ELSEVIER

Surgery for Obesity and Related Diseases 9 (2013) 470–473

SURGERY FOR OBESITY AND RELATED DISEASES

Rapid communication

Blood alcohol concentrations rise rapidly and dramatically after Roux-en-Y gastric bypass

Kristine J. Steffen, Pharm.D., Ph.D.[a,b,*], Scott G. Engel, Ph.D.[b,c], Garrett A. Pollert, B.S.[d], Li Cao, M.S.[b], James E. Mitchell, M.D.[b,c]

[a]*Department of Pharmaceutical Sciences, College of Pharmacy, Nursing, and Allied Sciences, North Dakota State University, Fargo, North Dakota*
[b]*Neuropsychiatric Research Institute, Fargo, North Dakota*
[c]*Department of Clinical Neuroscience, School of Medicine and Health Sciences, University of North Dakota, Forks, North Dakota*
[d]*Department of Psychological Science, University of Arkansas, Fayettville, Arkansas*

Received January 25, 2013; accepted February 1, 2013

Abstract

Background: This study provides new information on how rapidly and extensively alcohol is absorbed after Roux-en-Y gastric bypass (RYGB). Previous alcohol pharmacokinetic research in RYGB patients has not reported blood alcohol concentrations in this early time period after ingestion. The objective of this study was to examine the rate and extent of alcohol absorption, particularly in the first 10 minutes after a dose of alcohol.

Methods: Five female participants who had undergone RYGB 3 to 4 years previously completed the study. Participants were given .3 g/kg of actual weight of ethanol. After the dose of alcohol, blood samples were collected through an indwelling intravenous catheter every minute for the first 5 minutes and at 7.5, 10, 20, and 60 minutes.

Results: The observed mean C_{max} was 138.4 ± 28.6 mg/dL (range 98.0–170.0 mg/dL), and the observed mean T_{max} was 5.4 ± 3.1 minutes (range 2–10 minutes) after alcohol consumption.

Conclusions: Within minutes after consumption of a beverage containing a modest amount of alcohol, post-RYGB patients achieve disproportionately high blood alcohol concentrations. All 5 participants in this study reached blood alcohol concentrations >.08%, the legal driving limit in the United States, within 10 minutes after a dose of alcohol. Clinicians are encouraged to educate patients about the marked changes in alcohol pharmacokinetics that are they are likely to experience after RYGB and to guide patients in making modifications to alcohol intake after surgery accordingly. (Surg Obes Relat Dis 2013;9:470–473.)

Keywords: Alcohol; Gastric bypass; Pharmacokinetics; Absorption

Patients who undergo Roux-en-Y gastric bypass (RYGB) may be at increased risk of an alcohol use disorder after surgery [1–3]. One theoretical contributor to this phenomenon may be the alterations in the pharmacokinetics (PKs) of alcohol that have been reported after RYGB. It has been reported that substances that reach peak concentrations more rapidly are associated with higher addictive potential [4,5]. The present study extends the previous alcohol PK literature by examining the rate and extent of alcohol absorption after RYGB. These data may have implications for alcohol use disorders after RYGB, as well as for patient safety and education after surgery.

Alterations in alcohol PK after RYGB have been reported relative to presurgery [6] and to nonsurgical comparison groups [7,8]. Data have consistently shown higher maximum alcohol concentrations in patients who have undergone RYGB. Data for other bariatric procedures is more

*Correspondence: Kristine J. Steffen, Pharm.D., Ph.D., College of Pharmacy, Nursing, and Allied Sciences, North Dakota State University, NDSU Dept. 2665, P.O. Box 6050, Fargo, ND 58108-6050.
E-mail: kristine.steffen@ndsu.edu

1550-7289/13/$ – see front matter
http://dx.doi.org/10.1016/j.soard.2013.02.002

limited. A recent study found that alcohol metabolism is unaltered in patients who underwent gastric banding or sleeve gastrectomy [9], although an earlier study found higher alcohol levels and altered metabolism after sleeve gastrectomy [10]. After RYGB, there may be a reduction in first-pass metabolism through a decrease in stomach alcohol dehydrogenase [7]. A more probable explanation is that the reduced stomach volume and acceleration in gastric emptying time after surgery lead to rapid, extensive absorption from the jejunum [7].

Klockhoff et al. [7] found that patients who have undergone RYGB achieved a faster and higher blood alcohol concentration (BAC) relative to controls. However, the first BAC measurement in their study occurred 10 minutes postdrink, and other studies involving RYGB patients have similarly first measured BAC at 10–15 minutes postdrink [6,8]. Generally, the first measurement time point in these studies has corresponded with the maximum alcohol concentration (C_{max}). Observations from research in our laboratory suggested that previous studies may have measured BAC too late to capture the actual C_{max} after RYGB. We designed the present study to test our hypothesis that, in patients who have undergone RYGB, the C_{max} would be significantly higher and the time to C_{max} (T_{max}) would be faster, after alcohol ingestion than previous research has reported.

Methods

This study was Institutional Review Board approved. Five participants, were recruited who underwent RYGB surgery within the previous 18–60 months, were 21–65 years of age, had a body mass index (BMI) ≥ 18.5 kg/m^2, and regularly consumed alcohol (≥ 1 standard drink ≥ 1 time per month on average in the past 3 months) without significant adverse effects. Participants could be excluded for several reasons, most commonly including (1) medical or psychiatric contraindication to receiving a dose of alcohol or (2) medication that inhibits gastric alcohol dehydrogenase (H_2 antagonist, aspirin).

Participants who qualified on telephone interview were invited to the research facility for a screening appointment. All participants provided written informed consent before undergoing screening procedures, which included a history and physical examination, vital signs, height and weight, serum pregnancy, glucose, hepatic tests, and a urine toxicology screen.

The alcohol dose and administration protocol used in this study was based upon and is similar to the approach used by Klockhoff et al. [7]. Participants were asked to fast for a minimum of 4 hours before coming to the laboratory. Each participant consumed .3 g of ethanol per kilogram of body weight. The alcohol was administered in the form of 40%

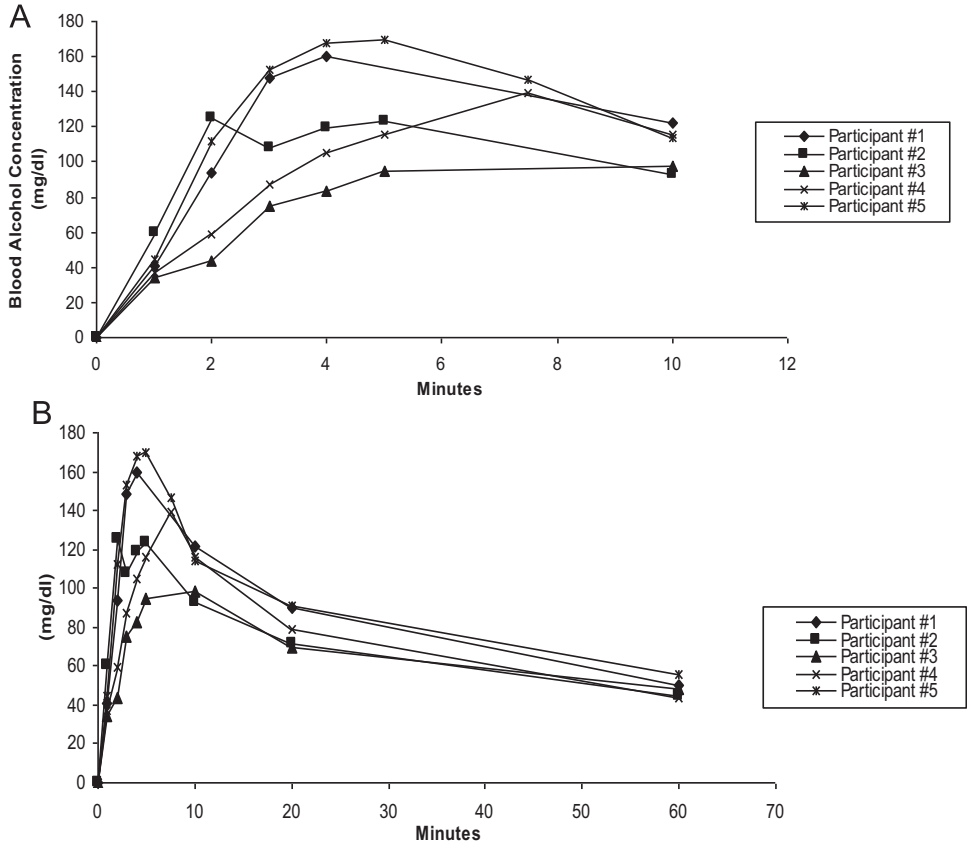

Fig. 1. (A) BAC 10 minutes postdrink. (B) BAC 60 minutes postdrink.

Table 1
Demographic characteristics and pharmacokinetics

		Mean ± SD	Range
Demographic characteristics	Age (yr)	40.8 ± 5.8	35–48
	Female (N = 5, 100%)	—	—
	Years post-RYGB	3.5 ± .31	3.2–4.0
	Height (inches)	64.2 ± 5.2	55–67
	Weight (kg)	89.6 ± 7.5	78.4–97.7
	BMI (kg/m^2)	31.6 ± 2.1	28.7–33.7
	Presurgery weight (kg)	125.8 ± 11.1	110.5–138.6
Pharmacokinetics	Dose of alcohol (g)	26.9 ± 2.3	23.5–29.3
	C_{max} (mg/dL)	138.4 ± 28.6	98.0–170.0
	T_{max} (min)	5.4 ± 3.1	2–10
	$AUC_{0–60\ min}$ (mg/dL × min)*	4574.1 ± 569.9	3965.8–5269.5
BAC (mg/dL: minutes postdrink)	1	43.4 ± 10.2	34.0–60.0
	2	86.8 ± 34.5	44.0–125.0
	3	114.2 ± 35.2	75.0–153.0
	4	127.0 ± 36.2	83.0–168.0
	5	126.0 ± 31.7	95.0–170.0
	7.5 (N = 2)	143.0 ± 5.7	139.0–147.0
	10	108.6 ± 12.4	93.0–122.0
	20	80.2 ± 10.0	70.0–91.0
	60	48.6 ± 4.8	44.0–56.0

*0 time-point in AUC calculation confirmed by breathalyzer assessment before the dose was administered. All other alcohol concentrations obtained from blood.

vodka, which contains approximately 14 g of ethanol per 1.5 ounces (~45 mL). Vodka was mixed with orange juice in a 1:1 ratio to yield a 50% v/v concentration. Participants were instructed to consume the drink evenly over 5 minutes.

Blood was obtained through an intravenous catheter to facilitate rapid collection of specimens. Blood was collected on 9 occasions—at 1, 2, 3, 4, 5, 7.5, 10, 20, and 60 minutes after ingesting the full dose of alcohol. Participants were allowed to leave the facility when BAC obtained by breathalyzer was ≤.01%.

Sanford Health Systems performed BAC quantification. BAC was determined through a colorimetric assay using the VITROS Chemistry Products Calibrator Kit 8 with quantification limits of 10–600 mg/dL. PASW Statistics 18 was used to generate descriptive demographic and PK data. AUC time curve from 0–60 minutes ($AUC_{0–60}$) was calculated using the linear trapezoidal method. Observed C_{max} and T_{max} data are presented.

Results

Participant demographic characteristics and PK values can be found in Table 1. The mean dose of ethanol given was 26.9 ± 2.3 g (mean ~86 mL vodka). The mean observed C_{max} was 138.4 ± 28.6 mg/dL (range 98–170 mg/dL). The mean observed T_{max} was 5.4 ± 3.1 minutes (range 2–10 minutes). At 1 minute postdrink, mean BAC was 43.4 ± 10.2 mg/dL, and by 2 minutes, the group reached a mean BAC of 86.8 ± 34.5 mg/dL, which is over the legal driving limit in the United States. Fig. 1 depicts the BACs in 10 and 60 minutes postdrink, respectively.

Discussion

Consistent with previous literature, the results of our study show that patients who have undergone RYGB rapidly achieve disproportionately high BAC concentrations in response to a modest amount of alcohol. As hypothesized, our data show that previous literature has underestimated the time and extent to which patients who have undergone RYGB may become intoxicated after alcohol ingestion.

The average dose of alcohol administered in this study equated to approximately 63 mL vodka for a 70-kg individual, with a mean dose of ~86 mL (roughly 2 standard 45 mL "shots") administered. The mean C_{max} observed in this study (1.384 ± .286 g/L) was approximately double the mean C_{max} (0.741 ± .221 g/L) reported by Klockhoff et al. [7]. In our study, T_{max} ranged from 2–10 minutes postdrink (mean 5.4 ± 3.1 minutes), whereas the median T_{max} was 10 minutes in the study by Klockhoff et al. [7], which was the first postdrink measurement time.

Conclusion

All 5 participants achieved BAC levels that substantially exceeded the legal driving limit of 80 mg/dl (.08%) within minutes after a dose of alcohol that should, under normal circumstances, produce a BAC significantly <.08% in individuals who have not undergone RYGB. Clinicians should educate patients to modify alcohol intake accordingly and to avoid engaging in potentially hazardous activities after drinking.

Acknowledgments

Supported by NIH Grants: 1R03AA019573-02, 1K23DK085066-03.

Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

References

[1] Conason A, Teixeira J, Hsu CH, Puma L, Knafo D, Geliebter A. Substance use following bariatric weight loss surgery. Arch Surg 2012;15:1–6.

[2] King WC, Chen JY, Mitchell JE, et al. Prevalence of alcohol use disorders before and after bariatric surgery. JAMA 2012;307: 2516–25.

[3] Suzuki J, Haimovici F, Chang G. Alcohol use disorders after bariatric surgery. Obes Surg 2012;22:201–7.

[4] Longo LP, Johnson B. Addiction: Part 1. Benzodiazepines—side effects, abuse risk and alternatives. Am Fam Physician 2000;61: 2121–28.

[5] National Institute on Drug Abuse [homepage on the Internet]. Bethesda, MD: National Institutes of Health; [updated 2010 Mar; cited 2012 Sept]. Drug Facts: Cocaine. Available at: http://www.drugabuse.gov/publications/drugfacts/cocaine.

[6] Woodard GA, Downey J, Hernandez-Boussard T, Morton JM. Impaired alcohol metabolism after gastric bypass surgery: a case-crossover trial. J Am Coll Surg 2011;212:209–14.

[7] Klockhoff H, Naslund I, Jones AW. Faster absorption of ethanol and higher peak concentration in women after gastric bypass surgery. Br J Clin Pharmacol 2002;54:587–91.

[8] Hagedorn JC, Encarnacion B, Brat GA, Morton JM. Does gastric bypass alter alcohol metabolism? Surg Obes Relat Dis 2007;3:543–8.

[9] Changchein EM, Woodard GA, Hernandez-Boussard T, Morton JM. Normal alcohol metabolism after gastric banding and sleeve gastrectomy: a case-cross-over trial. J Am Coll Surg 2012;215:475–9.

[10] Maluenda F, Csendes A, De Aretxabala X, et al. Alcohol absorption modification after a laparoscopic sleeve gastrectomy due to obesity. Obes Surg 2010;20:744–8.