Objective: Vascular depression (VaD) hypothesis supports a bidirectional relationship between cerebrovascular risk factors (CRFs) and depression. We examined whether such concept is appropriate for clinical interventions; i.e., whether treating depressive symptoms has an impact on cerebrovascular risk and vice-versa. Method: Systematic review on interventional studies published from October-1997 to April-2010 on MEDLINE and other databases. Search terms were “depressive disorder” (MeSH), “cerebrovascular disorders” (MeSH), and a batch of highly accurate terms to search for experimental and quasi-experimental trials. We used a structured questionnaire to assess the adequacy of the VaD criteria used for vascular, depression, neuroimaging, and neuropsychological features, as well as the main results of each study. Results: Of the 357 retrieved studies, 12 met our eligibility criteria. These studies adequately reported depression criterion, moderately reported neuroimaging and neuropsychological criteria, and showed severe flaws in vascular assessment. Efficacy trials suggested that nimodipine, transcranial magnetic stimulation, carotid stent placement, and citalopram were effective for VaD. Exploratory studies suggested that white-matter hyperintensities and global vascular risk are predictors of poor response. Although the low quality of the studies hinders the findings' generalization, studies of higher validity support the VaD concept for interventions. Conclusion: VaD seems to be a useful concept for clinical interventions; however, further trials should refine CRFs criteria to assess its impact on antidepressant efficacy.

Received on July 6, 2010; accepted on August 5, 2011
Intervenções terapêuticas para a depressão vascular: uma revisão sistemática

Resumo

Objetivo: A hipótese da depressão vascular (DV) defende uma correlação bidirecional entre fatores de risco cerebrovasculares e depressão. Nós investigamos se este conceito é apropriado para intervenções clínicas - ou seja, se o tratamento de sintomas depressivos modifica o risco cerebrovascular e vice-versa. Método: Revisão sistemática de estudos intervencionistas publicados entre outubro 1997 e abril 2010 nos bancos de dados MEDLINE e outros. Os unitermos procurados foram “depressive disorder” (MeSH), “cerebrovascular disorders” (MeSH) e um conjunto de termos altamente acurados para procurar por estudos experimentais ou quasi-experimentais. Nós usamos um questionário estruturado para examinar se os critérios de DV usados para depressão, vascular, neuroimagem e neuropsicológicos foram adequados, e os resultados principais de cada estudo. Resultados: De 357 artigos obtidos, 12 foram inclusos. Eles relataram adequadamente o critério de depressão, moderadamente os critérios neuropsicológicos e da neuroimagem e apresentaram erros graves no critério vascular. Estudos de eficácia sugeriram que nimozipina, estimulação magnética transcraniana, stent de carótida e citalopram são efetivos para DV. Estudos exploratórios sugeriram que hiperintensidades de substância branca e risco vascular global são preditores de pior resposta. Apesar da baixa qualidade dos estudos limitar a sua generalização, estudos de maior qualidade corroboraram o conceito de DV para intervenções. Conclusão: DV parece ser um conceito útil para intervenções clínicas, porém estudos futuros devem reforçar os critérios cerebrovasculares para identificar sua importância na eficácia do tratamento antidepressivo.

©2011 Elsevier Editora Ltda. Todos os direitos reservados.

Introduction

Major depressive disorder and cerebrovascular disorder are related conditions. First, they share similar environmental risk factors (high prevalence of smoking, poor dietary habits, lack of physical exercise) and endophenotypes (autonomic dysfunction, inflammation, platelet aggregation). Also, there is an increased prevalence in depressive symptoms in patients with diabetes mellitus, hypertension, and other cerebrovascular risk factors (CRFs). In fact, the term “Vascular Depression” (VaD), initially proposed by Alexopoulos and colleagues in 1997, is often used to acknowledge such relationship, emphasizing that cerebrovascular disease may “predispose, precipitate, or perpetuate” a depressive syndrome. One year later, Steffens and Krishnan also supported the term “vascular depression” after reviewing neuroimaging findings in patients with mood disorders.

Moreover, as stated by Kendell and Jablensky, a diagnostic entity must have “validity”, i.e., the syndrome definition should have natural boundaries separating it from related disorders, and “utility”, i.e., given that many psychiatric diagnoses present blur boundaries, the diagnostic concept should at least provide useful information regarding etiology and treatment response. Indeed, cross-sectional and longitudinal studies have supported that VaD has content, predictive, and discriminant validity, although the neuroimaging finding “white matter hyperintensity” was more accurate in predicting VaD than other “classic” cerebrovascular risk factors (CRFs), such as age, diabetes mellitus, arterial hypertension, smoking, and so on. Moreover, assuming its validity, it is difficult to explain certain observations such as the soaring incidence of CRFs in the elderly, which is not accompanied by a corresponding increase in depression; or the absence of significant association between depression and other robust CRFs such as hypercholesterolemia and smoking. Therefore, some authors suggested that VaD is better described as “subcortical ischemic depression” rather than as a “vascular depression”.

Along these lines, a key question is whether VaD is useful for therapeutic purposes; for instance, whether treatment of CRFs has an impact on depression symptoms; or depression treatment diminishes vascular risk in VaD. This is also critical for clinical practice, as both conditions (depression and cerebrovascular disorders) are becoming more prevalent with the ageing population. Nevertheless, although previous (systematic and comprehensive) reviews evaluated construct validity, biological plausibility, causality, neuroimaging findings and discriminant validity, none, to the best of our knowledge, scrutinized the VaD concept for interventional studies. Therefore, we systematically reviewed all studies proposing therapeutic interventions for VaD.

Method

Our systematic review was conducted according to the recommendations of the Cochrane group, and the present report follows PRISMA guidelines, which also recommends addressing the acronym “PICOS” (Patient, Intervention, Comparator, Outcome, Study design). Here, “P” is vascular depression; “I” is therapeutic interventions (both depression and vascular); “C” is placebo group or, in quasi-experimental studies, healthy volunteers, usual care or absent; “O” is improvement of depression symptoms; and “S” represents experimental and quasi-experimental studies. These terms are detailed below.

Literature review

We performed a systematic review of published articles from October 1997 (after the first Alexopoulos’ articles describing the concept of “vascular depression”) to April 2010 in the following databases: MEDLINE, Web of Science, EMBASE,
LILACS, and the Cochrane Central Register of Controlled Trials (CENTRAL). As VaD is not a MeSH term, an issue here was identifying articles that evaluated VaD although not directly referring to this condition. Therefore, all authors elaborated a step-wise search strategy. Initially, the search terms browsed in MEDLINE database were:

#1 “depressive disorder, major” (MeSH term);
#2 “depressive disorder” (MeSH term);
#3 “vascular depression”;
#4 “white matter hyperintensity”;
#5 “cerebrovascular disorders” (MeSH Term));

Subsequently, the following searches were performed: #1 AND #4 AND #6, #1 AND #5 AND #6, #3 AND #6, #2 AND #4 AND #6, #2 AND #5 AND #6. The references that were present in all search strategies were identified (Boolean term AND) and subtracted from each search strategy for identifying additional articles (Boolean term NOT). We could then identify the search strategy #2 AND #5 AND #6 as the most sensible and specific, and therefore it was used in the present review.

Similar search strategies were performed in other databases using correspondent terms (Appendix).

Finally, we also examined reference lists in systematic reviews and retrieved papers, and contacted experts on the field for identifying additional articles.

Eligibility criteria

We adopted the following inclusion criteria: (1) manuscript written in English, Spanish or Portuguese; (2) articles on Vascular Depression treatment; (3) experimental studies; (4) quasi-experimental studies. We excluded: (1) other designs, such as case reports, series of cases, case-controls and longitudinal studies; (2) studies assessing other conditions, such as post-stroke depression, vascular dementia; (3) non-original studies, including editorials, reviews, and letters to the editor.

Data extraction

For each study, data were extracted independently by two authors (ARB and IMB). Discrepancies were resolved by consensus, and the third author (TCA) consulted if needed. The following variables were extracted according to a structured checklist previously elaborated by the authors:

1. demographic and clinical characteristics, such as total sample (number), age (years), gender (percent of females), and type of therapeutic intervention;
2. assessment of cerebrovascular risk factors, i.e., whether systemic arterial hypertension, diabetes, smoking, dyslipidemia, obesity, and atrial fibrillation were evaluated (classified in “not evaluated”, “evaluated with medical records/clinical interview” and “prospectively evaluated through physical/laboratory exams”), and the use of composite risk scores (such as Framingham score);
3. assessment of major depression; including method for diagnosing (clinical interview, structured checklist) and assessment of depression characteristics (severity, refractoriness, concomitant use of medications, duration of index episode);
4. neuroimaging assessment i.e., whether neuroimaging evaluation was performed (classified in “not evaluated”, “evaluated through medical records/clinical interview” and “prospectively evaluated with a brain scan”) and, if so, which instrument was used (Computed Tomography, Magnetic Resonance Imaging, others). Also, we evaluated how the findings were classified in either dichotomic (presence vs. absence of lesions) or ordinal (scales assessing severity of lesions);
5. neuropsychological evaluation; we assessed whether it was performed (“not evaluated”, “evaluated through medical records/clinical interview” and “prospectively evaluated with a brain scan”), and which instruments were used;
6. outcomes, in which we described each study main results.

Quality assessment

We performed individual and comprehensive quality assessment for each study, focusing on two critical methodological issues:

1) internal validity — we followed Cochrane guidelines to evaluate bias risk in randomization/allocation (selection bias), blinding (performance bias), control comparison (performance bias), and outcome assessment and reporting (attrition,
measurements and reporting bias). For quasi-experimental
designs we adopted the classification of the Cochrane Non-
Randomized Studies Methods Group,19 in which the designs
were classified as “before-and-after” design (one-group
pretest-posttest design) and “controlled before-and-after
study (i.e., an intervention group plus a control group).

2) construct validity — whether the operational criteria
used for “vascular depression” and “cerebrovascular risk
factors” were appropriate; i.e., whether each study attended
the following criteria, as first defined by Alexopoulos and col-
leagues13: a) depression onset in subjects older than 65 years
or change in depression course; b) neuroimaging evidence
doors for vascular disease; c) clinical/laboratorial evidence
of cerebrovascular risk factors (CRFs), and the supporting
criteria; and d) neuropsychological impairment.

Quantitative analysis
Foreseeing that the number of studies would be low (as
the concept of VaD is relatively new and still under dispute
in literature) and between-study heterogeneity would be
important (as we chose to include experimental and quasi-
experimental study designs), we initially aimed not to per-
form any quantitative analysis, including meta-analysis and
techniques of meta-regression. Thus, quantitative analysis
was limited to descriptive statistics (mean, frequency, and
others). Therefore, we critically reviewed the main findings
of the studies and addressed their limitations.

Results
According to our search strategy, 357 references were ini-
tially found. Most were excluded after browsing the title and
abstract, as they were reviews, editorials, letters and studies
on stroke, dementia, and post-stroke depression. Thirty
articles were further retrieved for full-text assessment.
In this phase, 18 studies were excluded as they employed
longitudinal, cross-sectional, case series, and retrospec-
tive designs. Thus, 12 articles were included in our review
(Figure 1). Importantly, one reference described two studies20
although only the “sertraline” study was considered, as the
“citalopram” study did not evaluate CRFs.

The twelve included studies assessed 811 women and
664 men, with vascular depression (total = 1,475 subjects;
mean and SE = 123 ± 31 per study) and mean age of 62.3 (3.1)
years. Five studies performed pharmacological antidepressant
interventions; three studies used transcranial magnetic
stimulation (TMS) as a therapeutic tool; two studies treated
patients with the anti-hypertensive nimodipine; one with
cholesterol-lowering drugs; and one with carotid stenting
(Table 1).

Six studies were primarily designed to evaluate the effi-
cacy of one intervention for amelioration of depressive
symptoms in VaD. Two studies compared nimodipine versus
vitamin C21 and placebo,22 with patients also receiving an-
tidepressant drugs. In both studies, the nimodipine group
presented a greater response. Two studies evaluated TMS
efficacy for VaD, one study was small, open-label, with only
11 subjects;23 while the other24 was a randomized, sham-
controlled trial with 92 patients. In the pilot study, five
of 11 patients achieved response, while in the larger trial
active TMS was superior than sham TMS. The latter study
had a follow-up in which citalopram (20 mg/day) was given
to 13 rTMS- responders; after nine weeks, nine remained
responders.25 Finally, another open study26 tested whether
carotid stent placement improved depressive symptoms in

---

**Figure 1** Flow diagram showing the search strategy, number of records identified, included and excluded, and the reasons for exclusions, based on PRISMA guidelines.
patients with asymptomatic high-grade carotid stenosis (but not necessarily depression); observing that, of 48 patients with depressive symptoms, the number significantly dropped to 14 (9.8%, \( p < 0.01 \)) after four weeks.

The other six studies investigated whether CRFs, neuroimaging and neuropsychological testing were moderators, mediators, or predictors of antidepressant treatment. Four studies tested antidepressant drugs; one study tested the drug used on TMS; and another study evaluated the effects of cholesterol-lowering drugs, in which the authors observed that using such drugs was associated with an earlier relapse of depressive symptoms.\(^{27}\) The TMS study, a randomized, sham-controlled trial, used quantitative EEG as a predictor variable, observing that responders (vs. non-responders) had lower baseline low-theta power in the anterior cingulated cortex.\(^{28}\) One study of fluoxetine evaluated whether CRFs were moderators of treatment outcome,\(^{29}\) observing that the composite risk score was associated with poor response. Another study by the same group\(^{30}\) evaluated frequency and severity of white matter hyperintensities as moderators of treatment response, suggesting an association between lesion laterality and non-remission. Also, one study using sertraline evaluated severity of white matter hyperintensities as moderators of response, showing non-conclusive findings.\(^{31}\) Finally, one study of sertraline evaluated CRFs, MRI findings, and neuropsychological testing as predictors of response, finding that these variables were associated with non-remission\(^{11}\) (Table 1).

Regarding cerebrovascular assessment, five of 12 studies did not report clearly whether and which specific CRFs (dyslipidemia, hypertension, diabetes, smoking, obesity, atrial fibrillation) were assessed, as they just reported that patients “fulfilled vascular depression criteria”. Three studies assessed CRFs based on clinical interview and/or medical records, while four performed laboratory testing. The exception was atrial fibrillation, which was considered in only one study when composing the cerebrovascular risk score. In fact, six of 12 studies did not calculate a cerebrovascular risk score; four studies used CIRS (a score that calculates overall burden of medical illness); one study used their own score; and only one study used the Framingham risk score (Table 2).

Regarding depression assessment, seven studies made diagnosis using structured scales based on DSM-IV, through clinical interview, and one did not formally diagnosed depression, using a self-assessment questionnaire to index depression prevalence and severity. The remaining 11 studies used the Hamilton or Montgomery-Asberg scales to evaluate severity. All studies except one evaluated duration of index depressive episode. Three studies did not evaluate treatment-resistant depression. Finally, only four studies evaluated patients already on antidepressant drugs, the other eight studies either discontinued drugs or recruited drug-naïve patients before trial (Table 2).

Nine of 12 studies performed neuroimaging, all using Magnetic Resonance Imaging (MRI). Two of nine studies evaluated MRI findings in ‘presence vs. absence’ of lesions, while the other seven used objective criteria to assess the frequency and severity of findings, particularly white matter hyperintensities. In addition, eight of 12 studies performed neuropsychological assessment, three of which used only the Mini Mental State

### Table 1 Summary of the main characteristics and findings of each study

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Fem (%)</th>
<th>Age (y)</th>
<th>Objective</th>
<th>Intervention</th>
<th>Main Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taragano et al.(^{21})</td>
<td>84</td>
<td>71</td>
<td>65.5</td>
<td>Efficacy</td>
<td>nimodipine</td>
<td>Nimodipine + AD superior to Placebo + AD (response of 45% vs 25%, ( p = 0.05 ))</td>
</tr>
<tr>
<td>Salloway et al.(^{20})</td>
<td>59</td>
<td>40</td>
<td>69.2</td>
<td>Exploratory</td>
<td>Sertraline</td>
<td>WMH severity was not associated with response.</td>
</tr>
<tr>
<td>Steffens et al.(^{27})</td>
<td>244</td>
<td>58</td>
<td>69.8</td>
<td>Exploratory</td>
<td>Cholesterol-lowering</td>
<td>Intervention associated with increased relapse.</td>
</tr>
<tr>
<td>Fabre et al.(^{23})</td>
<td>11</td>
<td>54</td>
<td>67.9</td>
<td>Efficacy</td>
<td>TMS</td>
<td>Five of 11 patients achieved response in this open trial.</td>
</tr>
<tr>
<td>Taragano et al.(^{22})</td>
<td>101</td>
<td>54</td>
<td>69.8</td>
<td>Efficacy</td>
<td>nimodipine</td>
<td>Nimodipine + Fx superior to Placebo + Fx (response of 74% vs. 53%, ( p = 0.03 ))</td>
</tr>
<tr>
<td>Iosifescu et al.(^{28})</td>
<td>384</td>
<td>55</td>
<td>39.8</td>
<td>Exploratory</td>
<td>Fluoxetine</td>
<td>Global vascular risk associated with nonresponse.</td>
</tr>
<tr>
<td>Mlekusch et al.(^{26})</td>
<td>143</td>
<td>65</td>
<td>68</td>
<td>Efficacy</td>
<td>Carotid stenting</td>
<td>Intervention reduced depressive symptoms (33.6% to 9.8%, ( p = 0.01 ))</td>
</tr>
<tr>
<td>Iosifescu et al.(^{27})</td>
<td>84</td>
<td>40</td>
<td>40</td>
<td>Exploratory</td>
<td>Fluoxetine</td>
<td>WMH laterality (but not severity) associated with non-response.</td>
</tr>
<tr>
<td>Jorge et al.(^{24})</td>
<td>92</td>
<td>55</td>
<td>63</td>
<td>Efficacy</td>
<td>TMS</td>
<td>Response rates were 38% vs. 6.8% for the active group (( p &lt; 0.01 ))</td>
</tr>
<tr>
<td>Robinson et al.(^{25})</td>
<td>13</td>
<td>69</td>
<td>63.8</td>
<td>Efficacy</td>
<td>Citalopram</td>
<td>4 of 13 patients relapsed in 9 weeks in this follow-up study.</td>
</tr>
<tr>
<td>Narushima et al.(^{32})</td>
<td>43</td>
<td>58</td>
<td>63.2</td>
<td>Exploratory</td>
<td>TMS</td>
<td>EEG findings associated with nonresponse.</td>
</tr>
<tr>
<td>Shefler et al.(^{29})</td>
<td>217</td>
<td>55</td>
<td>68.4</td>
<td>Exploratory</td>
<td>Sertraline</td>
<td>CRFs, MRI findings and neuropsychological assessment associated with nonresponse</td>
</tr>
</tbody>
</table>

TMS: Transcranial Magnetic Stimulation; AD: antidepressant; WMH: white matter hyperintensity; Fx: fluoxetine;
EEG: electroencephalography; CRFs: cerebrovascular risk factors; MRI: magnetic resonance imaging.
Regarding statistics, selective reporting bias was likely in the study by Salloway et al. Twenty-a sub-sample of a larger controlled trial was analyzed. Because selection criteria in assembling this sub-sample were not described, this study has a risk of sample bias (Table 3).

Seven studies were quasi-experimental; all employed a before-and-after design, with two also having matched control groups. Risk of sample bias was high in the studies by Steffens et al., and Mlekusch et al., due to poorly described sample composition. The same studies may have presented performance bias: the former assumed that patients using “cholesterol-lowering drugs” present higher cholesterol levels than those not using it (which can be quite the opposite), while the latter used self-reported questionnaires to diagnose depression (which is not an appropriate instrument). Regarding statistics, selective reporting bias was likely in the same mentioned studies, as positive outcomes were preferentially addressed than negative ones. Nevertheless, all studies were exploratory, i.e., performed several comparisons to explore relationships between depression, CRFs, MRI findings, and neuropsychological testing. Such studies have an inherent risk of performance bias: obtain one of 20 findings positive just by chance (for a p = 0.05) (Table 3).

Construct validity

In despite of the original Alexopoulos’ criteria, which established age, neuroimaging, clinical, neuropsychological, and phenomenological criteria for VaD, not a single study
Table 3  Quality assessment of each study

<table>
<thead>
<tr>
<th>Study</th>
<th>Selection bias</th>
<th>Reason</th>
<th>Performance bias</th>
<th>Reason</th>
<th>Attribut bias</th>
<th>Reason</th>
<th>Attrition bias</th>
<th>Reporting bias</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taragano et al. 31</td>
<td>Moderate</td>
<td>Inadequate randomization method</td>
<td>Moderate</td>
<td>Inadequate control group</td>
<td>Low</td>
<td>ITT analysis</td>
<td>Moderate</td>
<td>Evidence of selective reporting</td>
<td></td>
</tr>
<tr>
<td>Salloway et al. 32</td>
<td>Moderate</td>
<td>Sub-group of a larger sample</td>
<td>Low</td>
<td>Adequate control group</td>
<td>Moderate</td>
<td>Attrition not described</td>
<td>Moderate</td>
<td>Results not fully described</td>
<td></td>
</tr>
<tr>
<td>Jorge et al. 44</td>
<td>Low</td>
<td>Adequate RCT</td>
<td>Moderate</td>
<td>Vulnerable blinding method</td>
<td>Low</td>
<td>ITT analysis</td>
<td>Moderate</td>
<td>Evidence of selective reporting</td>
<td></td>
</tr>
<tr>
<td>Narushima et al. 53</td>
<td>Low</td>
<td>Adequate RCT</td>
<td>Moderate</td>
<td>Vulnerable blinding method</td>
<td>Moderate</td>
<td>CC analysis</td>
<td>Low</td>
<td>Adequate reporting</td>
<td></td>
</tr>
</tbody>
</table>

Table 4  Compatibility of the construct validity of Vascular Depression of each study, vis-à-vis Alexopoulos’ original criteria

<table>
<thead>
<tr>
<th>Construct validity</th>
<th>Number of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular</td>
<td>5</td>
</tr>
<tr>
<td>Depression</td>
<td>1</td>
</tr>
<tr>
<td>Neuroimaging</td>
<td>3</td>
</tr>
<tr>
<td>Neuropsychological</td>
<td>4</td>
</tr>
</tbody>
</table>

Studies considered “inadequate” were those in which the criterion was not assessed, not reported or imperfectly assessed; “partially adequate”, when the criterion was assessed but not adequately measured; “adequate”, when the criterion was fully and adequately assessed.
risk scores, and six used either the CIRS (which measures medical illness in general) or their own scores.

**Discussion**

We reviewed twelve studies assessing different therapeutic strategies for vascular depression. All studies explored the concept of VaD, either by performing efficacy trials for treating depression symptoms or by designing studies exploring the relationship between CRFs, neuropsychological assessment, MRI findings, and depression.

The efficacy trials explored the bidirectional relationship between CRFs and depression; i.e., whether treating one condition clinically benefits the other. Three interesting studies tested whether “vascular” interventions (nimodipine and carotid stenting) could ameliorate depression symptoms—a hypothesis that, if valid, would corroborate the concept of VaD and increase the therapeutic arsenal for this type of depression in clinical practice. Along these lines, a recent study showed that depressed patients present decreased cerebrovascular reactivity, which is a dilatory, compensating mechanism of cerebral vessels—decreased levels lead to low cerebral blood flow. Thus, nimodipine may have restored normal cerebrovascular reactivity and, as a consequence, blood flow, which could have ameliorated depressive symptoms. However, although showing positive outcomes, these studies had enormous methodological drawbacks that hinder their generalizability. Another three studies tested TMS efficacy in VaD (one of them was a follow-up study with citalopram). Although presenting positive findings, these studies, in fact, did not improve the validity of VaD, as no CRFs were evaluated before and after intervention; therefore, VaD was “simply” a late-onset, geriatric depression. Such studies should, for instance, have verified whether and which vascular risk factors improve when depression is treated; data that could be useful when tailoring treatment strategies for patients with high vascular risk.

The other studies explored the concept that cerebrovascular disease may “predispose, precipitate, or perpetuate” a depressive syndrome. The two studies focusing on baseline CRFs modifying antidepressant treatment response did show an association between non-remission and global vascular risk score, thus supporting that CRFs perpetuate depressive episodes. The relationship of white matter hyperintensities with poor treatment response was evaluated in three studies, with a positive correlation in two of them. Still, recent meta-analyses showed that these lesions are associated with late-onset depression (vs. early-onset) and also with an increased risk of stroke and dementia, supporting the theory of cerebrovascular disease and depression.

One major limitation of the present review is that most studies presented poor assessment and characterization of CRFs, as many of them did not either describe the sample’s cerebrovascular profile or described it insufficiently. It should be underscored, though, that the original criteria of vascular depression are vague in this topic. Nevertheless, the reviewed studies failed to translate the knowledge on cardiovascular risk factors established since the late 1980s: for instance, the most important risk factors (gender and age) are not emphasized in the original criteria, as age is a separate criterion and gender is not described as a risk factor. Similarly, although it is known that each 10-unit changes in systemic blood pressure (above 120 mmHg) doubles the risk for stroke, almost all studies did not evaluate this factor. Global cerebrovascular risk assessment was also problematic, as many studies employed their own-designed scores in which different CRFs (such as age, smoking, diabetes, hypertension, and others) are simply summed up to estimate global risk, not considering the different weights of each CRF. Therefore, it is essential that further studies assess and describe the major risk CRFs individually, as well as using validated scores to estimate the global cerebrovascular risk. Another limitation is the validity of the construct of Vascular Depression perse. The present criteria have low discriminant validity, i.e., it discriminates poorly from other close definitions, such as “late-life depression”, post-stroke depression, and vascular dementia. Future studies should refine diagnostic criteria to identify which signs and symptoms distinguish VaD.

**Clinical and research implications**

In spite of the aforementioned limitations, our findings suggest that VaD might be a useful concept for therapeutic purposes. In clinical practice, for instance, it might be useful to screen the vascular risk of elderly depressed patients as well as neuroimaging and neuropsychological assessment. Higher vascular risk seems to indicate poor antidepressant response and, perhaps, the need for assessing and managing CRFs as well. In clinical research, future major depression trials, especially in the elderly, should also assess the vascular profile of their sample in order to identify predictors of non-response. Moreover, further trials could also test whether “cerebrovascular drugs”, such as acetylsalicylic acid, have an impact in depression symptoms, and, conversely, whether antidepressants decrease global vascular risk scores in VaD patients.

Another area of research is exploring “new” CRFs, such as C-reactive protein, intima-media thickening, and heart rate variability, which are independently associated with depression and increased risk of cardiovascular events; and, therefore, they might also be implicated in vascular depression etiology. Along these lines, another interesting area is genomic studies, aiming to identify endophenotypes associated with treatment response. Finally, another promising strategy is to apply new methods of neuroimaging for assessing vascular depression, such as diffusion tensor imaging (DTI), a technique that may be useful in detecting small vessel brain lesions. Therefore, future studies could apply novel neuroimaging methods to characterize changes in brain activity during VaD treatment.

**Conclusion**

In conclusion, our review showed that although some VaD clinical trials do support the vascular hypothesis of depression, most interventional studies had their findings hampered due to the loose criteria adopted in sample selection. Further VaD trials should address cerebrovascular risk factors more extensively in order to explore their impact on antidepressant efficacy. Future trials should also address the antidepressant impact of diminishing the cerebrovascular risk to investigate the relationship between vascular disorders and depression.
Disclosures

Andre Russowsky Brunoni
Employment: Institute of Psychology, Universidade de Sao Paulo (USP), Brazil.
Isabela Martins Benseñor
Employment: Hospital Universitario; Universidade de Sao Paulo (USP), Brazil.
Tania Correa de Toledo Ferraz Alves
Employment: ABC Region Medical School; Department and Institute of Psychiatry, Universidade de Sao Paulo (USP), Brazil.

References


Therapeutic interventions for vascular depression: a systematic review


36. Debette S, Markus HS. The clinical importance of white matter hyperintensities on brain magnetic resonance imaging: systematic review and meta-analysis. BMJ. 2010;341:c3666.


44. Bjerkeset O, Romild U, Smith GD, Hveem K. The associations of high levels of C-reactive protein with depression and myocardial infarction in 9258 women and men from the HUNT population study. Psychol Med. 2011;41(2):345-52.

