Hemorrhoid disease is one of the most frequently occurring, disabling conditions of mankind. We report the results of 120 patients with symptomatic internal and mixed hemorrhoid disease treated with direct current (d.c.) via a dual-tipped disposable needle probe (negative electrode). Evaluation and treatment utilized an operative anoscope which visualized one-eighth of the anal canal. Five hundred ninety segments revealed hemorrhoid disease (grade I = 114, 2 = 222, 3 = 178, 4 = 76). One or more segments (highest grade) were treated per office visit. Symptoms, frequency, and mean number of treatment applications per patient for complete symptom resolution were: bleeding, 85%, 4.0; protrusion, 58%, 3.9; pain, 52%, 3.6; and pruritus, 49%, 3.9. Ablation of hemorrhoid disease grade was directly correlated with milliampere current and time of application. No major complications occurred. All patients were successfully treated and remained symptom-free at a mean duration of follow-up of 23 months. Direct current electrotherapy is an effective, painless, and safe outpatient treatment approach to all grades of internal and mixed hemorrhoid disease.

INTRODUCTION

Hemorrhoid disease is one of the most frequently occurring and disabling conditions of mankind. Because of controversy in the definition of “hemorrhoids” (1), the consensus of the Advisory Panel of the Food and Drug Administration will be used in this text: “Hemorrhoids are abnormally large or symptomatic conglomerates of blood vessels, supporting tissues, and overlying mucous membrane or skin of the anorectal area” (2).

It is estimated that one-third of the population of the United States has symptomatic internal hemorrhoids (3) with an incidence of 50% at age 50 yr (4). Further, up to 80% of both sexes will have the symptoms of hemorrhoids at some time in their lives (5). Patients frequently postpone examination because of concern of pain associated with a particular treatment modality, hospitalization, cost, and time of disability. Such a delay in evaluation may lead to progression of the hemorrhoid disease, or late diagnosis of serious colorectal problems.

Direct current (d.c.) electrotherapy of hemorrhoid disease represents an alternative therapeutic approach that off-sets the above concerns. This method was first utilized in 1867. A comprehensive review of the subject was published by Wilbur E. Keesey, M.D., in 1934 (6). However, this approach to hemorrhoid disease was not advanced, nor has it enjoyed wide attention in the medical community.

The following represents the results of a study utilizing d.c. electrotherapy in the treatment of hemorrhoid disease. In addition, advancement in technology is presented.

METHODS

Subjects

One hundred twenty consecutive patients with symptomatic hemorrhoid disease completed d.c. electrotherapy. All underwent historical review, and visual and digital examination. No bowel preparation, oral or parenteral medication therapy, was required. Digital and anoscopy were performed with an anesthetic jelly lubricant. Anoscopy was performed with the Hinkle-James rectal speculum with an operative port exposing one-eighth of the circumference of the anal canal. Subjects with source other than hemorrhoid disease accounting for their symptomatology were excluded from the study.

Anoscopy

At anoscopy, eight segments were visualized with the patient in the right lateral position. Segment 1 is on the patient's left, and additional segments are numbered clockwise. Internal hemorrhoid disease was graded according to the method of Banov et al. (1): grade 1, tuft of hemorrhoidal tissue without prolapse through the anal canal; grade 2, prolapse with straining and spontaneous reduction; grade 3, prolapse with straining requiring manual reduction; and grade 4, nonreducible prolapse. Mixed hemorrhoid disease occurs when a vascular communication of diseased internal to the external hemorrhoid vasculature is present.
Direct current electrotherapy instrumentation

The current generator was developed to provide smooth d.c. current from 110 V a.c. The delivery of d.c. current to the hemorrhoid is by a probe handle and sterile disposable dual probe tip. The handle was designed for single hand application and incorporates milliampere and time display and controls for timer reset, initiation and cessation of current flow to the probe tip, and increase or decrease of current flow. Probe tips may be rotated in the handle for ease of application. The probe is the negative electrode and grounding pad the positive electrode (Microvasive Inc., Watertown, MA).

Direct current electrotherapy technique

With the patient in the right lateral position, the grounding pad was positioned securely, generally beneath the dependent thigh. The probe tip assembly was secured in the treatment handle in the horizontal position for left and right disease and vertical position for anterior and posterior disease. The hemorrhoid to be treated was isolated in the anoscope operative post. The hemorrhoid to be treated was isolated in the anoscope operative post. The probe tip was placed on, but not inserted into, the uppermost portion of the hemorrhoid, in the longitudinal axis of the vessel and at a slight angle to the anal canal (Fig. 1.). Inquiry as to the sensation of the probe tip by the patient was made, and if sensation was present, the probe tip was repositioned. The current was then initiated and raised to 2 mA. The probe tip then was advanced 0.5 cm into the hemorrhoid vessel. Further penetration is prevented by covering insulation. Current was increased over a 1- to 2-min period to a maximum of 16 mA or to patient tolerance. A rapid increase in current may be sensed as a dull ache, often avoided by a more gradual increase. Individuals noting discomfort at less than 16 mA were treated at a lower milliampere. Upon completion of treatment, the current was slowly decreased to zero by continuous depression of the appropriate control, after which the probe and anoscope were removed.

One or more hemorrhoid segments were treated per office visit. The highest grade(s) of disease was treated first. If, on evaluation, a previously treated segment revealed any grade of hemorrhoid disease, additional treatment was applied and the data incorporated into that segment. Patients returned for evaluation of prior and additional treatment after 10–14 days.

Completion of the treatment was defined as a complete anoscopy without the presence of hemorrhoid disease (all segments grade 0) in 99 patients and resolution of all symptoms with residual grade 1 hemorrhoid disease in one or more segments in 21 patients.

Follow-up data regarding symptomatology was obtained by direct contact. If symptoms suggestive of hemorrhoid disease were elicited, anoscopy was performed for diagnosis. Asymptomatic patients did not undergo anoscopy at follow-up.

Student's t test was used for statistical evaluation of data comparing hemorrhoid grades, and values were considered to be significantly different with $p < 0.05$. Data are expressed as mean ± SD (range).

RESULTS

One hundred twenty patients (74 male 46 female), mean age 48 (range 21–86) yr, underwent evaluation...
for symptomatic hemorrhoid disease and treatment utilizing d.c. electrotherapy.

The mean duration of symptoms was 119 (range 0.1 to 804) months. The mean number of months of symptoms correlated directly with grade of hemorrhoid disease; however, significant overlap between duration of symptoms and hemorrhoid grade exists (Table 1). Surgical hemorrhoidectomy had been performed in 12.5% of patients prior to d.c. current therapy and was performed with similar frequency in all hemorrhoid grade groups. Medical therapy, including prescription topical cream and/or suppositories and over-the-counter preparations, including stool-bulking agents, had been used by 85 patients and was similar for each grade. Long-standing hemorrhoid symptoms did not require a trial of topical therapy prior to d.c. current treatment. Symptoms at presentation and number of treatment applications required for complete resolution of these symptoms are presented in Table 2. The most common symptom was rectal bleeding in 85%, followed by internal hemorrhoid protrusion through the anal canal (58%), pain (52%), and pruritus (49%). The mean number of treatment applications for complete resolution of these symptoms was 4.0, 3.9, 3.6, and 3.9, respectively.

A total of 590 segments with hemorrhoid disease were treated. With eight segments evaluated per patient, this represented a mean of 4.92 segments with hemorrhoid disease. There were 114 grade 1, 222 grade 2, 178 grade 3, and 76 grade 4 hemorrhoids. Twenty-six patients had grade 2, 46 patients grade 3, and 37 patients grade 4 as maximal involvement (Table 1). There was a direct correlation of successful therapeutic resolution of hemorrhoid disease grade severity with mean milliampere current and duration of application of d.c. electrotherapy (Table 3, p < 0.01, comparing each hemorrhoid grade with another). On average, grade 1 hemorrhoid disease required 9.5 mA for 7.9 min and grade 4 required 12.2 mA for 14.3 min. More than one treatment application to a diseased hemorrhoid segment was required in about 20% of grades 1, 2, and 3 hemorrhoid disease and in 33% of grade 4 disease (Table 3). In general, this reapplication was related to patient sensitivity with resultant low milliampere application at the initial approach to that segment. Most hemorrhoid disease (78%) was successfully treated with one d.c. current application. The mean number of treatments and retreatment requirements for each hemorrhoid grade is shown in Table 3. A grade 1 hemorrhoid required two or more treatment applications in 23 of 114 segments (20%). Fifty-one applications were applied to these 23 segments for a mean of 2.22 retreatments in the retreatment group. Incorporating the retreatment group into the total grade 1 segments treated results in an overall requirement of 1.25 treatment application for ablation of grade 1 hemorrhoid disease.

All patients were successfully treated (ablation of all hemorrhoid disease in 99 patients and asymptomatic with residual grade 1 hemorrhoid disease in one or more segments in 21 patients, without visible scar tissue) and continued symptom free at a mean duration of follow-up of 23 (range 1-70) months. If a patient was treated until asymptomatic (21 patients) with residual grade 1 disease remaining, this residual was not treated and, therefore, not incorporated into treatment of grade 1 hemorrhoid disease. No major complications occurred. One patient experienced a vasovagal episode with syncope for 10 s immediately after d.c. current therapy without sequelae. He subsequently returned for

### Table 2

<table>
<thead>
<tr>
<th>Symptom</th>
<th>No. of treatments (±SD) for symptom resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Patients</td>
<td></td>
</tr>
<tr>
<td>Bleeding</td>
<td>85</td>
</tr>
<tr>
<td>Protrusion</td>
<td>58</td>
</tr>
<tr>
<td>Pain</td>
<td>52</td>
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<tr>
<td>Pruritus</td>
<td>49</td>
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</table>

### Table 3

<table>
<thead>
<tr>
<th>Hemorrhoid Disease</th>
<th>Total Treatment for Resolution (±SD)*</th>
<th>Mean No. of Treatments to Asymptomatic</th>
<th>Retreatment Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mA† ± Min‡</td>
<td>mA × min</td>
<td>No. of Segments</td>
</tr>
<tr>
<td>Grade 1</td>
<td>9.5 ± 2.3</td>
<td>7.9 ± 4.6</td>
<td>1.25</td>
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<tr>
<td>Grade 2</td>
<td>11.0 ± 2.2</td>
<td>9.4 ± 19.5</td>
<td>1.28</td>
</tr>
<tr>
<td>Grade 3</td>
<td>12.1 ± 2.5</td>
<td>11.0 ± 7.6</td>
<td>1.38</td>
</tr>
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<td>Grade 4</td>
<td>12.2 ± 3.4</td>
<td>14.3 ± 10.6</td>
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</tr>
<tr>
<td>Total</td>
<td>1.36</td>
<td></td>
<td>129</td>
</tr>
</tbody>
</table>

* Resolution to Grade 0; each grade compared to another significant at p < 0.01.
† mA, milliampere.
‡ Min, minutes.
treatment without adverse effect. One patient experienced pain following treatment, relieved in hours with a sitz bath. Subsequent treatment was not associated with post-procedure pain.

DISCUSSION

An effective, safe, and generally painless procedure for the outpatient treatment of internal and mixed hemorrhoid disease is presented. A therapeutic approach initially performed in 1867 and described in detail in 1934, this application of d.c. current in the treatment of hemorrhoid disease was virtually abandoned as a modality directed at a very common debilitating illness. Literature review reveals no recent publications on, or references to, this approach to hemorrhoid disease. Further, no instrumentation for the application of d.c. current to a diseased hemorrhoid could be found on direct contact of major medical and chiropractic supply houses in the western United States.

An instrument incorporating safety and ease of operator use was developed. The generator was designed to provide direct current to a probe handle and tip from 110V a.c. A controlled gradual delivery or withdrawal of current avoids the discomfort associated with sudden current change. Ease and comfort of treatment application is provided by a probe handle with data display and controls which allow single-hand use. The ability to rotate the probe tip in the handle offsets the need for significant rotation of the handle in treating different areas of the anorectal canal. Sterile-disposable probe tips offset the risk of potentially transmittable disease.

Patients were examined and treated in the right lateral position (in contrast to the traditional left lateral position used in sigmoidoscopic and colonoscopic procedures) allowing for greater comfort while holding the anoscope. The bend of the knees of the patient in this position allows table space to rest the operator's left elbow while holding the anoscope handle with the left hand. In this study, the operative anoscope allowed visualization of one-eighth of the anal canal circumference. The anal canal was, therefore, divided into eight segments. Direct current electrotherapy was applied to 590 hemorrhoid disease segments of 120 patients. Traditionally, three primary (left lateral, right posterior, and right anterior) and two secondary (left posterior and left anterior) positions of internal hemorrhoids are described (4). Therefore, overlap occurred in anatomical origin versus treatment localization of internal hemorrhoids in this study.

The mean number of hemorrhoid segments per patient was about 5. Direct current electrotherapy was directed at the highest grade hemorrhoid first, with one or more segments treated per office visit. Symptoms of bleeding, hemorrhoid protrusion through the anal canal, pain, and pruritus were resolved after treatment of an average of four segments. Overall, a second or more treatments of a particular segment was required in 22%. This was generally in patients intolerant of higher milliamperes of d.c. application. Low milliampere application requires a longer time of treatment. This group of patients resulted in a high variability of treatment requirements. However, most diseased hemorrhoids were successfully treated with a single treatment application (78%).

Our initial experience was directed toward ablation of all diseased hemorrhoid segments. Later patients underwent treatment until asymptomatic, often leaving low-grade hemorrhoid disease untreated. In that hemorrhoid therapy is directed toward symptoms in the vast majority of patients, the latter approach seems most appropriate. Should symptoms recur, patients are encouraged to present for evaluation and additional treatment and are generally willing to do so.

No treatment failures were encountered. This may relate to our approach to our patient population regarding retreatment. Two grade 4 and one grade 3 hemorrhoid required a total of six treatment applications to resolve to grade 0. Two grade 4, three grade 3, and one grade 2 hemorrhoid required five treatment applications. In general, symptoms improved with successive treatments, and repeated visits were acceptable to these patients.

No major complications occurred in the treatment of 590 diseased hemorrhoid segments. Minor complications were noted in two patients. One patient experienced a vasovagal episode with syncope for 10 s after treatment without apparent sequelae. He returned for additional treatment without adverse effect. One patient experienced rectal pain after treatment, which resolved in hours with a sitz bath. This did not occur with subsequent treatment. Direct current therapy of hemorrhoid disease is a safe treatment approach.

Direct current in milliamperes and time applied was directly correlated with disease grade ($p < 0.01$ comparing each grade to another). The milliampere-minute ($mA \times \text{min}$) product may be used as a guide in treatment requirements. A grade 2 hemorrhoid, on average, has a $mA \times \text{min}$ of 99 (Table 3). This implies that 10 mA applied will require about 10 min or 14 mA, 7 min of treatment. Other indicators of successful treatment are a deepening of the treated segment, indicating thrombosis, or a cessation of the popping sounds of gas release at the probe tip, indicating cessation of blood flow at the treatment position.

Some patients noted a sense of dull nonlocalized aching of the rectum at higher milliamperage. A decrease of milliamperage resolved this complaint. Thus, correctly applied, this therapeutic modality achieved a painless ablation of internal and mixed hemorrhoid...
disease. This was possible for several reasons. First, somatic sensory innervation decreases through the transitional zone of the anal canal and terminates at the dentate line (4). Treatment above the dentate line should, therefore, be painless. Second, the probe tip is placed on the hemorrhoid base above the dentate line prior to current flow, and the patient is asked about sensation. If sensed, it is repositioned. Third, current flow is initiated and brought to 2 MA, slowly. Depression of the current increase or decrease button results in gradual current change. Some patients may sense the tip at this time, allowing for a decrease to zero current and repositioning. A low milliampere current flow allows for ease in probe tip tissue penetration. A needle-sharp tip is not required if this technique is used. Fourth, after tip insertion into the hemorrhoid base, additional current flow is applied slowly. Increasing 2 to 4 mA every 15–30 s is generally well tolerated. A patient may be intolerant of moderate milliampere values during the first several minutes of therapy, after which a very gradual increase in current may be applied without discomfort. This may relate to local effects of direct current on the rectal autonomic innervation during the first portion of the treatment session with resultant desensitization.

The precise mechanism of action of direct current to bring about resolution of hemorrhoid disease is not known. Thrombosis of the hemorrhoid vascular network and associated vasa vasorum with eventual tissue resorption or slough is the postulated end result (7). When applied to hemorrhoid tissue, the negative pole of direct current could theoretically result in vascular thrombosis directly or, in events, eventually precipitating thrombosis by several mechanisms. 1) Generation of heat at the probe tip. Using a mean body resistance of 1000 ohms, 10 mA current flow results in an applied voltage of 10 V. Voltage times amperes equals watts. one watt of current applied for 1 h is equivalent to 860 calories or the ability to raise 860 ml of water 1°C in 1 h. Applied to the treatment of hemorrhoid disease, 10 mA is equal to 0.1 W applied. If applied for 10 min, a maximum of 14.3°C could result—probably an insufficient mechanism to bring about this therapeutic effect. In support of the lack of participation of direct current-generated heat are preliminary data using a thermister technique to measure tissue temperature between the dual probe tips. There was no significant temperature change when 10 mA were applied for 5 min to the mesenteric vein of the dog (Dennis M. Jensen, M.D., personal communication). 2) Direct trauma to the hemorrhoid vascular network by the probe tip. The significant difference of milliampere-minute product for treatment of different hemorrhoid grades demonstrates that trauma by the probe tip alone is insufficient to bring about disease resolution. 3) Vascular spasm of hemorrhoid network or associated vasa vasorum. It is well established that direct current applied to a solution of salt (NaCl), as present in a tissue environment, results in the hydroxyl molecule of water binding to sodium. This may result in membrane water shifts with resultant intracellular constituent concentration. An increase in cytosolic CA** concentration may initiate a CA**-dependent phosphorylation reaction with resultant smooth muscle contraction (8). 4) A chemical reaction (Fig. 3). Direct current results in the disassociation of water to OH− and H*/ which occurs at 1.2 V. Depending on the concentration of NaCl, NaCl will dissociate with the formation of NaOH at the negative electrode. Hydrogen gas is a resultant by-product of the formation of NaOH and is released. Tissue destruction by NaOH might then result in the release of thrombogenic substances. This chemical reaction results in tissue volume loss. This mechanism may explain the tissue shrinkage we observed and has been described with direct current application to hemorrhoid disease (6). Additionally, if the true positive electrode for the above reactions is within the hemorrhoid vascular network because of tissue resistance factors to current flow, rather than the applied grounding pad, free chlorine gas from Cl− oxidation may contribute directly (thrombogenesis) or indirectly (tissue destruction) to the hemorrhoid clotting process. Finally, other ions than Na* and Cl− may be oxidized or reduced by direct current application to hemorrhoid disease and contribute to the results presented.

Direct current offsets many concerns raised with other hemorrhoid therapies. It is successful on all grades of internal and mixed hemorrhoid disease. Properly applied, the procedure is painless. No bowel preparation, anesthetic, or medication is required. Patients are able to resume normal activities immediately after therapy. No major and only rare minor complications without sequelae dictate the safety of the procedure. Apparent sustained symptom resolution can be expected, and patient acceptance is good. However, more than one treatment is required in about one-fourth of
hemorrhoids, while the average treatment of hemorrhoids is approximately 11 min. Hence, successful treatment overall requires a dedication to the approach. Finally, the asymptomatic follow-up period is relatively limited to date, and continued study is required.

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REFERENCES