

# Parsing Brittle Diabetes Takes Solid Detective Work

BY SHERRY BOSCHERT  
San Francisco Bureau

SAN FRANCISCO — Diabetes patients whose lives are frequently disrupted by glycemic episodes requiring hospitalization need a multifaceted work-up to identify the cause of their brittle diabetes, Dr. Irl B. Hirsch said.

Compared with diabetes patients who have relatively stable and well-controlled glucose levels, patients with brittle dia-

betes tend to be younger and are more likely to be female, Dr. Hirsch said at a meeting sponsored by the American Diabetes Association. They also tend to have higher hemoglobin A<sub>1c</sub> values and to use more insulin, and are more likely to have psychiatric disorders or psychosocial problems, including family disruption, adolescent crises, and personality disturbances, said Dr. Hirsch, professor of medicine at the University of Washington, Seattle.

Both physical and psychiatric problems

can result in brittle diabetes. Look for the following to identify contributing factors:

► **Counterregulatory hormone excess.** This can cause insulin resistance and make diabetes very difficult to control. Cushing's disease, acromegaly, pheochromocytoma, and glucagonoma are rare causes of insulin resistance to consider in the work-up of brittle diabetes.

► **Insulin antibodies.** These are worth measuring but have a low yield in these patients. "Unless the physical exam sug-

gests a diagnosis of Cushing's disease or acromegaly or some endocrine disorder like that," go ahead and measure insulin antibodies, he said.

A potentially more productive approach is to measure both free and total insulin levels in a patient. A discrepancy in the results suggests that there's something binding up the insulin.

Be sure to use a clinical laboratory that knows how to measure free insulin, Dr. Hirsch cautioned. After the blood is drawn, several preparatory steps must be completed within 30 seconds before the sample is sent out to be assayed. "Not all labs do that," he said.

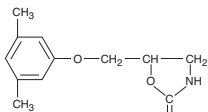
► **Celiac disease.** This occurs in approximately 7%-8% of childhood-onset type 1 diabetes patients and can lead to brittle diabetes. Screening for celiac disease typically focuses on identifying the transglutaminase IgA antibody, but 5% of the

## SKELAXIN® (Metaxalone) Tablets

### DESCRIPTION

SKELAXIN® (metaxalone) is available as an 800 mg oval, scored pink tablet.

Chemically, metaxalone is 5-[(3,5-dimethylphenoxy)methyl]-2-oxazolindione. The empirical formula is C<sub>17</sub>H<sub>15</sub>NO<sub>2</sub>, which corresponds to a molecular weight of 221.25. The structural formula is:



Metaxalone is a white to almost white, odorless crystalline powder freely soluble in chloroform, soluble in methanol and in 96% ethanol, but practically insoluble in ether or water.

Each tablet contains 800 mg metaxalone and the following inactive ingredients: alginate acid, ammonium calcium alginate, B-Rose Liquid, corn starch and magnesium stearate.

### CLINICAL PHARMACOLOGY

**Mechanism of Action:** The mechanism of action of metaxalone in humans has not been established, but may be due to general central nervous system depression. Metaxalone has no direct action on the contractile mechanism of striated muscle, the motor end plate or the nerve fiber.

### Pharmacokinetics:

The pharmacokinetics of metaxalone have been evaluated in healthy adult volunteers after single dose administration of SKELAXIN under fasted and fed conditions at doses ranging from 400 mg to 800 mg.

### Absorption

Peak plasma concentrations of metaxalone occur approximately 3 hours after a 400 mg oral dose under fasted conditions. Thereafter, metaxalone concentrations decline log-linearly with a terminal half-life of 9.0 ± 4.8 hours. Doubling the dose of SKELAXIN from 400 mg to 800 mg results in a roughly proportional increase in metaxalone exposure as indicated by peak plasma concentrations (C<sub>max</sub>) and area under the curve (AUC). Dose proportionality at doses above 800 mg has not been studied. The absolute bioavailability of metaxalone is not known.

The single-dose pharmacokinetic parameters of metaxalone in two groups of healthy volunteers are shown in Table 1.

Dose (mg)	C <sub>max</sub> (ng/mL)	T <sub>max</sub> (h)	AUC <sub>0-4</sub> (ng-h/mL)	AUC <sub>0-∞</sub> (ng-h/mL)	t <sub>1/2</sub> (h)	CL/F (L/h)
400*	983 (53)	3.3 (35)	7479 (51)	9.0 (53)	68 (50)	
800*	1816 (43)	3.0 (39)	15044 (46)	8.0 (58)	66 (51)	

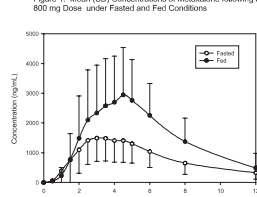
\*Subjects received 1x400 mg tablet under fasted conditions (N=42)  
\*Subjects received 2x400 mg tablets under fasted conditions (N=59)

### Food Effects

A randomized, two-way, crossover study was conducted in 42 healthy volunteers (31 males, 11 females) administered one 400 mg SKELAXIN tablet under fasted conditions and following a standard high-fat breakfast. Subjects ranged in age from 18 to 48 years (mean age = 23.5 ± 5.7 years). Compared to fasted conditions, the presence of a high fat meal at the time of drug administration increased C<sub>max</sub> by 177.5% and increased AUC (AUC<sub>0-4</sub>, AUC<sub>0-∞</sub>) by 123.5% and 115.4%, respectively. Time-to-peak concentration (T<sub>max</sub>) was also delayed (4.3 h versus 3.3 h) and terminal half-life was decreased (2.4 h versus 9.0 h) under fed conditions compared to fasted.

In a second food effect study of similar design, two 400 mg SKELAXIN tablets (800 mg) were administered to healthy volunteers (N=59, 37 males, 22 females), ranging in age from 18-50 years (mean age = 25.6 ± 8.7 years). Compared to fasted conditions, the presence of a high fat meal at the time of drug administration increased C<sub>max</sub> by 193.6% and increased AUC (AUC<sub>0-4</sub>, AUC<sub>0-∞</sub>) by 146.4% and 142.2%, respectively. Time-to-peak concentration (T<sub>max</sub>) was also delayed (4.9 h versus 3.0 h) and terminal half-life was decreased (4.2 h versus 8.0 h) under fed conditions compared to fasted conditions. Similar food effect results were observed in the above study when one SKELAXIN 800 mg tablet was administered in place of two SKELAXIN 400 mg tablets. The increase in metaxalone exposure coinciding with a reduction in half-life may be attributed to more complete absorption of metaxalone in the presence of a high fat meal (Figure 1).

Figure 1. Mean (SD) Concentrations of Metaxalone following an 800 mg Dose under Fasted and Fed Conditions.



### Distribution, Metabolism, and Excretion

Although plasma protein binding and absolute bioavailability of metaxalone are not known, the apparent volume of distribution (V/F ~ 800 L) and lipophilicity (log P = 2.42) of metaxalone suggest that the drug is extensively distributed in the tissues. Metaxalone is metabolized by the liver and excreted in the urine as unidentified metabolites.

### Pharmacokinetics in Special Populations

**Age:** The effects of age on the pharmacokinetics of metaxalone were determined following single administration of two 400 mg tablets (800 mg) under fasted and fed conditions. The results were analyzed separately, as well as in combination with the results from three other studies. Using the combined data, the results indicate that the pharmacokinetics of metaxalone are significantly more affected by age under fasted conditions than under fed conditions, with bioavailability under fasted conditions increasing with age.

The bioavailability of metaxalone under fasted and fed conditions in three groups of healthy volunteers of varying age is shown in Table 2.

Age (years)	Younger Volunteers		Older Volunteers	
	25.6 ± 8.7	39.3 ± 10.8	71.5 ± 5.0	
N	59	21	23	
Food	Fasted	Fasted	Fasted	Fed
	1816 (43)	3510 (41)	2719 (46)	2915 (55)
C <sub>max</sub> (ng/mL)			3168 (43)	3680 (59)

T <sub>max</sub> (h)	3.0	4.9	3.0	8.7	2.6	6.5
	(39)	(48)	(40)	(91)	(30)	(67)
AUC <sub>0-4</sub> (ng-h/mL)	14531 (47)	20683 (41)	19836 (40)	20482 (37)	23797 (45)	24340 (48)
	15045 (46)	20833 (41)	20490 (39)	20815 (37)	24194 (44)	24704 (47)

**Gender:** The effect of gender on the pharmacokinetics of metaxalone was assessed in an open label study, in which 48 healthy adult volunteers (24 males, 24 females) were administered two SKELAXIN 400 mg tablets (800 mg) under fasted conditions. The bioavailability of metaxalone was significantly higher in females compared to males as evidenced by C<sub>max</sub> (2115 ng/mL versus 1335 ng/mL) and AUC<sub>0-∞</sub> (17884 ng-h/mL versus 10328 ng-h/mL). The mean half-life was 11.1 hours in females and 7.6 hours in males. The apparent volume of distribution of metaxalone was approximately 22% higher in males than in females, but not significantly different when adjusted for body weight. Similar findings were also seen when the previously described combined dataset was used in the analysis.

**Hepatic/Renal Insufficiency:** The impact of hepatic and renal disease on the pharmacokinetics of metaxalone has not been determined. In the absence of such information, SKELAXIN should be used with caution in patients with hepatic and/or renal impairment.

### INDICATIONS AND USAGE

SKELAXIN (metaxalone) is indicated as an adjunct to rest, physical therapy, and other measures for the relief of discomforts associated with acute, painful musculoskeletal conditions. The mode of action of this drug has not been clearly identified, but may be related to its sedative properties. Metaxalone does not directly relax tense skeletal muscles in man.

### CONTRAINDICATIONS

Known hypersensitivity to any components of this product. Known tendency to drug induced, hemolytic, or other anemias. Significantly impaired renal or hepatic function.

### WARNINGS

SKELAXIN may enhance the effects of alcohol and other CNS depressants.

### PRECAUTIONS

Metaxalone should be administered with great care to patients with pre-existing liver damage. Serial liver function studies should be performed in these patients.

False-positive Benedict's tests, due to an unknown reducing substance, have been noted. A glucose-specific test will differentiate findings.

Taking SKELAXIN with food may enhance general CNS depression; elderly patients may be especially susceptible to this CNS effect. (See CLINICAL PHARMACOLOGY: Pharmacokinetics and PRECAUTIONS: Information for Patients section).

### Information for Patients

SKELAXIN may impair mental and/or physical abilities required for performance of hazardous tasks, such as operating machinery or driving a motor vehicle, especially when used with alcohol or other CNS depressants.

### Drug Interactions

SKELAXIN may enhance the effects of alcohol, barbiturates and other CNS depressants.

### Carcinogenesis, Mutagenesis, Impairment of Fertility

The carcinogenic potential of metaxalone has not been determined.

### Pregnancy

Reproduction studies in rats have not revealed evidence of impaired fertility or harm to the fetus due to metaxalone. Post marketing experience has not revealed evidence of fetal injury, but such experience cannot exclude the possibility of infrequent or subtle damage to the human fetus. Safe use of metaxalone has not been established with regard to possible adverse effects upon fetal development. Therefore, metaxalone tablets should not be used in women who are or may become pregnant and particularly during early pregnancy unless in the judgement of the physician the potential benefits outweigh the possible hazards.

### Nursing Mothers

It is not known whether this drug is secreted in human milk. As a general rule, nursing should not be undertaken while a patient is on a drug since many drugs are excreted in human milk.

### Pediatric Use

Safety and effectiveness in children 12 years of age and below have not been established.

### ADVERSE REACTIONS

The most frequent reactions to metaxalone include: CNS: drowsiness, dizziness, headache, and nervousness or "irritability";

Digestive: nausea, vomiting, gastrointestinal upset.

Other adverse reactions are:

Immune System: hypersensitivity reaction, rash with or without pruritus;

Hematologic: leukopenia; hemolytic anemia;

Hepatobiliary: jaundice.

Though rare, anaphylactoid reactions have been reported with metaxalone.

### OVERDOSAGE

Deaths by deliberate or accidental overdose have occurred with metaxalone, particularly in combination with antidepressants, and have been reported with this class of drug in combination with alcohol.

When determining the LD<sub>50</sub> in rats and mice, progressive sedation, hypnosis and finally respiratory failure were noted as the dosage increased. In dogs, no LD<sub>50</sub> could be determined as the higher doses produced an emetic action in 15 to 30 minutes.

**Treatment**—Gastric lavage and supportive therapy. Consultation with a regional poison control center is recommended.

### DOSAGE AND ADMINISTRATION

The recommended dose for adults and children over 12 years of age is one 800 mg tablet three to four times a day.

### HOW SUPPLIED

SKELAXIN (metaxalone) is available as an 800 mg oval, scored pink tablet inscribed with 8667 on the scored side and "S" on the other. Available in bottles of 100 (NDC 60793-136-01) and in bottles of 500 (NDC 60793-136-05).

Store at Controlled Room Temperature, between 15°C and 30°C (59°F and 86°F).

### Rx Only

Prescribing Information as of April 2007.



King Pharmaceuticals

Distributed by: King Pharmaceuticals, Inc., Bristol, TN 37620  
Manufactured by: Mallinckrodt Inc., Hobart, NY 13788



**Patients with brittle diabetes are more likely to have psychiatric disorders or psychosocial problems.**

DR. HIRSCH

population lacks IgA, Dr. Hirsch warned. Before looking for the antibody, measure IgA levels to make sure they're normal. If IgA is absent, the antibody test "becomes worthless," he said.

► **Gastroparesis.** Considering this "makes sense. If you have a mismatching of food and insulin, it makes the diabetes that much more difficult to control," Dr. Hirsch said.

► **Injection and pump sites.** Check these, because lipodystrophy may cause severe insulin resistance. Although the use of protease inhibitors is the most common cause of lipodystrophy in the general population, congenital lipodystrophy is the most frequent cause in Dr. Hirsch's patient population. Patients with congenital lipodystrophy typically get referred to him from a lipid clinic for severe hypertriglyceridemia and insulin resistance.

► **Timing of insulin injections.** Bad timing in relation to food intake probably is the most common mistake made in insulin therapy, he said. Problems with timing of injections usually won't disrupt a patient's life to the point of frequent hospitalizations, but they "certainly will cause glycemic instability," he said.

► **Psychological or psychiatric problems.** These can interfere with diabetes management, so a mental health evaluation is a key part of the work-up for most patients with brittle diabetes. Frequent episodes of diabetic ketoacidosis usually result from patients' not taking their insulin, Dr. Hirsch said. Severe depression can make it difficult for a patient to manage diabetes.

The mental health evaluation "is best performed by someone knowledgeable about diabetes, particularly with experience in eating disorders, because that's the big issue, especially in adolescents," he said. ■



www.kingpharm.com www.skelaxin.com

SKELAXIN is a registered trademark of King Pharmaceuticals Research and Development, Inc., a wholly owned subsidiary of King Pharmaceuticals, Inc.

Copyright © 2008 King Pharmaceuticals, Inc.

All rights reserved.

SKE5180

02/2008