The association of metabolic syndrome markers with adhesive capsulitis

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**Background:** Research has associated adhesive capsulitis with diabetes mellitus but suggests that glucose-mediated injury may begin before diabetes is diagnosed. The period preceding diabetes is often marked by metabolic syndrome.

**Methods:** We investigated the relationship between metabolic syndrome components (insulin resistance, hypertension, dyslipidemia, and obesity) and the development of adhesive capsulitis using a case-control study. We retrospectively reviewed 150 consecutive adhesive capsulitis patient charts to determine the prevalence of obesity and of medications used for treating metabolic syndrome elements and compared these with previously reported nationwide values.

**Results:** The prevalence of anti-hyperglycemia medications in the adhesive capsulitis cohort was 18.4% (95% confidence interval [CI], 12.9%-25.7%), twice the national rate of diagnosed diabetes of 7.6% (95% CI, 6.7%-8.5%). In the 20- to 39-year-old group, the prevalence of anti-hyperglycemic medications, 26.3% (95% CI, 11.8%-48.8%), was over 10 times the nationwide rate. The overall prevalence of hypertensive medication use in the adhesive capsulitis group, 33.1% (95% CI, 25.9%-41.2%), was notably higher than the nationwide rate, 21.6% (95% CI, 19.8%-23.4%). In the 40- to 64-year-old group, the prevalence of hypertension medication use, 36.8% (95% CI, 28.6%-46.0%), was notably higher than the nationwide rate of 24.5% (95% CI, 22.2%-27.0%). The prevalence of anti-lipid medications and obesity was similar between the groups.

**Conclusions:** The relationship between adhesive capsulitis and metabolic syndrome remains unclear. Our results confirm previous work associating hyperglycemia with adhesive capsulitis. We have also shown a possible association of hypertension, part of metabolic syndrome and a proinflammatory condition, with adhesive capsulitis, which has not been previously described.

**Level of evidence:** Level III, Cross-Sectional Study.

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**Keywords:** Adhesive capsulitis; metabolic syndrome; diabetes mellitus; hypertension; dyslipidemia; obesity

This study was approved by the Institutional Review Board at the University of Pennsylvania (protocol 814173).

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Adhesive capsulitis is a condition marked by pain and reduced active and passive glenohumeral motion, and full recovery may take several months or years to occur. Adhesive capsulitis has an increasing incidence with age and is observed in 2% of individuals aged between 52 and 72 years. There is disparity in the literature regarding the cause of adhesive capsulitis, suggesting a lack of understanding of the true pathophysiology of the condition. Both hypothyroidism and hyperthyroidism, as well as myocardial infarction, have been associated with adhesive capsulitis. Past studies show a convincing association between adhesive capsulitis and diabetes mellitus, with rates of adhesive capsulitis in diabetic patients up to 4 times those seen in the general population. In a series of patients diagnosed with adhesive capsulitis, Tighe and Oakley have shown that the prevalence of diabetes, or prediabetes, was remarkably high, approaching 72%.

Adhesive capsulitis is also associated with limited joint mobility and Dupuytren disease, suggesting a possible common pathologic mechanism. One hypothesis suggests that hyperglycemia associated with diabetes can induce collagen changes within joints. These changes in the collagen matrix may ultimately trigger the fibrotic and inflammatory changes seen in pathologic and biochemical studies of the disease. Other investigators have shown that hyperglycemia, in itself, is a proinflammatory state. Although past studies have observed a longer duration of diabetes and higher hemoglobin A1c levels in diabetic patients with shoulder and hand problems, others have failed to find a correlation between either glycemic control or duration of diabetes and adhesive capsulitis. Some authors suggest that the unaccounted-for years of hyperglycemia preceding the diagnosis of diabetes, instead of current glucose levels, likely contribute to the later development of adhesive capsulitis. Appropriately, evidence suggests that type 2 diabetes can develop 9 to 12 years before clinical diagnosis.

In many patients, the period preceding diabetes is marked by a group of risk factors known as metabolic syndrome. Metabolic syndrome is defined by the World Health Organization as a group of metabolic abnormalities including evidence of insulin resistance, as well as at least 2 of the following: large waist circumference (obesity), hypertension, dyslipidemia, and hypertriglyceridemia. Data suggest that this syndrome accounts for 30% to 52% of persons in whom type 2 diabetes develops and that patients with metabolic syndrome have a relative risk of diabetes development that is 1.96 to 4.57 times higher than that in unaffected individuals. Notably, the prevalence of metabolic syndrome in the United States increased from 27.9% in 1988-1994 to 34.1% in 1999-2006.

Although there are significant data connecting diabetes mellitus and adhesive capsulitis, there has been only limited research focused on the possible association between the remaining metabolic syndrome components and adhesive capsulitis. A study by Arkkila et al reported no association between hypertension, body mass index (BMI), or peripheral vascular disease and adhesive capsulitis. Although this study provides some insight, these trends were observed exclusively in diabetic patients and did not address dyslipidemia directly. The goal of our study, therefore, was to evaluate possible associations between metabolic syndrome components and adhesive capsulitis by comparing the prevalence of metabolic syndrome medications and obesity rates in a series of patients with adhesive capsulitis with previously reported data from the general population. We hypothesized that metabolic syndrome components, in addition to hyperglycemia, would be associated with the development of adhesive capsulitis.

**Methods**

We completed a retrospective review of 150 consecutive patients, aged 18 to 71 years, who were diagnosed with adhesive capsulitis at our sports medicine clinic between August 2007 and July 2011. Cases were identified by searching the billing records for the appropriate International Classification of Diseases, Ninth Revision codes. A case was excluded if all components of the patient’s chart could not be located.

Age at diagnosis, sex, height, weight, and medication list were all recorded. In addition, the history accompanying the development of adhesive capsulitis was noted and classified as either traumatic or idiopathic. Traumatic etiologies included discrete events such as a fall, motor vehicle accident, or surgical procedure, whereas an idiopathic etiology was indicated when no discrete event was reported by the patient. We evaluated the patient-reported medication list for each patient and used it to determine which metabolic syndrome indications were present in each case.

Retrospective evaluation of metabolic syndrome risk factors was difficult because waist circumference, blood pressure, fasting glucose level, and lipid panels are not regularly evaluated or reviewed in a sports medicine clinic. In contrast, the height, weight, and medication reconciliation list are regularly available in the patient’s chart and can provide insight into the presence of metabolic syndrome–related abnormalities. A BMI greater than 30 kg/m² was considered evidence of obesity because it met the World Health Organization criteria for metabolic syndrome.

We used the presence of medications aimed at treating metabolic syndrome derangements as proxies for the other elements of the metabolic syndrome criteria.

Patient medication reconciliation lists that included any drug routinely used to treat high blood pressure were considered positive for hypertension. Patients were considered to meet the criteria for insulin resistance if they were currently taking any type of oral diabetic medication or insulin. Because of the significant overlap in the indications and actions of cholesterol- and lipid-reducing drugs, the metabolic syndrome risk factors of low high-density lipoprotein levels and hypertriglyceridemia were combined into one group labeled hypercholesterolemia. Patients using any type of prescribed medications aimed at treating lipid or cholesterol derangements were considered to meet the criteria for the low high-density lipoprotein/hypertriglyceridemia component of metabolic syndrome.
On the basis of the proportion of patients taking medications for each metabolic syndrome component, a prevalence rate with a 95% confidence interval (CI) was calculated by use of the Wilson procedure. We also calculated age group specific prevalence values that corresponded with previously published age group specific prevalence data. Some patients presenting with adhesive capsulitis remember a specific insult that triggered the disease, such as a fall or recent surgery, whereas others report symptoms arising spontaneously. We sorted these patients into the idiopathic and traumatic/postoperative subgroups and completed a secondary analysis to calculate the prevalence of metabolic syndrome medication use in each group to determine whether these different histories correlated with different metabolic syndrome risks.

We compared the prevalence of medication use in our series of adhesive capsulitis patients with previously reported data from nationwide studies. The National Health and Nutrition Examination Survey (NHANES) is a series of semiannual studies that evaluate relevant diseases on a nationwide basis. The NHANES includes information related to all metabolic syndrome components including fasting blood glucose levels, fasting lipid levels, blood pressure, and height and weight of participants. Using data from the 2007-2008 NHANES, Flegal et al reported the nationwide prevalence of obesity, based on a BMI greater than 30 kg/m², for both men and women. We compared the prevalence of obesity in our series of patients with these nationwide values.

The nationwide prevalence of hypertension and use of antihypertensive medications were also studied by the Centers for Disease Control and Prevention using data derived from the 2005-2008 NHANES. The study reported a nationwide prevalence of hypertension in addition to reporting the prevalence of medication use for hypertension within patients who had the disease. To obtain an overall prevalence of antihypertensive medication use, we multiplied the reported nationwide prevalence of hypertension by the prevalence of medication use for patients with hypertension. We also multiplied the corresponding upper and lower limits of the 95% CIs from the nationwide prevalence of hypertension and the prevalence of medication use to determine a 95% CI for the calculated medication prevalence. These calculations allowed us to determine a national prevalence of hypertension medication use with a 95% CI (because these values could not be directly found in the literature). An identical method was used to calculate the prevalence of cholesterol medication use based on an additional study by the Centers for Disease Control and Prevention using data from the 2005-2008 NHANES.

The nationwide prevalence of both diagnosed diabetes and total diabetes (including undiagnosed cases) was reported by Cowie et al and relied on data from the 2005-2006 NHANES database. To compare the diabetic medication rates in our series of adhesive capsulitis patients with the general population, we assumed that the prevalence of diagnosed diabetes nationwide from the NHANES study was equivalent to the prevalence of diabetic medication use nationwide, an assumption that does not always hold true. Although it likely overestimates the nationwide prevalence of diabetic medications, this calculation provided the best comparison possible for patients in our study because other data were unavailable.

Direct statistical comparisons of the prevalence of metabolic syndrome medications in our adhesive capsulitis patient population with the prevalence of medication use in the general population by use of χ² testing were not possible because the actual proportions used to calculate the reported nationwide rates were unavailable. However, 95% CIs allowed the prevalence values from the 2 groups to be effectively compared. In comparisons in which their respective CIs did not overlap, notable evidence was provided that our adhesive capsulitis values and nationwide values were likely to be truly significantly different.

Results

We queried 207 patient charts, of which 54 were incomplete and 3 were excluded because of patient age, to gather 150 consecutive patients for this study. Of these patients, 62 (41.3%) presented with idiopathic adhesive capsulitis, 31 (20.7%) presented after a surgical procedure on the shoulder, and 57 (38.0%) presented after a known shoulder injury or trauma. Of the 150 patients included, 59.3% were women. In the idiopathic group, 62.9% were women, whereas 58.1% were women in the traumatic group. The mean age of the patients was 51.3 years (±10 years) in the overall group, 51.5 years (±8.3 years) in the idiopathic group, and 49.2 years (±10.8 years) in the traumatic group.

The mean BMI was 27.4 kg/m² (±5.3 kg/m²) in the overall group, 26.7 kg/m² (±5.3 kg/m²) in patients with idiopathic adhesive capsulitis, and 27.9 kg/m² (±5.4 kg/m²) in the traumatic group. Overall, 27.1% (95% CI, 17.4%-39.6%) of male group members aged 20 years or older were obese, a prevalence similar to the 32.2% (95% CI, 29.5%-35.0%) rate reported for this age group in the 2007-2008 NHANES database (Table I, Fig. 1). In women aged 20 years or older, the overall prevalence of obesity was 27.2% (95% CI, 18.7%-37.7%) in our cohort of adhesive capsulitis patients, which was similar to the 35.5% (95% CI, 33.2%-37.7%) prevalence of obesity observed in the NHANES (Table I, Fig. 1). The total prevalence of male and female obesity in the idiopathic and traumatic subgroups was also similar to the nationwide rates.12 The age group specific comparisons in both the male and female groups showed similar trends: the obesity rates observed in our series were similar to those previously observed nationwide.

The overall rate of hypertensive medication use by patients aged 18 years or older in our adhesive capsulitis group was 33.1% (95% CI, 25.9%-41.2%), a number notably higher than the prevalence of 21.6% (95% CI, 19.8%-23.4%) previously observed in the same group within the NHANES study (Table II, Fig. 1). In the traumatic subgroup, the overall prevalence of hypertensive medication use of 34.2% (95% CI, 24.8%-44.9%) was also notably higher than the values previously observed in the general population. In patients with idiopathic adhesive capsulitis, the prevalence of hypertensive medication use of 31.7% (95% CI, 21.3%-44.2%) was higher than the nationwide value; however, the 95% CIs of the groups overlapped. In the age group specific comparisons, the rates of hypertensive medication use of 36.8% (95% CI, 28.6%-46.0%) in the general group aged 40 to 64 years and 38.7% (95% CI, 27.6%-51.2%) in the traumatic subgroup aged 40 to 64 years were notably higher than the previously observed
nationwide rate of 24.5% (95% CI, 22.2%-27.0%) for this age group. The 95% CIs of the nationwide rates and those observed in our group of adhesive capsulitis patients overlapped in all other age group specific comparisons.

The overall rate of cholesterol-lowering medication use by patients aged 20 years or older in our cohort of adhesive capsulitis patients was 20.6% (95% CI, 14.7%-20.8%), a number similar to the rate of 16.1% (95% CI, 13.7%-18.8%) previously observed nationwide in the NHANES study. In patients with idiopathic adhesive capsulitis, the rate of anti-lipid medication use was 26.7% (95% CI, 17.1%-39.0%), which also overlapped with the prevalence observed nationwide. The observed rate of 16.1% (95% CI, 9.5%-25.3%) in the traumatic etiology group was similar to previously reported nationwide rates. In all of the age group specific analyses, the prevalence values of cholesterol-lowering drug use in our patients with adhesive capsulitis were similar to nationwide values.

The observed rate of diabetic medication use in adhesive capsulitis patients aged 20 years or older was 18.4% (95% CI, 12.9%-25.7%), a number notably above the national rate of diagnosed diabetes in the 2005-2006 NHANES of 7.6% (95% CI, 6.7%-8.5%) (Table III, Fig. 1). In patients aged 20 years or older with idiopathic adhesive capsulitis, the prevalence of diabetic medication use was 23.3% (95% CI, 14.4%-35.4%), which was also markedly higher than the NHANES data. Similarly, the overall rate of diabetic medication use in the traumatic adhesive capsulitis group of 14.8% (95% CI, 8.7%-24.1%) was notably above the nationwide rates. In the 20- to 39-year-old group analysis of all adhesive capsulitis patients, 26.3% (95% CI, 11.8%-48.8%) were taking diabetic medications, whereas a markedly lower rate of diabetes, 2.1% (95% CI, 1.5%-2.8%), was diagnosed nationwide. Similarly, increased rates in comparison with the nationwide data were observed in the 20- to 39-year-old idiopathic and post-traumatic groups, with rates of 50.0% (95% CI, 15.0%-85.0%) and 20.0% (95% CI, 7.1%-45.2%), respectively. The 40- to 59-year-old subgroup of general adhesive capsulitis patients, with a medication rate of 17.3% (95% CI, 11.2%-25.7%), also showed notably higher rates of diabetes compared with the previously reported national diagnosed diabetes rate of 7.9% (95% CI, 6.3%-9.5%) for this age group. Notably higher rates of diabetes were also observed in the 40- to 59-year-old idiopathic adhesive capsulitis group, with a medication rate of 25.0% (95% CI, 14.9%-38.8%). In all analyses of adhesive capsulitis patients within the 60- to 74-year-old range, the rates of diabetes were similar to previously reported nationwide values.

Discussion

Adhesive capsulitis has been clearly shown to be associated with diabetes. Adhesive capsulitis has been clearly shown to be associated with diabetes. However, studies looking for a connection between the degree of hyperglycemia or the...
duration of diabetes and the risk of adhesive capsulitis developing have produced conflicting results. Authors have suggested that the period of hyperglycemia before a diabetes diagnosis, estimated to be 9 to 12 years, may be when the shoulder damage begins to occur. Metabolic syndrome is a compilation of abnormalities that often precede or coexist with a diagnosis of type 2 diabetes, and its components are associated with increased cytokine production. In this study, we were able to explore possible associations between metabolic syndrome elements and the development of adhesive capsulitis, another inflammatory condition.

We observed an overall prevalence of anti-hyperglycemic medication use in adhesive capsulitis patients that was over twice the national prevalence of diagnosed diabetes. This trend was even greater in the 20- to 39-year old group, in whom we observed a prevalence of anti-hyperglycemic medication use in adhesive capsulitis patients 10 times greater than the observed rate of diagnosed diabetes in the general population (26.3% vs 2.1%). Although our results
are consistent with previous studies closely linking adhesive capsulitis and diabetes,\textsuperscript{1,2,4,18,24,27} Tighe and Oakley\textsuperscript{24} reported a 38.6% prevalence of diabetes in a group of adhesive capsulitis patients, a number over twice the 18.4% rate we observed. This discrepancy may be because of a different age distribution between studies or may represent different burdens of disease among study populations. In the 60- to 74-year-old group, the prevalence of treated diabetes was similar between adhesive capsulitis patients and the general population, but this observation is likely because of the increased prevalence of diabetes in the nationwide population.\textsuperscript{10} The prevalence of treated hypertension was also notably higher in patients with adhesive capsulitis. The overall prevalence of hypertensive medication use in patients with adhesive capsulitis of 33.1% was approximately 50% greater than the 21.6% prevalence observed in the general population.\textsuperscript{8} It is notable to observe a possible association between hypertension and adhesive capsulitis because it has not been previously reported. Arkkilä et al\textsuperscript{1} observed that hypertension was not associated with adhesive capsulitis, but the population examined in the study exclusively comprised diabetic patients, limiting the generalizability of those results. Essential hypertension has been linked with increased systemic cytokine and C-reactive protein levels.\textsuperscript{3} Because hyperglycemia has been shown to be a proinflammatory state, the simultaneous occurrence of hypertension and adhesive capsulitis, both linked to inflammation, is not surprising.

It is important to consider that hypertension has been observed in 70.9% of patients with type 2 diabetes\textsuperscript{23} and that the previously known association between diabetes and adhesive capsulitis could be indirectly linking the 2 diseases. A study by Suh et al\textsuperscript{23} using the NHANES 1999-2004 database observed that of the 70.9% of patients with type 2 diabetes aged 30 years or older with hypertension, 78.9% were being treated with prescription medications, yielding a 55.9% rate of patients with type 2 diabetes with hypertension being treated with antihypertensive medications. In our study, it is difficult to calculate a similar rate because we were unable to separate patients with type 1 diabetes from those with type 2 diabetes because of study limitations; however, when focusing on patients aged 40 years or older (those more likely to have type 2 diabetes), we observed that 61.9% of patients taking diabetic medications were also taking antihypertensive medications. The slightly higher rate of hypertension observed within our diabetic patients, 61.9%, as compared with 55.9%, despite our inclusion of an unknown number of patients with type 1 diabetes, lends credibility to the idea that the rate of hypertension observed within the group of adhesive capsulitis patients is higher than would be expected. A further analysis showed that 29.3% of patients (34 of 116; 95% CI, 21.8%-38.2%) with adhesive capsulitis who were nondiabetic were taking hypertension medications. This rate is also higher than the previously discussed nationwide antihypertensive medication rate of 21.6% (95% CI, 19.8%-23.4%); however, the CIs do overlap, likely

<table>
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<tr>
<th>Table II</th>
<th>Comparison of prevalence of antihypertensive medication use in patients with adhesive capsulitis and general population</th>
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<tbody>
<tr>
<td>Prevalence of antihypertensive medication use</td>
<td>Nationwide\textsuperscript{8}</td>
</tr>
<tr>
<td>All patients aged (\geq 18) y</td>
<td>21.9% (95% CI, 19.8%-23.4%)</td>
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<tr>
<td>Patients aged 18-39 y</td>
<td>2.8% (95% CI, 1.9%-3.9%)</td>
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<tr>
<td>Patients aged 40-64 y</td>
<td>24.5% (95% CI, 19.8%-23.4%)</td>
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<tr>
<td>Patients aged (\geq 65) y</td>
<td>54.9% (95% CI, 51.3%-58.4%)</td>
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</table>

The values are reported as prevalence (sample size) (95% CI). A notably increased prevalence of hypertension medications was observed in patients with adhesive capsulitis. Notable differences where 95% CI do not overlap.

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because of the smaller sample size used for this analysis. Overall, the higher-than-expected antihypertensive medication rates in diabetic patients and in nondiabetic patients lend credibility to the thought that hypertension may be independently associated with adhesive capsulitis. Additional larger-scale studies with greater power or hypertensive animal models will be necessary to fully assess the independent relationship between hypertension and adhesive capsulitis.

The prevalence of cholesterol-lowering medication use in our cohort of patients with adhesive capsulitis was similar to the prevalence in the general population. Similarly, the prevalence of obesity in patients with adhesive capsulitis was similar to the nationwide prevalence of obesity. This is in agreement with previous research by Arkkila et al that found no association between adhesive capsulitis and either peripheral vascular disease or BMI when studying the disease in diabetic patients. In our study, we used BMI instead of large waist circumference, the official metabolic syndrome obesity criteria, and this discrepancy could affect the validity of our conclusions because intra-abdominal fat specifically has been implicated in the disease. Overall, the similarity in obesity and cholesterol medication rates between groups suggests that these abnormalities are not associated with adhesive capsulitis.

In some patients, adhesive capsulitis can present in an idiopathic manner, whereas in others, the condition develops after surgery or a traumatic event. The subgroup analyses of patients with idiopathic adhesive capsulitis and post-traumatic/postoperative adhesive capsulitis produced medication rates that were equivalent to those observed in the overall adhesive capsulitis analysis. This coherence between groups suggests that they all have a similar relationship with diabetes and the other metabolic syndrome elements and that a history of a traumatic insult or lack thereof does not represent a distinct disease mechanism. Notably, the rates of diabetic medication use trended higher in patients with idiopathic disease compared with the general adhesive capsulitis group, suggesting that hyperglycemia may be linked even more tightly to “idiopathic” adhesive capsulitis. We posit that if one were to delve deeply into the metabolic profile of many “idiopathic” adhesive capsulitis patients, subtle markers of a proinflammatory condition, such as thyroid disorder, autoimmune dysfunction, hypertension, or hyperglycemia, may be indeed present.

Our study is limited by our use of medication lists as proxies for underlying metabolic abnormalities. For example, we cannot identify diet-controlled or unmedicated diabetic patients or hypertensive patients with our methods. However, the omission of medications would underestimate the prevalence of metabolic syndrome risk factors in our population and cannot explain the markedly increased prevalence of diabetic and hypertension medication use observed. Another limitation of our study is the small sample sizes, as well as the larger CIs within a number of our age group analyses. These small sample sizes may not provide adequate power to detect a difference between our
cohort and the nationwide control group, raising the possibility of type II errors. In addition, it is possible that patients may have omitted medications from their lists, and on the basis of our methods, it is impossible to determine whether unmedicated patients are truly disease free, issues that also raise the possibility of incorrectly accepting the null hypothesis in analyses in which no differences were observed. All of these limitations raise the risk of a type II error in the obesity and dyslipidemia analyses, but they cannot explain the notably higher rates of diabetic and hypertensive medication use observed within adhesive capsulitis patients. Although we were able to compare our patients with the nationwide population, the prevalence of metabolic syndrome in the United States is over 30%, and it is possible that this high rate may have masked relatively higher rates of metabolic syndrome risk factors in adhesive capsulitis patients. An additional limitation is that the prevalence of metabolic syndrome has been rising in the United States and the time lag of up to 6 years between the NHANES studies and our patient data may account for some of the increased medication rates we reported, although this seems unlikely to explain the magnitude of differences we observed. One issue that is important to consider is that patient medication lists reviewed retrospectively did not indicate whether patients were being treated for type 1 or type 2 diabetes. The inclusion of patients with type 1 diabetes may have diluted possible associations between adhesive capsulitis and metabolic syndrome because type 1 diabetes is not associated with the same constellation of metabolic abnormalities. The population of patients at the sports medicine clinic in our study may have been more active and healthier to begin with, making it difficult to observe increased rates of metabolic syndrome components when we performed the comparison with the nationwide population. In contrast, patients in the clinic may be more motivated to seek medical care, falsely elevating the metabolic syndrome medication rates above national averages, but this is unlikely because of their average rate of lipid-controlling medication use observed within the group. Future case-control or prospective cohort studies are necessary to eliminate the possible influence of confounding factors within our data and to further evaluate the connection between metabolic syndrome and adhesive capsulitis. Finally, the generalizability of our results is limited by our patient population. Our study comprised patients presenting for diagnosis and treatment of adhesive capsulitis at a sports medicine clinic affiliated with an academic medical center and does not represent all patients in whom adhesive capsulitis develops.

### Table IV

<table>
<thead>
<tr>
<th>Prevalence of diabetic medication use</th>
<th>General adhesive capsulitis</th>
<th>Idiopathic adhesive capsulitis</th>
<th>Postoperative or post-traumatic adhesive capsulitis</th>
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</thead>
<tbody>
<tr>
<td>All patients aged ≥ 20 y</td>
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<tr>
<td>Patients aged 20-39 y</td>
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<td>Patients aged 40-59 y</td>
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<tr>
<td>Patients aged 60-79 y</td>
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<tr>
<td>Prevalence of diabetic medication use</td>
<td>18.4% (26 of 141) (95% CI, 12.9%-25.7%)</td>
<td>23.3% (14 of 60) (95% CI, 14.4%-35.4%)</td>
<td>20.0% (3 of 15) (95% CI, 7.1%-45.2%)</td>
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<tr>
<td>Patients aged 20-39 y</td>
<td>26.3% (5 of 19) (95% CI, 11.8%-48.8%)</td>
<td>50.0% (2 of 4) (95% CI, 15.0%-85.0%)</td>
<td>0.0% (0 of 8) (95% CI, 0.0%-32.4%)</td>
</tr>
<tr>
<td>Patients aged 40-59 y</td>
<td>17.3% (18 of 104) (95% CI, 11.2%-25.7%)</td>
<td>25.0% (12 of 48) (95% CI, 14.9%-38.8%)</td>
<td>30.0% (3 of 10) (95% CI, 10.8%-60.3%)</td>
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</table>

The values are reported as prevalence (sample size) (95% CI). A notably increased prevalence of diabetic medications was observed in patients with adhesive capsulitis.

**Conclusion**

The results of our study continue to highlight the role that hyperglycemia plays in the development of adhesive
Metabolic syndrome and adhesive capsulitis; however, dyslipidemia and obesity do not appear to be associated with adhesive capsulitis. In patients presenting with adhesive capsulitis, a concurrent diagnosis of hyperglycemia should be considered, particularly in those in the 20- to 39-year-old group. Interestingly, the rate of antihypertensive medication use was also notably higher in patients with adhesive capsulitis, lending support to the idea that hypertension, an important component of metabolic syndrome, may also play a role in the development of adhesive capsulitis. Essential hypertension, linked to increased systemic inflammation, may serve as a marker for adhesive capsulitis risk because both processes are associated with increased levels of cytokine production. Overall, these findings suggest that the relationship between adhesive capsulitis and metabolic syndrome remains unclear because hyperglycemia and hypertension appear to be associated with the disease but there is no apparent connection between adhesive capsulitis and obesity or dyslipidemia. Although metabolic syndrome as a whole is not convincingly associated with adhesive capsulitis, inflammatory processes related to hyperglycemia and hypertension may play an important role in triggering inflammation within the shoulder.

**Disclaimer**

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