

# Association between alcohol consumption and rotator cuff tear

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**Background and purpose** — Long-term alcohol intake is associated with various negative effects on capillary microcirculation and tissue perfusion. We hypothesized that alcohol consumption might be a risk factor for both the occurrence and the severity of rotator cuff tears (RCTs).

**Patients and methods** — A case-control study was performed. We studied 249 consecutive patients (139 men and 110 women; mean age 64 (54–78) years) who underwent arthroscopic rotator cuff repair. Tear size was determined intraoperatively. The control group had 356 subjects (186 men and 170 women; mean age 66 (58–82) years) with no RCT. All participants were questioned about their alcohol intake. Participants were divided into: (1) non-drinkers if they consumed less than 0.01 g of ethanol per day, and (2) moderate drinkers and (3) excessive drinkers if women (men) consumed > 24 g (36 g) per day for at least 2 years.

**Results** — Total alcohol consumption, wine consumption, and duration of alcohol intake were higher in both men and women with RCT than in both men and women in the control group. Excessive alcohol consumption was found to be a risk factor for the occurrence of RCT in both sexes (men: OR = 1.7, 95% CI: 1.2–3.9; women: OR = 1.9, 95% CI: 0.94–4.1). Massive tears were associated with a higher intake of alcohol (especially wine) than smaller lesions.

**Interpretation** — Long-term alcohol intake is a significant risk factor for the occurrence and severity of rotator cuff tear in both sexes.

smoking (Carbone et al. 2012), and hypercholesterolemia (Kim et al. 2000), can—from local hypoxia—lead to tendon degeneration and rupture (Benson et al. 2010).

Many studies on humans and animals have shown that habitual high-dose intake of ethanol-containing beverages has various negative effects on capillary microcirculation and tissue perfusion (Liu et al. 2002, Fuchs 2005, Zilkens et al. 2005, Beilin and Puddey 2006, Costanzo et al. 2010, Wakabayashi 2011, Shirpoor et al. 2012).

We therefore hypothesized that long-term intake of high doses of alcohol might be a risk factor for both the occurrence and the severity of rotator cuff tears (RCTs).

## Patients and methods

We performed a case-control study. The cases consisted of 249 consecutive patients, mean age 64 (54–78) years (139 men), who were treated arthroscopically for a full-thickness rotator cuff tear. The tear had been diagnosed by physical examination, plain radiography, and magnetic resonance imaging.

Exclusion criteria were a previous operation of the shoulder, inflammatory or rheumatologic joint disease, primary osteoarthritis of the affected shoulder, BMI > 25, and having hypertension, diabetes mellitus, or hypercholesterolemia and not receiving the correct drug therapy.

The Southern California Orthopedic Institute classification of complete RCTs (Snyder 2002) was used to classify tendon tears intraoperatively as follows: (1) complete tears, such as a puncture wound (type I); (2) tears usually < 2 cm that still encompassed only 1 of the rotator cuff tendons, with no retraction of the torn ends (type II); (3) complete tears involving an entire tendon, with minimal retraction of the torn edge, usually 3–4 cm (type III); and (4) tears involving 2 or more rotator cuff tendons, often with associated retraction and scarring of the remaining tendon ends and often an L-shaped tear that is frequently irreparable (type IV).

The supraspinatus and infraspinatus tendons have a hypovascularized portion approximately 15 mm in length at their insertion on the great tuberosity (Rothman et al. 1965, Blevins et al. 1997). Any systemic or local disease or life habit that can negatively influence the capillary microcirculation, such as arterial hypertension (Gumina et al. 2013), cardiopulmonary disease (Harryman et al. 2003), obesity (Gumina et al. 2014),

To limit the number of groups and to make the sample more representative, we considered the lesions belonging to type I to be small, those of types II and III to be large, and those of type IV to be massive.

The control group started with 428 consecutive subjects with no history of shoulder pathologies who had been enrolled at the outpatient clinic of our hospital. All the controls were given a physical examination of both the anterior rotator cuff tendons (lift-off test, Napoleon test, bear-hug test) and the posterosuperior rotator cuff tendons (full can test, Patte test, external rotation lag sign, strength in external rotation) (Hegeudus et al. 2008) and to an ultrasound (US) examination of both shoulders. Subjects were excluded from the control group if 1 or more of the tests were positive and/or if US examination revealed an asymptomatic RCT. After examination, the control group consisted of 356 subjects with a mean age of 66 (58–82) years (186 men and 170 women).

A standardized questionnaire was used to obtain information about smoking habits (never-smoker, current smoker, or former smoker), diabetes mellitus (presence or absence), and alcohol consumption. The types of alcoholic beverage consumed, and the amount and duration of use were investigated in detail.

Data for beer consumption, wine consumption (wine + fortified wine), and liquor consumption (aperitif + spirit) were analyzed separately and then summed to estimate the total alcohol consumption per day. Alcohol intake for a particular beverage, in grams per day, was calculated by multiplying the frequency of consumption by its respective ethanol content (1 bottle of beer = 330 mL, 1 mL beer = 0.046 g ethanol; 1 glass of wine = 125 mL, 1 mL wine = 0.104 g ethanol; 1 glass of fortified wine = 90 mL, 1 mL fortified wine = 0.167 g ethanol; 1 glass of aperitif = 40 mL, 1 mL aperitif = 0.25 g ethanol; 1 shot of spirit = 30 mL, 1 mL spirit = 0.33 g ethanol). In our country a standard Alcoholic Unit (AU) contains 12 grams of alcohol (National Research Institute for Food and Nutrition, guidelines 2003). The guidelines for healthy nutrition recommend to consume no more than 2–3 AUs per day for men and 1–2 AUs per day for women. Therefore, we considered men and women separately.

Non-drinkers were defined as those individuals who consumed less than 0.01 g of ethanol per day. Male subjects were classified as non-drinkers and drinkers (subjects who had drunk more than 0.01 g of alcohol a day for at least 2 years). Male drinkers were further divided into moderate drinkers (subjects who consumed less than 36 grams per day) and excessive drinkers (subjects who consumed more than 36 g per day). Women were classified as non-drinkers and drinkers (subjects who had drunk more than 0.01 g of alcohol a day for at least 2 years). In the same way, female drinkers were further divided into moderate drinkers (subjects who consumed less than 24 g per day) and excessive drinkers (subjects who consumed more than 24 g per day).

## Statistics

Calculation of sample size was done using G\*Power 3 software (Heinrich-Heine-University, Dusseldorf, Germany). According to logistic regression, we determined that at least 603 patients would be required, assuming an odds ratio value of 1.1, a 2-tailed  $\alpha$ -value of 0.05 (sensitivity of 95%), and a  $\beta$ -value of 0.10 (with a study power of 90%).

We used parametric tests after using the Kolmogorov-Smirnov test to verify that the variables were normally distributed. Unpaired sample t-test was performed to evaluate differences between RCT subjects and control subjects according to total alcohol intake and wine, beer, and liquor intake. To evaluate the risk of RCT in drinkers and non-drinkers (both men and women), odds ratios (ORs) were calculated according to Altman.

Non-drinkers were excluded to assess a potential dose-response relationship in drinkers only. An OR of > 1.0 would mean that alcohol consumption was associated with a statistically significantly higher risk of rotator cuff tear.

1-way ANOVA was used to evaluate differences in alcohol intake levels between subjects with RCT. Significance levels for multiple comparisons were adjusted with the Bonferroni-Holm procedure. Logistic regression was used to identify risk factors for RCTs using the following factors as explanatory variables: age, sex, daily alcohol intake, smoking habit, and diabetes mellitus.

All statistical tests were 2-sided with a probability level of 0.05, and all results are expressed with 95% confidence interval. SPSS version 18 was used for calculations.

## Ethics

All participants signed an informed consent form in accordance with the Declaration of Helsinki. According to Italian law, this study did not need any ethical committee approval.

## Results

Age, sex distribution, and BMI were similar in the cases and controls (Table 1). Total alcohol consumption, wine consumption, and history of alcohol intake were statistically significantly higher in both men and women with RCT than in both men and women in the control group. Moreover, there was higher consumption of beer in men with RCT than in male control subjects (Table 2).

We observed an association between drinking and the presence of RCT in both men (OR = 1.4, CI: 0.6–1.8;  $p = 0.02$ ) and women (OR = 2.2, CI: 0.7–3.1;  $p = 0.04$ ).

No statistically significant risks from moderate drinking were observed in either men (OR = 0.8, CI: 0.4–0.9) or women (OR = 0.6, CI: 0.4–1.4). However, significant risks were found for excessive drinkers of both sexes (men: OR = 1.7, CI: 1.2–3.9,  $p = 0.04$ ; women: OR = 1.9, CI: 0.94–4.1,  $p = 0.04$ ). Regarding the duration of alcohol consumption, we

Table 1. Baseline characteristics of patients

Cases	249	
Tear type:		
Small	94	
Large	88	
Massive	67	
Controls	356	
Sex, M/F	325/280	p = 0.08
Mean age (range), years		
Cases	64 (54–78)	
Controls	66 (58–82)	p = 0.2
BMI		
Men	23 (18–25)	
Women	23 (19–24)	p = 0.2

found significant risks for the occurrence of RCT in both men [(OR = 1.4, CI: 0.86–1.7), p=0.04] and women [(OR = 1.2, CI: 0.8–2.1), p=0.03] (Table 3, see Supplementary data).

We found higher alcohol consumption in patients with massive RCTs than in those with small RCTs (p = 0.01) and large RCTs (p = 0.03) (Table 4, see Supplementary data).

Finally, logistic regression analysis revealed that daily alcohol intake, smoking, and diabetes mellitus—all considered individually—were associated with the occurrence of rotator cuff tear (p < 0.001, p = 0.03, and p < 0.001, respectively) (Table 5).

## Discussion

Little is known about the relationship between alcohol intake and RCT. Only 1 study (Titchener et al. 2014) has assessed such a relationship and the authors found that alcohol intake was not associated with rotator cuff disease. However, this conclusion was reached without precisely considering the amount of alcohol ingested by participants on a daily basis, how long they had this habit, and possible differences between men and women. The same amount of alcohol may have different negative effects in men and women; these differences are due to higher ethanol bioavailability in women since it is

Table 2. Mean values (range) of history of alcohol intake: total alcohol intake, and wine, beer, and liquor intake in cases and controls, according to sex

	Women	p-value	Men	p-value
Years of alcohol intake				
Cases	31 (14–45)		35 (18–58)	
Controls	26 (15–40)	0.02	29 (17–42)	0.04
Total ethanol intake <sup>a</sup>				
Cases	15 (3–38)		29 (3–40)	
Controls	13 (2–36)	0.04	25 (3–39)	0.03
Ethanol from wine <sup>a</sup>				
Cases	9.9 (1–22)		24 (0–32)	
Controls	7.8 (0–18)	0.04	20 (0–28)	< 0.001
Ethanol from beer <sup>a</sup>				
Cases	2.9 (0–6)		6.2 (0–12)	
Controls	2.5 (0–7)	0.5	4.4 (0–9)	0.03
Ethanol from liquor <sup>a</sup>				
Cases	0.9 (0–2)		0.8 (0–2.1)	
Controls	0.7 (0–2.5)	0.6	0.8 (0–2)	0.7

<sup>a</sup> in g per day.

metabolized more slowly at the gastric level and has a lower distribution volume than in men. Thus, in women the same amount of alcohol consumed leads to a greater blood level of ethanol and has more toxic effects (Kasper et al. 2005).

We observed that men and women with RCT had a longer history of alcohol intake than corresponding controls; moreover, they consumed higher amounts of alcohol per day, irrespective of whether one considers total alcohol intake or wine intake only.

Regarding beer consumption, we found significant differences only between men with RCT and male controls. No significant difference was found regarding consumption of spirits. We explain these data as being a result of the higher consumption of wine in our country than that of beer or spirits. One must therefore consider the statistical bias due to the small number of patients and healthy subjects who were drinkers of beer and spirits, and the low amounts of these drinks that were consumed.

We observed that excessive consumption of alcohol was a significant risk factor for the occurrence of RCT in both men

Table 5. Logistic regression analysis of age, sex alcohol intake, smoking, and diabetes mellitus and odds ratios (ORs) with 95% CI

	Cases (n = 249)	Controls (n = 356)	OR	95% CI	p-value
Age (range), years	64 (54–78)	66 (58–82)	0.97	(0.76–1.2)	0.008
Sex, M/F	139/110	186/170	0.36	(0.15–0.66)	0.06
Alcohol intake (range) <sup>a</sup>	23 (3–40)	19 (2–39)	1.2	(0.88–2.3)	0.002
Smoking (never/current/former)	102/108/39	176/129/51	1.1	(0.65–2.9)	0.03
Diabetes mellitus (presence/absence)	93/156	122/234	4.4	(1.6–5.2)	< 0.001

<sup>a</sup> in g per day

and women. There was no risk associated with moderate alcohol intake. These results may be explained by direct toxic effects of alcohol on tendons through inhibition of fibroblast proliferation and collagen synthesis (Hapa et al. 2009) when alcohol consumption is greater than the recommended doses (< 3 alcohol units (AUs) for men and < 2 AUs for women). Furthermore, the duration of the habit of drinking alcohol was a significant risk factor for the onset of cuff rupture. We also found that rotator cuff tear size increased with increasing alcohol consumption. Patients with higher alcohol intake may have greater impairment in the microvasculature of the insertional tendon area. Moreover, as revealed by logistic regression analysis, we found that heavy alcohol intake was an independent risk factor for the onset of RCT in both sexes, even when adjusting for other known risk factors such as smoking habit and diabetes.

Our study had some limitations. First, the controls were not examined by MRI to preclude the possibility of an asymptomatic RCT, but only to physical and ultrasound examination. We believe that since the tests and the ultrasonography that we performed had great sensitivity, accuracy, and specificity for RCT diagnosis, our results would not be substantially affected by this. Secondly, the amount of alcohol consumed per day may have been underreported by subjects who felt that they consumed more alcohol than they should.

In summary, the daily alcohol consumption by patients with rotator cuff tear was greater than that in healthy controls, and their alcohol-drinking habit had lasted for a longer time. A daily consumption of more than 3 AUs for men and 2 AUs for women was found to be a significant risk factor for RCT occurrence. Moreover, an excessive alcohol intake that was higher than that recommended was also a significant risk factor for tendon damage and severity of the tear.

### Supplementary data

Tables 3 and 4 are available on the Acta Orthopaedica website at [www.actaorthop.org](http://www.actaorthop.org), identification number 9040.

PD and CV: study concept and design, data collection, analysis and interpretation of data, and writing of the manuscript. VT: analysis and interpretation of data, statistical analysis, and critical review of the manuscript. GG: study design and critical review of the manuscript. GS: study concept and design, analysis and interpretation of data, and critical review of the manuscript.

No competing interests declared.

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