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Research Article,

"Association Between Serum Inflammatory Lipoproteins and Adhesive Capsulitis Accompanied By Diabetes-A Case Control Study"

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Abstract:

Background: Adhesive capsulitis is common and can cause stiffness and pain. Diabetes and dyslipidemia are known to be associated with adhesive capsulitis. However, there is no report of any association between serum lipid levels accompanied by diabetes patients.
Objective: To assess association between serum inflammatory lipoproteins and adhesive capsulitis accompanied by diabetes.
Methods: This is a case-control study was conducted in Department of Physical Medicine and Rehabilitation, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh. We investigated all the patients who visited our clinic because of their shoulder problems from January to June-2017. Among those patients, 375 were diagnosed with adhesive capsulitis. Of these, we excluded 44 patients (11%) who had no laboratory results. Individuals with normal shoulder function (bilaterally pain-free, with full range of motion and no shoulder muscle weakness), no thyroid dysfunction, and no previously diagnosed systemic diseases. Individuals in the first control group had neither adhesive capsulitis nor diabetes. Individuals in the second control group had newly diagnosed diabetes without adhesive capsulitis.
Results: Demographic data, serum lipid levels, and the prevalence of dyslipidemia for the 25 patients with adhesive capsulitis accompanied by diabetes and 75 individuals of two control groups were matched by age and sex. For the patients with adhesive capsulitis, the mean duration of symptoms was 5.8±2.7 months; the median interval between initial examination and blood sampling was 6.0 days (interquartile range [IQR], 1.0–8.0). Low-density lipoprotein and non HDL were associated with adhesive capsulitis accompanied by diabetes. Specifically, patients with adhesive capsulitis and diabetes had greater odds ratios of hyperlow-density lipoproteinemia when compared with individuals with neither adhesive capsulitis nor diabetes (OR, 3.19; 95% CI, 1.21–8.38; p =0.019) and when compared with individuals without adhesive capsulitis but with newly diagnosed diabetes (OR, 5.76; 95% CI, 1.67–19.83; p= 0.005). Similarly, patients with adhesive capsulitis accompanied by diabetes had greater odds ratios of hypernonhigh-density lipoproteinemia when compared with individuals with neither adhesive capsulitis nor diabetes (OR, 7.39; 95% CI, 2.72–20.09; p < 0.001) and when compared with individuals without adhesive capsulitis but with newly diagnosed diabetes (OR, 3.26; 95% CI, 1.40–7.61; p = 0.006).
Conclusions: Inflammatory lipoproteinemias, particularly hyperlow-density lipoproteinemia and hypernonhighdensity lipoproteinemia, are associated with adhesive capsulitis accompanied by diabetes. Further research is needed to evaluate whether inflammatory lipoproteinemias are a cause, a related cofactor,

or an aggravating factor in the development of adhesive capsulitis in people who have diabetes.

Keywords: Level of Evidence Level III, prognostic, adhesive capsulitis.

Introduction:

Adhesive capsulitis is one of the most frequently encountered shoulder disorders in clinical practice [1, 2]. Several characteristics have been reported as adhesive capsulitis risk factors, including age, female sex, dyslipidemia, thyroid abnormality, and diabetes [2, 3,4]. Diabetes is the most frequently cited risk factor [5, 6]. Various studies have reported that for patients with diabetes, the lifetime risk of developing adhesive capsulitis ranges from 4.3% to 30% [7,8,9], indicating that patients with diabetes are five to nine times more likely than the general population to develop the disorder [9,10]. Dyslipidemia is known to occur frequently in patients who have diabetes and thyroid disorders [11, 12]. Increased serum concentrations of nonhigh-density lipoprotein (nonHDL), consisting of low-density lipoprotein (LDL) and triglyceride-rich lipoproteins such as intermediate-density lipoprotein (IDL) and very-low-density lipoprotein (VLDL), induce inflammation on the arterial walls, where they cause atherosclerosis [13]. The development of adhesive capsulitis has not been completely elucidated. The glycation process has been proposed as a diabetes-related mechanism for the development of adhesive capsulitis [14]. Previous studies have reported that dyslipidemia is associated with adhesive capsulitis [15, 16]. However, to our knowledge, no study has shown an association between serum inflammatory lipoproteins and adhesive capsulitis accompanied by diabetes. It would be helpful to understand more fully the roles of inflammatory lipoproteins in the pathogenesis of adhesive capsulitis. Because dyslipidemia, diabetes, and thyroid disorders frequently occur together, it is necessary to determine whether any of these three variables is an independent risk factor for adhesive capsulitis [17, 16]. Lo et al. [18] reported that diabetes and hyperlipidemia are independent risk factors for adhesive capsulitis. Another study reported that after adjustment for age, sex, and dyslipidemia, diabetes is an independent risk factor for the development of adhesive capsulitis and, additionally, that hyperlipidemia is associated with a higher risk of adhesive capsulitis development [3]. However, neither of these studies specified which types of serum lipid abnormalities is associated with a higher risk of adhesive capsulitis development. One recent study reported an association between serum inflammatory lipoproteins and primary adhesive capsulitis [16]. However, we are not aware of any study that has shown an association between serum inflammatory lipoproteins and adhesive capsulitis accompanied by diabetes.

Materials and Methods:

This is a case-control study was conducted in Department of Physical Medicine and Rehabilitation, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh. We investigated all the patients who visited our clinic because of their shoulder problems from January to June-2017. Among those patients, 375 were diagnosed with adhesive capsulitis. Of these, we excluded 44 patients (11%) who had no laboratory results. Among the remaining patients, 175 had diabetes that was diagnosed at the authors' clinic or confirmed by medical history. Our case group included 25 patients with newly diagnosed adhesive capsulitis accompanied by newly diagnosed diabetes that had no other diagnosed systemic diseases or rotator cuff tears. The two control groups each had 75 age- and sex-matched individuals with normal shoulder function (bilaterally pain-free, with full range of motion and no shoulder muscle weakness), no thyroid dysfunction, and no previously diagnosed systemic diseases. We considered the patients who had a glycosylated hemoglobin A1c(HbA1c) level of 6.5% to have diabetes.

We excluded from this study 141 of the 175 patients (81%) with diabetes for one or more of the following reasons: 44 patients (27%) had associated intrinsic lesions such as a rotator cuff tear, labral lesion, or biceps injury, and 97 (55%) had a history of using hypoglycemic agents prescribed for their known diabetes and/or cholesterol- lowering drugs prescribed for their dyslipidemia. The remaining 25 patients received their first-diagnoses of diabetes during blood tests involved in diagnosing adhesive capsulitis and were included in this study.

We evaluated any association between adhesive capsulitis accompanied by diabetes and serum

lipid profile, including total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides, and nonhighdensity lipoprotein (non HDL). Conditional logistic regression analysis was used to evaluate the strengths of associations between serum lipid levels and adhesive capsulitis accompanied by diabetes, as determined by odds ratios (ORs) and 95% confidence intervals (CIs). Based on blood tests, they were determined to have diabetes without combined thyroid abnormality. Adhesive capsulitis was diagnosed based on the presence of both active and passive motion restrictions of the glenohumeral joint in flexion, abduction, and internal rotation, with external rotation measured with the arm at the side restricted to < 50% of that of the normal side.

Because serum lipid levels are highly affected by a person's age and sex, the two control groups were each composed of 75 age- and sex-matched individuals who visited our health promotion center for routine health checkups during the same period [19, 20]. Without exception, all individuals had a full serum lipid profile performed during same period. We selected individuals who were age- and sex- matched with the patients who had been diagnosed with adhesive capsulitis accompanied by diabetes. Each control group was, therefore, three times as large as the case group. In case-control studies, the statistical power can be increased by selecting more than one control per case, although the additional gain is small if the case: control ratio exceeds 1:4 [20, 21]. We used three times as many controls as cases in each comparison because that was the maximum number of control individuals for age and sex-matching who were available to us through the health promotion center. The inclusion criteria for the control groups were normal shoulder motion, no bilateral differences, and no shoulder symptoms. Patients in the control group had no medication history of treatment for diabetes, thyroid disease, or dyslipidemia. They also had no history of trauma or shoulder surgery. The first control group was composed of individuals with neither adhesive capsulitis nor diabetes. The second control group was composed of individuals who were newly diagnosed with diabetes during routine health checkups. This second control group was designed to eliminate any confounding effect of diabetes on serum lipid levels.

We studied the following Serum lipid level: total cholesterol, triglycerides, LDL, and high-density lipoprotein (HDL). Non HDL is calculated by subtracting HDL from total cholesterol [23]. We used the dyslipidemia criteria of the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) guidelines [24]. The categorical data, categorizing the serum lipid as either with or without abnormality according to the previously suggested cut-off values, included the following dyslipidemias: hypercholesterolemia (total cholesterol of 200 mg/dL), hyperlowdensity lipoproteinemia (LDL of 100 mg/dL), hypertriglyceridemia (triglycerides of 150 mg/dL), hypohighdensity lipoproteinemia (HDL of < 40 mg/dL for men and < 50 mg/dL for women), and hypernonhigh-density lipoproteinemia (nonHDL of 130 mg/dL). Serum lipid profile examinations were done after 8-hour fasting followed by venipuncture.

Data Analysis: We calculated the odds ratios (ORs) and 95% confidence intervals (95% CIs) to identify any association between serum lipid levels and diabetes and adhesive capsulitis, using univariate conditional logistic regression analysis. Significance was set at $p < 0.05$. Continuous data were evaluated for total cholesterol, LDL, HDL, triglycerides, and non HDL. Categorical data were evaluated for hypercholesterolemia, hyperlowdensity lipoproteinemia, hypohighdensity lipidemia, hypertriglyceridemia, and hypernonhigh-density lipoproteinemia. We did not perform multivariable conditional logistic regression analysis because the variance in flation factor was 10.2 and the condition index was 28.3 for multicollinearity among lipid profiles. Therefore, we considered multicollinearity to be present among the Serum lipid level. All statistical analyses were performed with use of Statistics version 21.0 (IBM, SPSS Statistics for Windows USA).

Results:

Demographic data, serum lipid levels, and the prevalence of dyslipidemia for the 25 patients with adhesive capsulitis accompanied by diabetes and 75 individuals of two control groups were matched by age and sex (Table-1). For the patients with adhesive capsulitis, the mean duration of symptoms was 5.8± 2.7 months; the median interval between initial examination and blood

sampling was 6.0 days (interquartile range [IQR], 1.0–8.0); and the median interval between initial examination and ultrasound or MRI was 5.7 days (IQR, 0.0–7.1). In the scale and categorical analyses, body mass index was not associated with adhesive capsulitis accompanied by diabetes when we compared individuals in all three study groups (Table 2). We found that HbA1c levels were associated with adhesive capsulitis accompanied by diabetes when comparing the patients in the case group to individuals who had neither adhesive capsulitis nor diabetes; HbA1c levels were not associated with individuals newly diagnosed with diabetes who did not have adhesive capsulitis (Table -2).

Table -1: Demographic data, serum lipid levels, and dyslipidemia prevalence in the studied groups.

Characteristics	Patients with adhesive capsulitis accompanied by diabetes (n = 25)	Individuals with neither adhesive capsulitis nor diabetes (n = 75)	Individuals without adhesive capsulitis but with newly diagnosed diabetes (n = 75)
Male sex*	15 (60%)	46 (61.33%)	46 (61.33%)
Age† (years)	54 ± 8	54 ± 8	54 ± 8
Body mass index† (kg/m^2)	24 ± 3	24 ± 3	24 ± 3
Body mass index* $ 25 kg/m^2	7 (28%)	26 (34.66%)	26 (34.66%)
Hemoglobin A1c‡	7 (7-8)	6 (5-6)	7 (7-8)
Hemoglobin A1c* (< 6.5%)	0 (0%)	75 (100%)	0 (0%)
Hemoglobin A1c* ($ 6.5)	25 (100%)	0 (0%)	75 (100%)
Hemoglobin A1c* (6.5 # HbA1c < 7.0%)	12 (48%)	0 (0%)	45 (60%)
Hemoglobin A1c* (7.0 # HbA1c < 7.5%)	7 (28%)	0 (0%)	10 (13.33%)
Hemoglobin A1c* ($ 7.5%)	6 (24%)	0 (0%)	20 (26.66%)
Serum lipid levels (mg/dL)			
Total cholesterol‡	211 (157-282)	167 (105-250)	174 (149-200)
Low-density lipoprotein†	136 (80-209)	104 (49-187)	108 (86-131)
High-density lipoprotein‡	55 ± 15	53 ± 14	51 ± 12
Triglyceride‡	132 (84-191)	96 (71-133)	128 (78-173)
Nonhigh-density lipoprotein‡	155 (90-233)	116 (59-209)	122 (97-156)
Prevalence of dyslipidemia*			
Hypercholesterolemia	11 (44%)	15(20%)	25 (26.66%)
Hyperlow-density lipoproteinemia	19 (76%)	42 (56%)	45 (60%)
Hypo high-density lipoproteinemia	7 (28%)	20 (26.66%)	16 (21.33%)
Hypertriglyceridemia	11 (44%)	12 (16%)	30 (40%)
Hypernonhigh-density	18 (72%)	25 (33.33%)	30 (40%)
lipoproteinemia			

*The values are given as the number of individuals, with the percentage in parentheses.
†the values are given as the mean and SD of continuous variables with normal distribution.
‡the values are given as the median, with the interquartile range in parentheses, of continuous variables with non-normal distribution.

Table-2: Univariate conditional logistic regression analyses for body mass index and hemoglobin A1c.

Variables	Odds ratios (95% confidence intervals)	p value
Compared with individuals with neither adhesive capsulitis nor diabetes Scale data		
Body mass index (kg/m2)	1.03 (0.89-1.19)	0.680
Hemoglobin A1c	83.60 (8.17-855.84)	< 0.001
Categorical data		
Body mass index ($ 25 kg/m2)	0.85 (0.34-2.13)	0.729
Hemoglobin A1c*	434.45 (8.76-21555.71)	0.002
Compared with individuals without adhesive capsulitis but with newly diagnosed diabetes Scale data		
Body mass index (kg/m2)	1.01 (0.88-1.16)	0.853
Hemoglobin A1c	0.82 (0.46-1.46)	0.494
Categorical data		
Body mass index ($ 25 kg/m2)	0.92 (0.41-2.06)	0.838
Hemoglobin A1c†	0.95 (0.60-1.49)	0.818

*Values of hemoglobin A1c were divided into two categories, either $ 6.5% or < 6.5%.

†ordinal values were evaluated, using three ranges of serum hemoglobin A1c levels: 6.5% # HbA1c < 7.0%, 7.0% # HbA1c < 7.5%, and $ 7.5%.

Table-3: Univariate conditional logistic regression analyses for various serum lipids and for the presence of various dyslipidemias*.

Variables	Odds ratios (95% confidence intervals	p value
Scale data		
Total cholesterol	1.03 (1.02-1.05)	< 0.001
Low-density lipoprotein	1.04 (1.02-1.06)	< 0.001
High-density lipoprotein	1.01 (0.98-1.04)	0.468
Triglyceride	1.01 (1.00-1.01)	0.030
Nonhigh-density lipoprotein	1.03 (1.02-1.05)	< 0.001
Categorical data		
Hypercholesterolemia	3.50 (1.48-8.29)	0.004
Hyperlow-density lipoproteinemia	3.19 (1.21-8.38)	0.019
Hypohigh-density lipoproteinemia	1.05 (0.44-2.53)	0.910
Hypertriglyceridemia	3.53 (1.56-8.01)	0.003
Hypernonhigh-density lipoproteinemia	7.39 (2.72-20.09)	< 0.001

*In these analyses, we compared patients with adhesive capsulitis accompanied by diabetes with the individuals with neither adhesive capsulitis nordiabetes.

In our comparison of individuals with adhesive capsulitis and diabetes and those with neither adhesive capsulitis nor diabetes, we found that adhesive capsulitis accompanied by diabetes was very slightly associated with total cholesterol (OR, 1.03; 95% CI, 1.02-1.05; p < 0.001), LDL (OR, 1.04; 95% CI, 1.02-1.06; p < 0.001), triglycerides (OR, 1.01; 95% CI, 1.00-1.01; p = 0.030), and non HDL (OR, 1.03; 95% CI, 1.02-1.05; p < 0.001). Similarly, adhesive capsulitis accompanied by diabetes was associated with hypercholesterolemia (OR, 3.50; 95% CI, 1.48-8.29; p =0.004), hyperlow-density lipoproteinemia (OR, 3.19; 95% CI, 1.21-8.38; p = 0.019), hypertriglyceridemia (OR, 3.53; 95% CI, 1.56-8.01; p = 0.003), and hypernonhigh-density lipoproteinemia (OR, 7.39; 95% CI, 2.72-20.09; p < 0.001. Interestingly, neither HDL nor hypohigh-density lipoproteinemia were associated with adhesive capsulitis accompanied by diabetes compared with individuals with neither adhesive capsulitis nor diabetes (Table 3).

Table-4: Univariate conditional logistic regression analyses for various serum lipids and for the presence of various dyslipidemias*.

Variables	Odds ratios (95% confidence intervals	p value
Scale data		
Total cholesterol	1.02 (1.01-1.03)	< 0.001
Low-density lipoprotein	1.02 (1.01-1.03)	0.001
High-density lipoprotein	1.03 (1.00-1.06)	0.075
Triglyceride	1.00 (1.00-1.01)	0.179
Nonhigh-density lipoprotein cholesterol	1.02 (1.01-1.03)	0.001
Categorical data		
Hypercholesterolemia	2.23 (1.03-4.86)	0.043
Hyperlow-density lipoproteinemia	5.76 (1.67-19.83)	0.005
Hypohigh-density lipoproteinemia	0.84 (0.37-1.92)	0.677
Hypertriglyceridemia	1.17 (0.54-2.54)	0.692
Hypernonhigh-density lipoproteinemia	3.26 (1.40-7.61)	0.006

*In these analyses, we compared patients with adhesive capsulitis accompanied by diabetes with the individuals without adhesive capsulitis but with newly diagnosed diabetes identified during routine health checkups.

We compared patients with adhesive capsulitis accompanied by diabetes and individuals without adhesive capsulitis who had newly diagnosed diabetes, we found that adhesive capsulitis and diabetes was very slightly associated with total cholesterol (OR, 1.02; 95% CI, 1.01-1.03; p < 0.001), LDL (OR, 1.02; 95% CI, 1.01-1.03; p = 0.001), and non HDL (OR, 1.02; 95% CI, 1.01-1.03; p = 0.001). Adhesive capsulitis accompanied by diabetes was associated with hypercholesterolemia (OR, 2.23; 95% CI, 1.03-4.86; p = 0.043), hyperlow-density lipoproteinemia (OR, 5.76; 95% CI, 1.67-19.83; p = 0.005), and hypernonhigh-density lipoproteinemia (OR, 3.26; 95% CI, 1.40-7.61; p = 0.006. High- density lipoprotein, hypohigh-density lipoproteinemia, triglycerides, and hypertriglyceridemia were not associated with adhesive capsulitis accompanied by diabetes in a comparison involving individuals with newly diagnosed diabetes without adhesive capsulitis (Table 4).

Discussion:

Diabetes and dyslipidemia are known to be related to adhesive capsulitis. However, to our knowledge, no study has shown an association

between serum inflammatory lipoproteins and adhesive capsulitis amid diabetes. We, therefore, aimed to work out if there are associations between Serum lipid level and adhesive capsulitis amid diabetes, of which inflammatory lipoproteins are associated factors. Another study reported that the mean serum cholesterol levels of two such groups were at an equivalent level [25]. Therefore, any incidence of asymptomatic structure tears within the current control group wouldn't influence the leads to the other direction. The case group population during this study is comparatively small. Although some members of the control group had asymptomatic structure tears, we are still confident that their serum lipid levels weren't less than those of the patients with intact rotator cuffs because we controlled for other influencing factors. One previous study of serum lipid levels of patients with structure injuries reported that their serum cholesterol levels were above those of patients with intact shoulders [26]. Nonetheless, we believe that the study population is of sufficient size, and therefore the statistics bear this out, therein we were ready to detect between-group differences. Future studies are needed to undertake to duplicate our findings, and to ascertain whether or not they generalize to other populations. It might probably be useful to know further the pathophysiology of adhesive capsulitis involved in an inflammatory process. The present study had several limitations. We didn't evaluate the regional prevalence of and ethnic differences in Serum lipid level. We didn't evaluate, with either ultrasound or MRI, the structure status of the patients within the control groups. However, we did include an impact group whose members had full shoulder motion and no shoulder symptoms. A longitudinal study, using national health insurance data from Taiwan without determining each subject's serum lipid profile, has reported hyperlipidemia as an independent risk factor for diabetes and adhesive capsulitis [18]. According to the results of those previous studies and of this current study, dyslipidemia is strongly associated not only with primary adhesive capsulitis, but also with adhesive capsulitis accompanied by diabetes. Inflammatory lipoproteins, such as LDL and non HDL, are well-known risk factors for atherosclerotic cardiovascular diseases [23]. The present study didn't completely exclude the unlikely possibility of a relationship between lipid abnormalities and structure tears. Finally, albeit this study adjusted for diabetic effects on serum lipids, we didn't have data regarding duration of the hyperglycemic condition either within the patients with adhesive capsulitis amid diabetes or in individuals without adhesive capsulitis but with newly diagnosed diabetes. Therefore, we were unable to rule out completely whether dyslipidemia is suffering from diabetes. We found that hyperlowdensity lipoproteinemia and hypernonhighdensity lipoproteinemia are associated with adhesive capsulitis accompanied by diabetes. Regarding serum lipid abnormalities in adhesive capsulitis, one previous study has reported elevated serum triglycerides and total cholesterol levels in patients with primary adhesive capsulitis [7]. Another study has reported that inflammatory lipoproteinemias, especially hyperlowdensity lipoproteinemia and hypernonhighdensity lipoproteinemia, have an association with primary adhesive capsulitis [16]. According to the results in both our case-control comparisons, LDL, hyperlowdensity lipoproteinemia, non HDL and hypernonhighdensity lipoproteinemia were associated with adhesive capsulitis accompanied by diabetes. Body mass index and serum HbA1c level, which are known to be associated with diabetes severity, were not associated with patients with adhesive capsulitis accompanied by diabetes. This suggests that inflammatory lipoproteins are independent risk factors for adhesive capsulitis accompanied by diabetes. Although a variety of abnormalities have been described in adhesive capsulitis, the underlying pathophysiological process in adhesive capsulitis involves synovial inflammation with subsequent joint capsule fibrosis. The characteristic histological finding of adhesive capsulitis is inflammatory contracture of the capsule with acute vasculitis [27, 28]. Increased expression of the intercellular adhesion molecule- 1 (ICAM-1) has been reported in the joint capsules of patients with adhesive capsulitis [29]. The increased expressions of cytokines, such as transforming growth factor beta 1 (TGF-b1) and connective tissue growth factor, have been reported in synoviocytes treated with ICAM-1, but not in synoviocytes not treated with ICAM-1 [29]. Increased expression of TGF-b and platelet-derived growth factor (PDGF) has been identified

in capsular tissues from patients with adhesive capsulitis, suggesting that those cytokines, which are well-known fibrosis-inducing factors, contribute to capsular fibrosis [30]. Those results are similar to findings regarding atherosclerosis. Inflammatory lipoproteins induce vascular inflammation and immune reactions. Low-density lipoprotein is prone to oxidative modification by reactive oxygen species, resulting in oxidized LDL, which can induce endothelial cell activation in vessel walls [30]. The endothelial cell activation leads to the expressions of ICAM- 1 and vascular cell adhesion molecule-1 (VCAM-1), which attract inflammatory cells and inflammation-related cytokines [31]. This study suggests that inflammatory lipoproteinemias and related inflammatory processes of adhesive capsulitis are involved in molecular mechanisms that are similar to those seen in atherosclerotic cardiovascular disease. A cohort study reported that a 1 mg/dL decrease in the total cholesterol serum level was associated with a 1.5% reduction in coronary heart disease mortality [32]. An LDL-lowering simvastatin study reported that each additional 1% reduction in LDL reduced major coronary events by 1.7% [33]. These frequently cited lipid studies have shown consistently that small differences in serum total cholesterol or lipoprotein levels cause changes in the incidence of cardiovascular events and mortality. Questions remain about the possible need for routine serum lipid profile screening and for improvement of serum lipoprotein levels using lipid-lowering drugs in patients with adhesive capsulitis accompanied by diabetes.

Conclusion:

In conclusion, inflammatory lipoproteinemias, particularly hyperlow-density lipoproteinemia and hypernonhigh- density lipoproteinemia, are associated with adhesive capsulitis accompanied by diabetes. Further research is needed to evaluate whether inflammatory lipoproteinemias are a cause, a related cofactor, or an aggravating factor in the development of adhesive capsulitis with diabetes.

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