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Relationship Between the Serum Total Bilirubin and Inflammation in Patients With Psoriasis Vulgaris

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Background: Psoriasis is a chronic and recurrent inflammatory skin disease. Previous studies have shown that bilirubin has anti-inflammation and antioxidant effects. However, the various roles of bilirubin in psoriasis patients are still unclear. *Objective:* To investigate the serum total bilirubin (TB) level in the individuals with psoriasis vulgaris and further evaluate the relationship between serum TB concentration and C-reactive protein (CRP) to clarify the effect of bilirubin on inflammation. *Methods:* A total of 214 patients with psoriasis vulgaris and 165 age- and gender-matched healthy control subjects were recruited. The peripheral leukocyte count (*white blood cell,* WBC) and differential, serum biochemical and immunologic indexes including serum TB, immunoglobulin (Ig) G, IgA, IgM, complement C_3 and C_4, as well as serum CRP concentrations were measured. *Results:* Results showed that the serum TB level decreased significantly and peripheral WBC, neutrophil, and serum CRP concentrations increased significantly in patients with psoriasis vulgaris. Meanwhile, the serum CRP was negatively correlated with serum TB levels but positively correlated with peripheral WBC and the Psoriasis Area and Severity Index (PASI). Logistic regression analysis showed that the serum TB was a protective factor for psoriasis vulgaris. *Conclusion:* The present study suggests that lower serum TB is associated with the enhancement of the inflammatory response in psoriasis vulgaris. Therefore, lower serum TB has a prognostic significance for worsening psoriasis vulgaris. Bilirubin may play a crucial role in inflammation by contributing to the inhibition of the inflammatory response. J. Clin. Lab. Anal. **30**:768–775, 2016. © 2016 Wiley Periodicals, Inc.

Key words: psoriasis vulgaris; bilirubin, inflammation; CRP; logistic regression

INTRODUCTION

Psoriasis is an immune-mediated chronic and recurrent inflammatory skin disease, affecting approximately 2% of the population in the world and impacting the patients' quality of life (1). The C-reactive protein (CRP) is an important inflammatory biomarker, produced and released by the liver under the stimulation of inflammatory

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mediators (2). Increased serum concentration of CRP reflects activation of systemic inflammation in the body (2, 3). The substantial inflammatory role played by CRP in the pathogenesis of psoriasis has been studied in several clinical investigations, and there is increasing evidence that the serum CRP level is significantly elevated in psoriasis patients and closely associated with the severity of psoriasis (3, 4).

The amount of circulating leukocytes in circulation plays a central role in inflammatory diseases. Increased peripheral leukocyte counts are correlated with the intensity of the inflammatory response and adverse outcomes (5). Similar to any inflammatory disease, psoriasis often induces an increase in blood leukocytes, especially neutrophils (NEUT). Several clinical studies reported increased levels of NEUT in the peripheral blood of these patients (2, 4). The activation of NEUT triggers a series of physiological and pathological responses including deregulation, enzyme release, and generation of reactive oxygen species (ROS). This has been shown to mediate the inflammatory process and greatly enhance the inflammatory response, and contribute to tissue damage (6). To counterbalance the injurious effects of the oxidants in inflammation, there are endogenous antioxidant systems in human body, which may promote the detoxification of ROS. Once the balance between the two systems is broken, enhanced tissue inflammation will occur and the psoriasis will worsen (7).

Oxidative stress is pathologically essential to process various inflammatory diseases (8–10). Bilirubin, a potent antioxidant under physiological conditions by inhibiting oxidation, has anti-inflammatory effects (11, 12). Rapid regeneration of bilirubin by biliverdin reductase is enough to protect cells and tissues against the oxidants (13). The above-mentioned mechanism may also help bilirubin to play a direct anti-inflammatory role (14, 15). The bilirubin has been proved to act against atherosclerosis (AS) that is closely associated with chronic vascular wall inflammation (16). Several studies further revealed a relationship between bilirubin and AS diseases (17, 18). There is evidence that a decreased concentration of serum bilirubin is indicative of an elevated clinical risk of developing AS (19). The oxidative stress in inflammation is one of the main pathogenesis processes in psoriasis (20). As an important endogenous antioxidant, bilirubin can inhibit the inflammation in tissues (14, 15, 21). There are several studies trying to shed light on the change of serum bilirubin in psoriasis. However, the outcomes have been inconsistent (22–25).

Although the antioxidant effects as well as the protective role against inflammation of bilirubin have been extensively explored in both retrospective and prospective studies (12, 13, 17–19), the change of serum bilirubin concentration and its relation to inflammation in psoriasis have not yet been elucidated. Our objective was to investigate the change of serum total bilirubin (TB) in psoriasis vulgaris patients to evaluate the anti-inflammatory role of bilirubin in psoriasis.

MATERIALS AND METHODS

Study Subjects

This study had been approved by the Ethical Committee of Capital Medical University and Beijing Traditional Chinese Medicine (TCM) Hospital. A written informed consent was obtained from all participants prior to enrollment. The principle of the Helsinki Declaration for using human subjects was obeyed. A total of 214 patients with psoriasis vulgaris (55 females and 159 males) from the Department of Dermatology, TCM Hospital, were enrolled as the patient group. The diagnosis of psoriasis was based on clinical findings and laboratory examinations. Meanwhile, 165 healthy subjects (56 females and 109 males) were enrolled as controls. A questionnaire interview was conducted to collect individual information. Both patients and control subjects were then physically examined. Those with a past/present medical history of liver, renal, cardiovascular and cerebrovascular diseases, heart failure, peripheral arterial disease, hypertension, hypercholesterolemia, hypothyroidism, obstructive sleep apnea, diabetes, insulin resistance, chronic inflammatory disease, such as rheumatic arthritis, system lupus erythematous, inflammatory bowel disease, cutaneous lymphoma, nonmelanoma skin cancer, or any kinds of tumor, drinking and smoking were excluded from the study. The controls also had no history of any skin disease and presented normal hematological, biochemical, and immunological index values. In the patient group, the patients have no clinical finding of joint complaints and radiological evidence of psoriatic arthritis (PsA), the subjects of psoriasis coexisting PsA, and the individuals with dermatologic diseases other than psoriasis were also excluded. In addition, none of the psoriasis patients had received any systemic or specific nutritional supplement or medication, namely anti-inflammatory drugs, antioxidants, local steroid medication, or any phototherapy treatment for at least 1 month prior to blood collection. Psoriasis severity was evaluated by the Psoriasis Area and Severity Index (PASI) presented at the time of blood collection (7). In order to diminish the subjectivity, the PASI of psoriasis patients was evaluated by the same group of dermatologist.

Blood Samples Collection

All blood samples were obtained by venipuncture and collected into vacuum blood collection tubes (INSEPACK®, Sekisui, Beijing). Peripheral whole blood

samples were collected into tubes containing EDTA-K^{+2}. The peripheral leukocyte parameters were analyzed within 2 h after the blood sample collection. Serum samples were obtained by centrifugation of blood samples for 10 min at 3,500 rpm to obtain the cellular components. Subsequently, the serum samples were stored at −80°C until analysis.

Peripheral Blood WBC Parameter Analysis

The peripheral white blood cell (WBC) parameters including leukocyte count and differential count were determined with the LH780 hematology auto-analyzer (Beckman Coulter Inc. Brea, CA, USA).

Serum Immunological Index Detection

The serum CRP, immunoglobulin (Ig) G, IgM, IgA and complement C_3, C_4 concentrations were measured with rate turbidimetry and nephelometry. The reagent kits were purchased from the Beckman Coulter, Inc. (Brea, CA, USA) and measured with the IMMAGE 800 Immunochemistry System (Beckman Coulter, Inc., Brea, CA, USA).

Serum ALT, CK, Cre, and TB Determination

The serum alanine aminotransferase (ALT), creatine kinase (CK), and creatinine (Cre) were measured with the enzyme kinetics assay. The ALT kit was purchased from the Beckman Coulter, Inc. (Brea, CA, USA); the CK kit was purchased from the Diasys Diagnostic Systems GmbH (Holzheim, Germany) and Cre kit was purchased from the Merit Choice Bioengineering Co., Ltd. (Beijing, China). The serum TB level was measured with the diazo colorimetric assay using a kit purchased from the Merit Choice Bioengineering Co., Ltd.. All the four indexes were measured on the Beckman Coulter AU5821 automatic analyzer (Beckman Coulter, Inc., Brea, CA, USA).

Statistical Analysis

The Statistical Package of Social Science (SPSS) 17.0 for Windows (SPSS Inc., Chicago, IL) was used for statistical analysis. The normality of data was tested by one sample Kolmogorov–Smirnov test. For the normal data, unpaired *t*-test was used for comparison between the two groups, while Mann–Whitney *U*-test was used for the data abnormally distributed. The χ^2 test was used for comparing the dichotomous variables of the two groups, while Spearman correlation was performed in bivariate analyses. The influence of analyzed parameters including the age, gender, peripheral blood WBC parameter, serum TB, and immunological index on psoriasis was assessed by binary logistic regression analyses. For all tests, two-tailed P values were reported and the results were considered statistically significant when $P < 0.05$.

RESULTS

General Information of Psoriasis Patients and Controls

General information on the subjects of this study was summarized in Table 1. The psoriasis vulgaris patients and control subjects appeared to adequately match with respect to age and gender. There was no significant difference in age and gender distributions between the psoriasis patient group and controls.

Peripheral Blood Leukocyte Count and Differential Count

The peripheral blood WBC (leukocyte) count and differential count are shown in Table 1. The peripheral blood leukocyte count of psoriasis patients was significantly higher than the controls. Meanwhile the differential count of peripheral blood leukocytes of psoriasis vulgaris patients showed that the absolute count and percentage of NEUT and eosinophils (EOS) were significantly higher than the controls ($P < 0.001$), while the percentage of lymphocytes (LYM) and monocytes (MONO) in psoriasis vulgaris patients were obviously lower than the controls ($P < 0.001$).

The Serum ALT, CK, Cre, and TB Levels

There was no significant difference in the serum ALT, CK, and Cre level between psoriasis patients and controls ($P > 0.05$; Table 1). The serum TB concentration of psoriasis patients was obviously lower than the controls ($P < 0.05$).

The CRP, IgG, IgM, IgA, and Complement C_3, C_4 Concentrations

Results of immunological marker levels between the psoriasis group and controls are shown in Table 1. The serum CRP, IgG, and complement C_4 concentrations of psoriasis vulgaris patients were significantly higher than the controls ($P < 0.05$).

Correlations Among the Serum CRP, Serum TB levels, and Peripheral Blood WBC Parameters as well as Immunological Index in Psoriasis Patients

In psoriasis vulgaris patients, the peripheral blood WBC count was positively correlated with serum CRP

TABLE 1. Subject Characteristics of Psoriasis Patients and Controls

		Psoriasis patients ($n = 214$)		Controls ($n = 165$)		
		Mean (SD)	Media (IR)	Mean (SD)	Media (IR)	*P*-value
Age	year	41.02 (12.55)	44.00 (20.30)	42.22 (9.68)	42.00 (14.00)	0.116
Gender	M/F (%)	159/55 (74.30/25.70)		109/56 (66.06/33.94)		0.081
PASI	–	15.76 (7.35)	15.8 (9.00)	–	–	–
Peripheral Blood WBC count and classification						
WBC	($\times 10^9$/l)	6.94 (1.88)	6.50 (2.31)	6.17 (1.51)	6.00 (2.06)	<0.001
Neutrophil granulocyte	(%)	61.53 (7.94)	62.20 (10.00)	58.03 (6.87)	58.30 (9.60)	0.002
Neutrophil granulocyte	($\times 10^9$/l)	4.30 (1.39)	4.15 (1.79)	3.62 (1.17)	3.53 (1.35)	<0.001
Lymphocyte	(%)	28.67 (8.83)	27.40 (11.90)	32.51 (6.65)	32.20 (9.10)	0.003
Lymphocyte	($\times 10^9$/l)	1.95 (0.78)	1.85 (0.87)	1.98 (0.51)	2.04 (0.61)	0.075
Mononuclear leukocyte	(%)	5.97 (1.95)	5.45 (2.30)	6.73 (2.45)	6.10 (2.20)	<0.001
Mononuclear leukocyte	($\times 10^9$/l)	0.41 (0.18)	0.37 (0.19)	0.41 (0.15)	0.39 (0.17)	0.710
Eosinophilic granulocyte	(%)	4.07 (3.82)	3.00 (2.70)	2.00 (1.01)	1.80 (0.90)	<0.001
Eosinophilic granulocyte	($\times 10^9$/l)	0.31 (0.46)	0.21 (0.20)	0.12 (0.06)	0.10 (0.06)	<0.001
Serum biochemical and immunological index						
Alanine aminotransferase	U/l	23.81 (18.86)	18.00 (16.00)	22.51 (14.93)	17.00 (15.00)	0.594
Creatine kinase	U/l	75.95 (46.11)	64.00 (38.00)	78.40 (23.95)	74.50 (30.00)	0.721
Creatinine	μmol/l	71.83 (14.71)	71.00 (23.00)	68.04 (15.14)	68.00 (26.00)	0.095
Total bilirubin	μmol/l	11.69 (4.47)	10.95 (5.20)	13.64 (5.75)	13.18 (7.80)	<0.001
Immunoglobulin G	g/l	12.21 (2.53)	12.00 (3.20)	11.33 (1.86)	11.40 (2.40)	0.002
Immunoglobulin A	g/l	2.60 (1.35)	2.33 (1.41)	2.26 (0.80)	2.17 (0.99)	0.064
Immunoglobulin M	g/l	0.89 (0.34)	0.83 (0.43)	1.02 (0.41)	0.95 (0.54)	0.001
Complement C_3	g/l	1.16 (0.24)	1.13 (0.28)	1.16 (0.25)	1.12 (0.37)	0.890
Complement C_4	g/l	0.28 (0.20)	0.26 (0.09)	0.25 (0.10)	0.23 (0.07)	0.020
C-reactive protein	mg/dl	9.17 (14.98)	3.37 (7.02)	2.66 (2.47)	2.11 (1.96)	<0.001

χ^2 test, nonparametric test (Mann–Whitney test), or Student's *t*-test were used, the SD is the standard deviation and IR is the interquartile range.

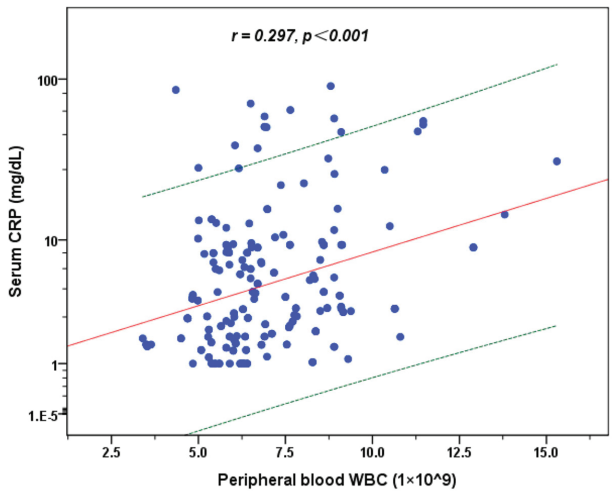

Fig. 1. Correlation between serum CRP concentration and peripheral blood WBC count in psoriasis vulgaris patients. Regression prediction line and 95% individual confidence intervals (dotted line) are provided.

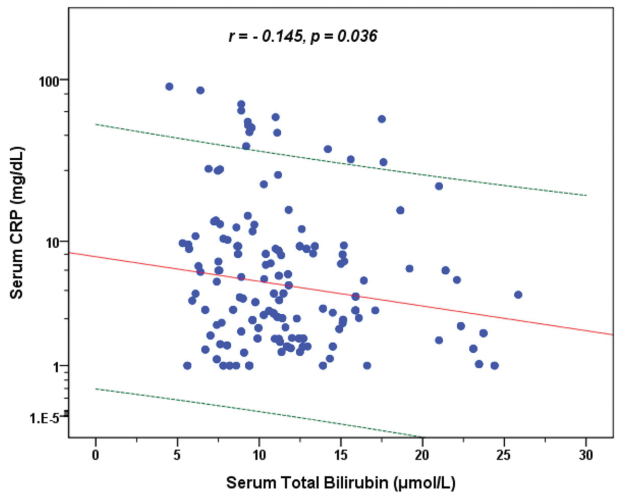

Fig. 2. Correlation between serum CRP and TB concentration in psoriasis vulgaris patients. Regression prediction line and 95% individual confidence intervals (dotted line) are provided.

concentration (Fig. 1; $r = 0.297$, $P < 0.001$) and the serum TB level was negatively correlated with the serum CRP concentration (Fig. 2; $r = -0.145$, $P = 0.036$). The correlations of serum CRP as well as serum TB concentrations with peripheral blood WBC count, differential count, and immunological indexes in psoriasis vulgaris patients are shown in Table 2. The serum CRP level was significantly positively correlated with the count and percentage of peripheral blood NEUT, MONO, and negatively correlated with LYM absolute count and percentage. The serum CRP level was also significantly positively correlated with the serum IgA, C_3 and C_4 concentrations. Meanwhile, the

TABLE 2. The Relationship Between Peripheral Blood WBC Classification as well as Immunological Index With Serum CRP and TB Concentrations in Psoriasis Patients

	Serum CRP		Serum TB	
	r	*P*-value	*r*	*P*-value
Peripheral blood WBC count and classification				
Neutrophil granulocyte count	0.431	0.000	0.067	0.331
Neutrophil granulocyte (%)	0.468	0.000	−0.059	0.393
Lymphocyte count	−0.209	0.002	0.059	0.393
Lymphocyte (%)	−0.469	0.000	0.030	0.662
Mononuclear leukocyte count	0.375	0.000	−0.008	0.910
Mononuclear leukocyte (%)	0.257	0.000	−0.120	0.082
Eosinophilic granulocyte count	0.157	0.022	0.152	0.068
Eosinophilic granulocyte (%)	0.083	0.225	0.131	0.058
Serum immunological index				
Immunoglobulin G	0.066	0.337	−0.051	0.461
Immunoglobulin A	0.233	0.001	−0.229	0.001
Immunoglobulin M	−0.087	0.209	−0.152	0.058
Complement C_3	0.378	0.000	−0.109	0.116
Complement C_4	0.449	0.000	−0.128	0.066

The Spearman correlation was used. $P < 0.05$ is considered statistically significant.

serum TB level was significantly correlated with the serum IgA concentrations.

Correlations Between the Serum CRP, Serum TB levels, and PASI in Psoriasis Vulgaris Patients

In the psoriasis patients, the serum CRP was significantly positively correlated with the PASI ($r = 0.172$, $P = 0.012$), whereas the serum TB was negatively correlated with the PASI but without significant ($r = -0.125$, $P = 0.070$).

Logistic Regression Analysis

The result of binary logistic regression analysis is shown in Table 3. The χ^2 value of this logistic model was 208.796 ($P < 0.001$), −2 log-likelihood was 286.114, and the overall predicted correct percentage of the model was 81.8 %. The results of logistic analyses showed that the serum TB was the protective factor (OR = 0.859, $P < 0.001$, 95 % CI of OR was 0.797–0.926) and the serum CRP was risk factor (OR = 1.259, $P = 0.001$, 95 % CI of OR was 1.104–1.436) for psoriasis vulgaris.

DISCUSSION

During an inflammatory process, several inflammatory factors induce NEUT activation an in turn the release of activation products. This phenomenon seems to increase serum CRP and may contribute to the pathophysiology of psoriasis (2, 3). A recent study reported that elevated levels of serum CRP is a risk factor for chronic inflammatory diseases, such as cardiovascular diseases, and may predict a long-term risk of cardiovascular events (26–31). CRP itself may play an active role in inflammation by inhibiting NEUT chemotaxis and endothelial cell adhesion, reducing transmigration to the site of inflammation (26, 27).

It has been observed that psoriasis is associated with inflammatory conditions (30, 31). Earlier studies suggested that there is a strong linkage between the severity of psoriasis and enhancement in inflammatory response. The serum CRP level is closely associated with PASI in psoriasis (32,33), and previously we have shown that there was a significant positive correlation between serum CRP levels and PASI scores in psoriasis patients. The present study reconfirmed the results. Therefore, the serum CRP could be used as an accurate and sensitive blood biomarker to evaluate and monitor the severity of psoriasis during diagnosis and treatment in clinic (34, 35).

In the case of inflammation, the NEUT seem to play a crucial role by contributing to the development of oxidative stress (2). The deterioration of psoriasis seems to be linked to an imbalance between enhanced inflammation and their inhibitors. The insufficiency of the antioxidant defense in psoriasis may lead to an enhanced and uncontrolled inflammatory process (7). Several conditions may trigger the enhancement of psoriasis, such as infections, skin traumas, and stress conditions. All of them could induce an additional inflammatory stimulus, which may disrupt the fragile balance between the inflammation products and counterbalancing of endogenous anti-inflammatory factors (7). In this study, the peripheral WBC and NEUT were significantly increased in patients with psoriasis vulgaris, which suggest that the number of peripheral blood WBC and NEUT were closely

TABLE 3. Logistic Regression Analysis of Psoriasis Patients and Controls

Parameters	*B*	SE	Wald	OR	95% CI for OR	*P*-value
Age	0.007	0.014	0.265	1.007	0.980–1.036	0.607
Gender	0.306	0.322	0.906	1.358	0.723–2.550	0.341
WBC count	−1.084	0.607	3.192	0.338	0.103–1.111	0.074
NEUT count by NEUT %	0.021	0.010	4.277	1.021	1.001–1.041	0.039
LYM count by LYM %	0.033	0.018	3.248	1.033	0.997–1.071	0.071
MONO count by MONO %	−0.345	0.129	7.123	0.708	0.549–0.912	0.008
EOS count by EOS %	2.972	0.507	34.339	19.530	7.228–52.770	0.000
Serum TB	−0.152	0.038	15.749	0.859	0.797–0.926	0.000
Serum IgG	0.340	0.090	14.402	1.404	1.179–1.674	0.000
Serum IgA	−0.029	0.203	0.020	0.972	0.652–1.447	0.887
Serum IgM	−1.095	0.442	6.132	0.335	0.141–0.796	0.013
Serum C_3	−1.813	0.839	4.675	0.163	0.032–0.844	0.031
Serum C_4	1.726	2.877	0.360	5.618	0.020–1,578.294	0.549
Serum CRP	0.231	0.067	11.823	1.259	1.104–1.436	0.001
Constant	−0.965	1.546	0.390	0.381	–	0.532

$P < 0.05$ is considered statistically significant. *B*, estimated coefficient; SE, standard error; OR, odds ratio; CI, confidence interval.

related to the inflammatory condition in psoriasis vulgaris. Our data confirmed that the psoriasis patients were in a more severe inflammatory condition, as indicated by the significant increase in CRP levels in serum, blood total leucocytes, and NEUT compared to controls. Actually, we found that serum CRP was correlated positively and significantly with total leucocytes and NEUT in psoriasis vulgaris patients.

Several studies have shown an increased risk of cardiovascular disease in psoriasis patients (36, 37). Balta et al. reported that the psoriasis was significantly associated with subclinical AS even when the patient's PASI scores are lower (38, 39). Meanwhile, the epidemiological evidence suggested that lower TB was implicated in AS development (17, 18). Previous studies also demonstrated that lower serum TB was significantly related to oxidative and inflammatory conditions, while higher serum bilirubin could inhibit inflammation (40), serum bilirubin level was significantly negatively correlated with the artery intima media thickness (IMT) in nondiabetic and Type 2 diabetic subjects (41). These results further suggest that the bilirubin has significant anti-inflammatory effect. Although the exact role of bilirubin on inflammation development in psoriasis remains unclear, given the remarkable anti-inflammatory properties, bilirubin may inhibit oxidative stress and inflammation in psoriasis. There are only a few studies that have investigated the serum bilirubin level in psoriasis and are related with inflammation. However, the controversy exists regarding the change in serum bilirubin in psoriasis. Severin et al. and Coimbra et al. reported that the serum bilirubin level was slightly or significantly elevated in psoriasis patients (22,25), whereas Balta et al. and Nemati et al. found that the serum bilirubin was lower or significantly decreased in psoriasis patients ((23, 24)). The result of those studies suggests that the serum bilirubin in psoriasis patients has been consistent and inconclusive. Furthermore, the relationship between the serum bilirubin and inflammation has also not been demonstrated clearly. Consequently, the clinical relevance of serum bilirubin with respect to inflammation in psoriasis is still debatable and should be investigated further.

We hypothesized that lower serum TB enhances chronic inflammation in psoriasis subjects, and the psoriasis individuals with a higher serum bilirubin level would be less likely to be vulnerable to the inflammatory mediators. In order to explore the possible relationship between chronic inflammation and bilirubin in psoriasis, we investigated the serum TB and CRP concentration in psoriasis vulgaris. Our results showed that the serum TB level of psoriasis vulgaris patients was obviously lower than the controls. It is noteworthy that we did identify a strong inverse correlation between serum TB and CRP levels in psoriasis vulgaris patients. The logistic analyses also showed that the serum TB was the protective factor, while the serum CRP was a risk factor for psoriasis vulgaris. These results further support the theory that bilirubin may suppress the inflammatory effects in psoriasis vulgaris.

The PASI score, the most common outcome measure in clinical practice of psoriasis, is a nonlinear scale that does not allow reliable assessment of subtle variations of erythema, induration, and desquamation (42). Meanwhile, the definitions of its constituent components require an estimation of the percentage body surface area, which is easily influenced by environmental factors and is difficult to measure accurately (43). Therefore, the PASI cannot reflect the severity of inflammation accurately in psoriasis. The present study also showed that the serum TB was insignificantly negatively related to the PASI in psoriasis patients.

Our study suggested that the serum TB may be a helpful biomarker in prediction and monitoring the inflammatory effects of psoriasis vulgaris patient in clinical practice. However, the present investigation has several limitations. First, we only observed the effects of serum TB on inflammatory condition in psoriasis vulgaris subjects and did not evaluate the effect of other antioxidants, such as vitamins B, C, E, folic acid, and glutathione, as well as selenium etc. Previous studies have shown that those substances also have anti-oxidative or anti-inflammatory effects, and have the potential to act synergistically, however further investigation is required. Second, all subjects in this study were Chinese, therefore the results may be different in other ethnic populations. Third, the number of psoriasis vulgaris subjects in this study was relatively small, further investigations with larger psoriasis vulgaris population are needed. Despite these limitations, our results still suggested that lower serum bilirubin level might enhance inflammation in psoriasis, which may in turn potentiate the tissue damage. The bilirubin may play an important role in the inflammatory process in psoriasis; lower concentrations of serum bilirubin may be a potential risk factor for psoriasis vulgaris patients.

CONCLUSION

The present study shows that lower serum TB is associated with the enhancement of inflammatory response in psoriasis vulgaris. Bilirubin appears to be a beneficial effect against inflammation and plays an important role in the inflammatory process in psoriasis vulgaris. The results of the present study might be helpful in understanding the role of bilirubin in psoriasis. Further detailed and comprehensive investigations are required to clarify the mechanism of this process.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

Abbreviations

AS = atherosclerosis
CRP = C-reactive protein
EOS = eosinophils
Ig = immunoglobulin
LYM = lymphocytes
MONO = monocytes
NEUT = neutrophils
PASI = Psoriasis Area and Severity Index
ROS = reactive oxygen species
TB = total bilirubin
WBC = white blood cell or leukocyte

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