ORIGINAL ARTICLE

Reflux probability in saphenous veins of women with different degrees of chronic venous insufficiency

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J Vasc Bras. 2007;6(3):238-45.

ABSTRACT

Background: Presence of reflux in saphenofemoral and saphenopopliteal junctions represents important data for indication of varicose vein surgery. Studies demonstrated that in most patients with chronic venous insufficiency junctions are competent and reflux is present in segments in the course of saphenous veins.

Objectives: To identify the probability of different reflux patterns in the saphenous veins of women with various degrees of chronic venous insufficiency and to evaluate whether junction impairment is associated with severity of venous insufficiency.

Methods: A total of 1,184 lower limbs of 672 women were evaluated by color-flow Doppler ultrasonography and classified according to clinical, etiologic, anatomic and pathophysiological classification (CEAP). The extremities were divided according to severity of venous insufficiency into three groups: mild (CEAP C1-C2), moderate (CEAP C3) and severe (CEAP C4-C6). Bayes' theorem was used to evaluate CEAP classification as a predictor of reflux patterns. The association between CEAP clinical classification and reflux patterns with or without saphenofemoral and saphenopopliteal insufficiency was analyzed using chi-square test ($p < 0.05$).

Results: Out of 1,184 lower limbs, 50.2% had varicose veins without edema (CEAP C2). The most common reflux pattern was the segmental in both great (35.14%) and small (8%) saphenous vein, regardless of severity of venous insufficiency. Saphenofemoral and saphenopopliteal junctions were the source of reflux in 12 and 6% of lower limbs, respectively. Considering the association between CEAP clinical class and saphenous vein insufficiency, there was significant difference between presence of reflux in saphenofemoral ($p = 0.0009$) and saphenopopliteal ($p = 0.0006$) junctions in advanced disease.

Conclusions: Venous reflux begins mainly in saphenous vein segments. Saphenous vein junctions are not the main sources of reflux in the superficial venous system. Risk of reflux in saphenous vein junctions increases with clinical severity of chronic venous insufficiency.

Keywords: Venous insufficiency, varicose veins, saphenous vein, ultrasonics, Doppler.

RESUMO

Contexto: A presença de refluxo nas junções safeno-femoral e safeno-poplítea é um dado importante para programação da cirurgia de varizes. Estudos mostraram que, na maioria dos pacientes com insuficiência venosa crônica, as junções estão competentes, e o refluxo está presente ao longo do trajeto das veias safenas.

Objetivos: Identificar probabilidade de diferentes padrões de refluxo nas veias safenas de mulheres com vários graus de insuficiência venosa crônica e avaliar se o comprometimento das junções das safenas está associado com gravidade da insuficiência venosa.

Métodos: Um total de 1.184 membros inferiores de 672 mulheres foram estudados pela ultra-sonografia vascular com Doppler colorido e avaliados pela classificação clínica, etiológica, anatômica e patológica (CEAP). As extremidades foram agrupadas de acordo com a gravidade da insuficiência venosa em graus leve (CEAP C1-C2), moderado (CEAP C3) e grave (CEAP C4-C6). Para avaliar a classificação clínica CEAP na predição do padrão de refluxo, utilizou-se o Teorema de Bayers. Para avaliar associação entre classificação clínica CEAP e padrões de refluxo com ou sem comprometimento das junções das safenas, utilizou-se o teste qui-quadrado ($p < 0,05$).

Resultados: Das 1.184 extremidades avaliadas, 50,2% apresentavam varizes sem edema (CEAP C2). O padrão de refluxo segmentar foi o mais freqüente nas veias safenas magna (35,14%) e parva (8%), independente da gravidade da insuficiência venosa. As junções safeno-femoral e safeno-poplítea foram fontes de refluxo em 12 e 6% das extremidades, respectivamente. Considerando a associação entre classificação clínica CEAP e insuficiência das junções das safenas, foi observada diferença significativa entre presença de refluxo nas junções safeno-femoral ($p = 0,0009$) e safeno-poplítea ($p = 0,0006$) na doença avançada.

Conclusões: O refluxo inicia-se predominantemente em segmentos no trajeto das veias safenas. As junções das safenas não são as principais fontes causadoras do refluxo no sistema venoso superficial. À medida que piora a apresentação clínica da insuficiência venosa, aumenta a probabilidade de refluxo nas junções das safenas.

Palavras-chave: Insuficiência venosa, varizes, veia safena, ultra-som, Doppler.

Introduction

Presence of chronic venous insufficiency (CVI) is easily identified by the symptoms present by the patient and by inspection of lower limbs. Physical examination can provide information about presence, location and extension of valve insufficiency. However, accurate identification of reflux sources in the venous system is only possible through investigation by complementary diagnostic means. Such complementary information is important for diagnosis improvement, for treatment planning, as well as for a better understanding of the disease natural history. Color-flow Doppler ultrasound (CFDU) is able to accurately identify distribution and extension of venous reflux. This examination has become a choice method for peripheral venous assessment.[1,2]

CFDU allows identification of reflux patterns and preoperative mapping for varicose vein surgery. Presence of reflux in the saphenofemoral junction (SFJ) and saphenopopliteal junction (SPJ) is important data for surgical planning. Recent studies carried out with CFDU showed that, in most

patients with CVI, SFJ and SPJ are competent. These patients have reflux in isolated or multiple segments along the great and short saphenous veins.[3-7]

By adopting the clinical, etiologic, anatomic and pathologic classification (CEAP), it was possible to study specific groups of patients with the same evolution stage of CVI. Such approach allows a more precise definition of the guidelines to treat these patients.[8]

This study aims at identifying probability of different reflux patterns in great saphenous veins of women with varied degrees of CVI and assessing whether SFJ and SPJ impairment is associated with clinical severity of venous insufficiency.

Method

Only female patients were included in the study, with signs or symptoms of CVI, primary etiology, resulting from valve insufficiency (reflux), consecutively assessed by CFDU.

Male patients were excluded, as well as women with previous history of deep venous thrombosis or varicose vein surgery and women with CVI resulting from congenital vascular malformation.

This study was approved by the Research Ethics Committee in human beings of Pontifícia Universidade Católica do Paraná (PUCPR) under protocol number 876.

Clinical assessment

Lower limbs were clinically classified when the examination was performed by the vascular sonographer, according to CEAP classification[8] in seven clinical classes: C_0 = absence of visible or palpable signs of venous disease; C_1 = telangiectasia or reticular vein; C_2 = varicose veins; C_3 = edema; C_4 = skin changes resulting form venous disease (pigmentation, eczema, lipodermatosclerosis); C_5 = skin changes with healed ulcer; C_6 = skin changes with active ulcer.

To evaluate association between SFJ and SPJ insufficiency and CVI clinical severity, lower limbs were divided into three evolutionary stages: mild (CEAP classes C_1 and C_2), moderate (CEAP class C_3) and severe (CEAP classes C_4 to C_6), based on natural history of CVI, similar to the classification suggested by Porter et al.[8]

Color-flow Doppler ultrasound assessment

The patients were assessed using a color-flow Doppler ultrasound device Siemens,® model Elegra,® initially to exclude recent or previous venous thrombosis, with the patient in a supine position, through cross-sectional ultrasound sections in B mode and maneuvers of vein compressibility, using low frequency transducers (5 MHz).

The study of great and short saphenous veins was performed with the patient standing erect, with high frequency transducer (7 MHz), to obtain vein images in longitudinal ultrasound sections in B mode. With the aid of color-flow imaging, reflux was assessed using Valsalva's maneuver and manual muscle compression distal to the transducer. Quantification of reflux of saphenous veins was based on van Bemmelen's criteria,[9] with peak reflux equal or higher than 30 cm/s being considered significant or upper reflux duration longer than half a second.

Assessment of reflux patterns in great and short saphenous veins

Based on detection of reflux in great and short saphenous veins, six reflux patterns were identified:[4]

-Perijunctional reflux pattern: characterized by reflux in the SFJ or SPJ, drained by tributary veins of the SFJ or SPJ, with maintenance of valve competence in the main saphenous vein.

-Proximal reflux pattern: characterized by reflux in the SFJ or SPJ and in the main saphenous vein, originated directly from the femoral or popliteal veins through the SFJ or SPJ, drained by superficial tributary veins or perforating vein in the topography of the leg and thigh, with maintenance of valve competence in the rest of the saphenous vein.

-Distal reflux pattern: characterized by absence of reflux in the SFJ or SPJ and in the proximal main saphenous vein. Presence of reflux in the saphenous vein until the perimalleolar region, caused by superficial tributary vein or perforating vein in the topography of the leg or thigh.

-Segmental reflux pattern: characterized by a single segment of the saphenous vein with reflux, in the topography of the leg and/or thigh, with no involvement of the SFJ or SPJ, caused and drained by tributary or perforating vein.

-Multisegmental reflux pattern: characterized by two or more segments of the saphenous vein with reflux in the topography of the leg and/or thigh. This reflux pattern is subdivided into multisegmental with reflux in the SFJ or SPJ and multisegmental with no reflux in the SFJ or SPJ.

-Diffuse reflux pattern: characterized by reflux in the whole main saphenous vein extension, from the SFJ or SPF to the perimalleolar region.

Statistical analysis

To assess CEAP clinical classification in predicting reflux patterns, Bayes' theorem was used, with the aim of estimating probability for each reflux pattern, according to clinical classification. Probabilities for each reflux pattern, as well as conditional classifications of mild, moderate or severe for each reflux pattern were estimated by results in the study sample.

The chi-square test was used to evaluate the association between CEAP clinical association and reflux patterns with and without SFJ or SPJ involvement. P values ≤ 0.05 were defined as statistically significant.

Results

A total of 1,184 lower limbs were assessed in 672 female patients, aged between 17-87 years, mean of 41 years. Of the 1,184 lower limbs assessed, 601 were right, 583 were left and 158 were bilateral examinations.

According to CEAP classification, most lower limbs (50.25%) had varicose veins with no edema (CEAP C_2) (Table 1).

Table 1 - Grouping of patients according to CEAP classification (clinical)

CEAP classification					
1	2	3	4	5	6
288	595	273	21	4	3
24.33%	50.25%	23.05%	1.78%	0.34%	0.25%

Great saphenous vein assessment

Among the 1,184 lower limbs assessed, there was no reflux in the great saphenous vein in 29.47% of cases. In 835 great saphenous veins with reflux, the following reflux patterns were detected: 1.07%, perijunctional reflux pattern; 7.66%, proximal pattern; 12.81%, distal pattern; 49.82% segmental pattern; 19.40%, multisegmental pattern not involving JSF; 5.38%, multisegmental pattern involving JSF; and 3.83%, diffuse pattern.

Of 288 great saphenous veins in limbs identified as CEAP C_1, 157 (54.51%) had no reflux, and 87 (30.21%) had segmental reflux. The great saphenous veins of limbs identified as CEAP C_2, C_3 and C_4 had segmental reflux, respectively, in 214 (35.97%) 104 (38.10%) and nine (42.86%). Among great saphenous veins of limbs identified as CEAP C_5, two (50%) had multisegmental reflux, and in CEAP C_6there was a similar proportion of absent, segmental and diffuse patterns (33.33%) in each limb (Table 2).

Table 2 -Association between reflux patterns in the great saphenous vein and CEAP classification

Reflux pattern	CEAP classification (clinical)						Total (%)
	1	2	3	4	5	6	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Without	157 (54.51)	140 (23.53)	51 (18.67)	0 (0.00)	0 (0.00)	1 (33.33)	349 (29.47)
I - Perijunctional	2 (0.69)	4 (0.67)	3 (1.10)	0 (0.00)	0 (0.00)	0 (0.00)	9 (0.76)
II - Proximal	5 (1.74)	32 (5.38)	24 (8.79)	2 (9.52)	1 (25.00)	0 (0.00)	64 (5.41)
III - Distal	18 (6.25)	65 (10.92)	23 (8.42)	1 (4.76)	0 (0.00)	0 (0.00)	107 (9.04)
IV - Segmental	87 (30.21)	214 (35.97)	104 (38.10)	9 (42.86)	1 (25.00)	1 (33.33)	416 (35.14)
V - Multisegmental with SFJ	2 (0.69)	34 (5.71)	8 (2.93)	1 (4.76)	0 (0.00)	0 (0.00)	45 (3.80)
V - Multisegmental without SFJ	13 (4.51)	95 (15.97)	46 (16.85)	6 (28.57)	2 (50.00)	0 (0.00)	162 (13.68)
VI - Diffuse	4 (1.39)	11 (1.85)	14 (5.13)	2 (9.52)	0 (0.00)	1 (33.33)	32 (2.70)
Total	288 (100)	595 (100)	273 (100)	21 (100)	4 (100)	3 (100)	1184 (100)

% = percentage of cases; multisegmental with SFJ = multisegmental pattern with involvement of the SFJ; multisegmental without SFJ = multisegmental pattern with no involvement of the SFJ; n = number of cases; SFJ = saphenofemoral junction; without = absence of reflux.

Probability of finding segmental reflux in the great saphenous vein in classes C_1, C_2, C_3, C_4, C_5 and C_6 is, respectively, 30.21, 35.97, 38.10, 42.86, 28.57 and 28.57% (Table 3).

Table 3 -Probability of reflux patterns in the great saphenous vein in different degrees of CVI

Reflux pattern	C_1 (%)	C_2 (%)	C_3 (%)	C_4 (%)	C_5 and C_6 (%)
Without	54.51	23.53	18.68	0.00	14.29
I - Perijunctional	0.69	0.67	1.10	0.00	0.00
II - Proximal	1.74	5.38	8.79	9.52	14.29
III - Distal	6.25	10.92	8.42	4.76	0.00
IV - Segmental	30.21	35.97	38.10	42.86	28.57
V - Multisegmental with SFJ	0.69	5.71	2.93	4.76	0.00
V - Multisegmental without SFJ	4.52	15.97	16.85	28.57	28.57
VI - Diffuse	1.39	1.85	5.13	9.53	14.29
Total	100	100	100	100	100

% = percentage of cases; CVI =chronic venous insufficiency; multisegmental with SFJ = multisegmental pattern with involvement of the SFJ; multisegmental without SFJ = multisegmental pattern with no involvement of the SFJ; n = number of cases; SFJ = saphenofemoral junction; without = absence of reflux.

Among limbs with reflux, presence of reflux in the SFJ was identified in only 12.67%. Considering the association between the CEAP classification and SFJ insufficiency, there was statistically significant difference (p = 0.0009) between presence of SFJ reflux and later stages of the disease. The percentage of great saphenous veins with SFJ reflux was lower in cases with mild CEAP classification (10.65%), increasing in cases of moderate (17.95%) and severe (25%) classification.

Short saphenous vein assessment

Among 1,184 limbs assessed, 79.81% had no short saphenous vein reflux. In lower limbs with short saphenous vein reflux, 41% had segmental reflux pattern.

Of 288 legs classified as CEAP C_1, 265 (92.01%) had no short saphenous vein reflux, and eight (2.78%) had segmental reflux. Segmental reflux was observed in 61 (10.25%), 24 (8.79%) and four (19.05%) of 595 limbs classified as CEAP C_2, C_3 and C_4, respectively. Of short saphenous veins classified as CEAP C_5, two (50%) had distal reflux, and in CEAP C_6, two (66.67%) had diffuse pattern (Table 4).

Table 4 -Association between reflux patterns in the short saphenous vein and CEAP classification (clinical)

Reflux pattern	CEAP classification (clinical)						Total
	1	2	3	4	5	6	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Without	265 (92.01)	474 (79.66)	193 (70.70)	11 (52.38)	2 (50.00)	0 (0.00)	945 (79.81)
II - Proximal	6 (2.08)	30 (5.04)	14 (5.13)	0 (0.00)	0 (0.00)	0 (0.00)	50 (4.22)
III - Distal	5 (1.74)	22 (3.70)	28 (10.26)	3 (14.29)	2 (50.00)	0 (0.00)	60 (5.07)
IV - Segmental	8 (2.78)	61 (10.25)	24 (8.79)	4 (19.05)	0 (0.00)	1 (33.33)	98 (8.28)
V - Multisegmental with SPJ	1 (0.35)	0 (0.00)	2 (0.73)	0 (0.00)	0 (0.00)	0 (0.00)	3 (0.25)
V - Multisegmental without SPJ	1 (0.35)	8 (1.34)	5 (1.84)	0 (0.00)	0 (0.00)	0 (0.00)	4 (1.19)
VI - Diffuse	0 (0.00)	0 (0.00)	6 (2.20)	3 (14.29)	0 (0.00)	2 (66.67)	11 (0.93)
I - Perijunctional	2 (0.69)	0 (0.00)	1 (0.37)	0 (0.00)	0 (0.00)	0 (0.00)	3 (0.25)

% = percentage of cases; multisegmental with SPJ = multisegmental pattern with involvement of the SPJ; multisegmental without SPJ = multisegmental pattern with no involvement of the SPJ; n = number of cases; SPJ = saphenopopliteal junction; without = absence of reflux.

If clinical class is C_1, then the probability the patient has of presenting short saphenous vein reflux is 92.01%. If it is $C_{2 \text{ and }} C_4$, the probability of the patient presenting segmental reflux pattern in the short saphenous vein is 10.25% and 19.05%, respectively. If clinical class is C_3, then the probability the patient has of presenting distal reflux in the short saphenous vein is 10.26%. For classes C_5 and C_6, the patient has the same probability of presenting diffuse and distal reflux and absence of reflux (28.57%).

The probability of not finding reflux in the short saphenous vein in classes C_1, C_2, C_3, C_4, C_5 and C_6 is, respectively, 92.01, 79.66, 70.70, 52.39 and 28.57% (Table 5).

Table 5 -Probability of reflux patterns in the short saphenous vein in different degrees of CVI

	Classification (%)		
	Mild (C_1 and C_2)	Moderate (C_3)	Severe (C_4, C_5 and C_6)
Reflux pattern	n (%)	n (%)	n (%)
Without	739 (83.69)	193 (70.70)	13 (46.42)
II - Proximal	36 (4.08)	14 (5.13)	0 (0.00)
III - Distal	27 (3.06)	28 (10.26)	5 (17.86)
IV - Segmental	69 (7.81)	24 (8.79)	5 (17.86)
V - Multisegmental with SPJ	1 (0.11)	2 (0.73)	0 (0.00)
V - Multisegmental without SPJ	9 (1.02)	5 (1.83)	0 (0.00)
VI - Diffuse	0 (0.00)	6 (2.20)	5 (17.86)
I - Perijunctional	2 (0.23)	1 (0.36)	0 (0.00)
Total	883 (100)	273 (100)	28 (100)

% = percentage of cases; CVI =chronic venous insufficiency; multisegmental with SPJ = multisegmental pattern with involvement of the SPJ; multisegmental without SPJ = multisegmental pattern with no involvement of the SPJ; n = number of cases; SPJ = saphenopopliteal junction; without = absence of reflux.

Among cases with reflux, presence of SPJ impairment was identified in only 5.66%. Considering the correlation between CEAP classification and SPJ insufficiency, there was a statistically significant difference (p = 0.0006) between SPJ insufficiency and later stages of CVI. The percentage of short saphenous veins with SPJ reflux was lower in limbs with mild CEAP classification (4.19%), increasing in cases of moderate (8.06%) and severe (17.86%) classification (Table 5).

Discussion

CVI is a prevalent disease with relevant social consequences, accounting for high costs with treatment and absenteeism, especially in cases of venous ulcer. It is estimated to affect about 5-20% of the adult population in developed countries; of these, 3.6% are cases of active or healed venous ulcer.[10,11]

The most widely used classification for CVI clinical assessment is the CEAP classification. Stratification of patients in different clinical classes allows specific populations with CVI to be studied with regard to their peculiarities. However, issues related to the origin of reflux in the superficial venous system and the relationship between CVI clinical severity and reflux sources still have to be better investigated.

The *Edinburg Vein Study* assessed, among the general population, 1,566 people aged between 18-64 years, of whom 124 had complaints compatible with CVI. Prevalence of the disease in this population was 9.4% in women and 6.6% in men, and approximately 1/3 of these patients had independent reflux in the superficial venous system. Also in that study, the higher CVI severity, the higher the incidence of reflux.[12]

CFDU is considered the choice method to assess venous reflux, since it allows detecting and measuring reflux, providing anatomic and functional details of veins, as well as identifying reflux patterns, their main sources and draining points, and allowing venous screening.[13] All those

characteristics allow the patient to have both individualized diagnosis and treatment.

Venous reflux can originate from valve insufficiency in communication points between the deep and superficial venous system (SFJ, SPJ and direct perforating veins) or from independent reflux sources, such as pudendal, perineal, gluteal and indirect perforating veins (with no direct communication with saphenous veins). Labropoulos et al.[13] assessed the superficial venous system of 860 patients using CFDU and observed presence of reflux in superficial tributary veins originated form independent source of refluxes of saphenous veins in 9.7% of cases.

In a similar study, Seidel et al.[14] studied the sources of superficial reflux of 1,712 patients with normal saphenous veins and found 43% of independent reflux of saphenous veins. According to the authors, a likely explanation for the higher incidence of reflux in relation to the previous study could be related to the individual characteristics of assessed populations.

In this study, sources of independent reflux of great and short saphenous veins were assessed, as well as their relation with CVI severity, therefore without any attempt of identifying independent sources of reflux. Reflux patterns were identified in short and great saphenous veins and SFJ and SPJ impairment as direct sources of reflux.

Identification of reflux patterns in saphenous veins allows individual diagnosis and treatment for different CVI classes. However, there is no standardization in the literature as to how superficial reflux can be identified. Based on the classification adopted in this study, independent segmental reflux was the most frequently found, both in the great (35%) and short (8%) saphenous vein. Such data are corroborated by Labropoulos et al.'s findings,[5] who identified 68% of reflux located in infrapatellar segments of the great saphenous vein, followed by 55% of reflux located in suprapatellar segments of the great saphenous vein. SFJ and SPJ incompetence, according to those authors, was detected in 32 and 6% of assessed limbs, respectively.

As to SFJ and SPJ involvement in the genesis of saphenous vein reflux, Jutley et al.,[6] in a retrospective study of 223 limbs of 176 patients with primary varicose veins, found SFJ and SPJ incompetence in 30 and 9%, respectively. On the other hand, Wills et al.[15] studied 315 limbs of 188 patients with complaints of CVI and found greater involvement of SFJ and SPJ in, respectively, 63 and 19% of lower limbs. However, it should be stressed that, in the study by Wills et al., patients with previous treatment of lower limb varicose veins (38%) were included.

Abu-Own et al.,[16] in a study of 190 limbs, and Cooper et al.,[17] in a study of 706 limbs, reported change in SFJ in 67 and 54% of cases, respectively. In both studies, patients of both genders were assessed, mean age of 48 and 50 years, with primary varicose veins.

In the present study, SFJ and SPJ impairment in 1,184 assessed limbs was, respectively, 12.6 and 5.6%. Explanation for the lower incidence of SFJ and SPJ reflux could be related to selection of populations in different studies. In selection criteria, only women were included, with primary CVI, no history of varicose vein surgery or deep venous thrombosis. Therefore, a specific population of patients was studied, different from other authors who selected mixed populations of women, men, patients with previous history of thrombosis or surgery, among other factors.[5,6,15]

The results of this study show that, different from what was thought, reflux in the superficial venous system is not predominantly originated from the SFJ and SPJ, but in most cases in independent or multiple segments, along the whole extension of saphenous vein, caused by tributary veins or direct perforating veins. It was observed that, as CVI worsens clinically, the probability of SFJ and SPJ reflux increases, since there was a significant difference in prevalence of SFJ and SPJ insufficiency in later stager of the disease.

In this study, only 2.37% (n = 28) of lower limbs were in more advanced stages of CVI (CEAP

classes C_4, C_5 and C_6). Prevalence of lower limbs in CEAP C classes$_4$, C_5 and C_6 found in this study corroborates the findings in the literature, which report prevalence of 1 to 3.6% of active or healed venous ulcer cases in patients with CVI.[10,11]

However, despite that large difference as to prevalence of lower limbs in CEAP classes C_1, C_2 and C_3, statistical analysis showed a tendency of greater probability of SFJ and SPJ reflux in more advanced stages of venous disease.[10,11]

The findings of this research reinforce the need of individual approach to different CVI degrees in specific populations. Women in different clinical classes can present peculiar characteristics when compared between themselves or with male populations. Women with any degree of CVI should have a segmental reflux screened in CFDU examination, since this pattern has the highest probability of being responsible for clinical findings. In addition, the low probability of SFJ and SPJ reflux has a great preservation potential of saphenous veins in patients with indication of varicose vein surgery.

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Manuscript received February 26, 2007, accepted June 14, 2007.