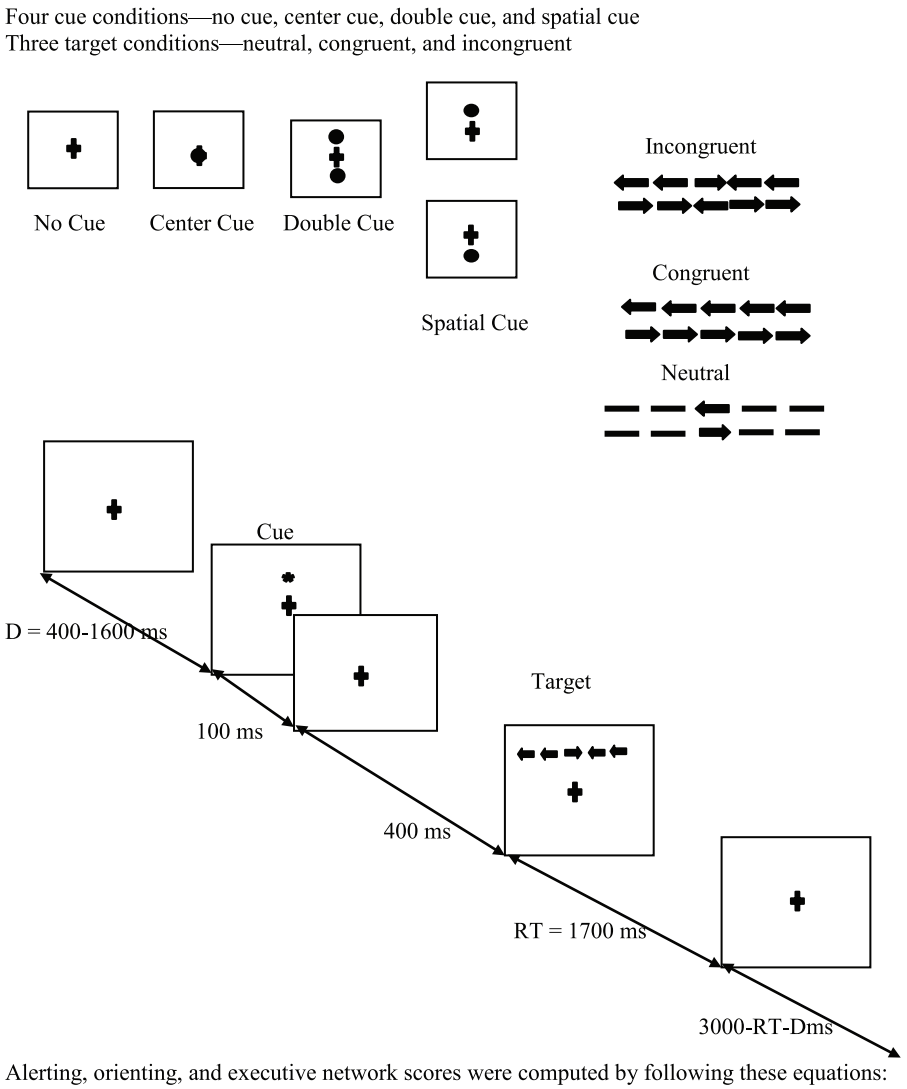

Figure 1: Schematic presentation of attention network task (Fan *et al.*, 2002)[18]

patients with depressive symptoms (mean = 45.67; SD = 37.9) conditions; t (18) =2.35, $P < 0.05$. It also clearly indicated that the patient's orientation was decreased due to their depressive symptoms.

Results also suggested that a depressive symptom among RA patients had an effect on alerting and executive control, however, not statistically significant. Figure 4 shows the differences between alerting, orienting, and executive control effects between RA patients with depressive symptoms and RA patients without depressive symptoms through the graph.

Discussion

RA is a chronic disease that can be associated with depression. The present study examined the effect of depressive symptoms on ANT performance among patients with RA. Researchers have shown that pain influences the performances on the neuropsychological test. Dick *et al.* used three groups (RA, fibromyalgia, and musculoskeletal) and compared them with healthy control and revealed that all three groups of chronic pain patients had impaired cognitive functioning on the test of everyday attention.[26] Abeare *et al.* found through their study on 157 adults with RA that pain was inversely related to executive functioning.[27]

Rezaei *et al.* worked on 100 adults with RA and assessed illness perception, depression, and pain. They found that 66% of RA patients showed a clinically significant level of depression. Depressive symptoms were significantly associated with perceived pain by RA patients. Patient's beliefs toward their

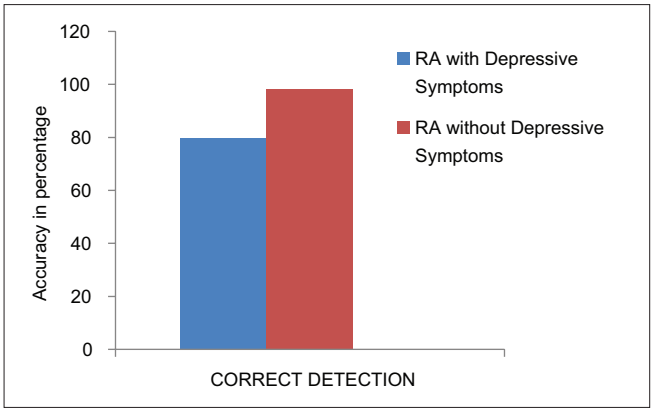

Figure 2: Showing the mean value of correct detection for both groups

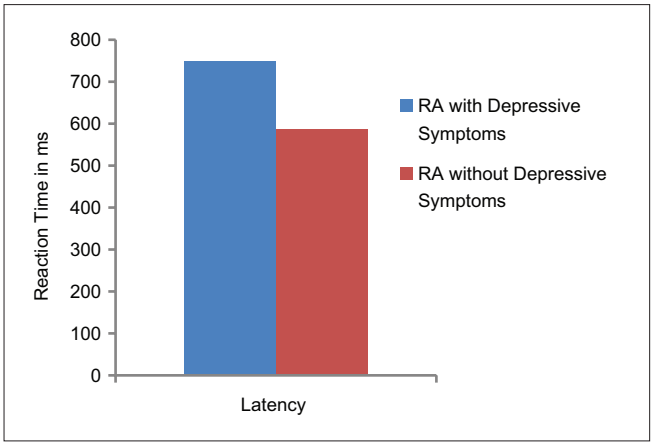

Figure 3: Showing the mean value of reaction time for both groups

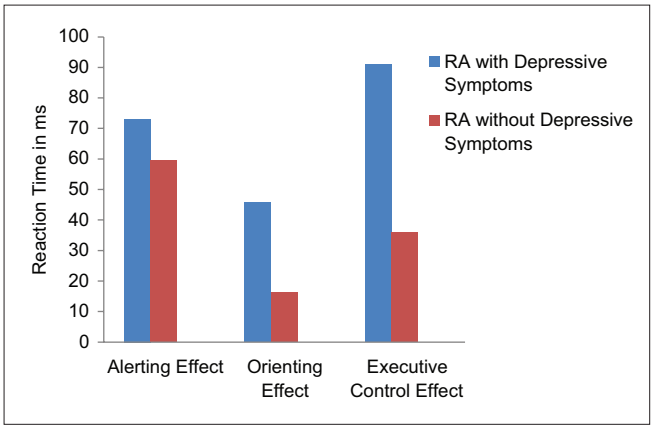

Figure 4: Showing the mean value of alerting, orienting, and executive control effect for both groups

disease mediated the relationship between depression and pain. This study also highlights the importance of the patient's belief and emotional responses to their symptoms and illness as key factors influencing satisfaction with the consultation and the further use of the health care system. Studies revealed that various types of other factors like disease duration, disease activity, fatigue, physical disability, economic strains, and lack of social support leads to depression.[28] However, depression is found as one of the major comorbid conditions with RA which affects the performance of the individual.

The present study also supports previous findings that RA patients would show a significant level of depression. Moreover, pain is a major symptom of RA. Kojima *et al.* also proved that depression severity and inflammation were associated with each other and appeared to have independent effects of perceived pain. Due to inflammation and this pain, depression is commonly correlated with each other.[29] It has been found that pain and depression both affect cognitive functioning. Cognitive impairment and depression are linked by the functional and structural transformation in the cortical and subcortical areas of the brain, which regulates the processing of emotional and cognitive information.[30]

The present study also attempts to explore the effect of depressive symptoms on attentional network functioning, which might be helpful to a rheumatologist in treating RA. Results clearly revealed that depression affects attentional performance among patients with RA. Depressive symptoms possess the accuracy rate and RT. RA patients with depressive symptoms took more time and committed more errors during task performance. Orientation was found to be more effective and improved in RA patients without having depressive symptoms. RA is related to significant psychiatric comorbidity of psychological aspects. The main psychiatric disorders reported in RA cases are anxiety, depression, or sometimes both.[31-34] Results further suggested that pain and depression both are very common in RA and both are affected by each other. Although the mechanism of the relationship between pain and depression still not known, the presence of depression has been repeatedly linked to poor health, increased higher level of pain, impaired mood, and functional disability in RA patients.[3,9,10] Pain is known to disrupt attentional performance in both healthy adults and patients with chronic pain. Moore *et al.* found that pain-related attentional impairment was found on the n-beck, attentional switching, and divide attention.[35]

The results further revealed the lower accuracy rate and increased RT for RA patients with depression comorbidity. Also, the performance of RA patients with depression as comorbidity showed a significant difference in orienting that basically regulates the selective allocation of attention. However, there was no significant difference in alerting and executive dimensions, which indicates better performance while attending changes and conflict resolutions in contrast to difficulty in selecting the stimulus to be attended and adequately utilizing the required mental resources. People with greater pain and more depressed respectively perform less well on tests of cognitive function. The better cognitive function might be protective against the emergence of pain prior to an arthritis diagnosis but the cognitive function is subsequently impaired by pain and depression.[36] Meade *et al.* reviewed and revealed that age, education, disease activity, and depression were associated with cognitive impairment.[37]

Table 2: Showing the mean (M), standard deviation (SD) and *t*-value of alerting, orienting, and executive function

Dimensions of attentional network task	RA with depressive symptoms (*n*=10)	RA without depressive symptoms (*n*=10)	*t*	Sig. Level
	Mean (SD)	Mean (SD)		
Alerting effect	73.14 (30.9)	59.47 (28.3)	1.03	0.316
Orienting effect	45.67 (37.9)	16.17 (11.2)	2.35	0.030*
Executive control effect	91.08 (36.8)	35.9 (24.5)	1.25	0.226

*Significant at 0.05 level

The study has limitations that included a small number of patients and further correlation of the severity of RA patients with depression and attention was not assessed. A higher number of patients may be taken to make such a correlation.

This study highlights the importance of estimation of the prevalence of depression in RA patients. Pain is known to affect cognition, particularly mental flexibility, and attention. Continuous mood assessment by rheumatology clinical staff may serve to improve awareness and early identification of depression. Regular screening and early intervention would provide a psychological as well as the physical aspect of healing of early RA.

The present study shows the potential utility of measuring attention in patients of RA and the importance of its assessment with other tools for the measurement of psychological symptoms. Therefore, it may be helpful in the clinical evaluation and screening of patients who may benefit from various related psychological interventions that would complement their medical care and treatment.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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