

# Irreversible Electroporation: Disappearance of Observable Changes at Imaging Does Not Always Imply Complete Reversibility of the Underlying Causal Tissue Changes

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23 **Letter to editor**  
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9 We read with great interest Padia et al. article emphasizing the potential role of early MR  
10 assessment of irreversible electroporation (IRE) ablation in hepatocellular carcinoma (HCC)  
11 patients (1). We especially appreciated that authors pointed out that IRE efficacy cannot be assessed  
12 like for other physical ablative methods because cell death is no longer mainly related to thermal  
13 coagulative necrosis (2). One singularity of the technique is that below 600V/cm the change in  
14 permeability of cell membrane are assumed to be reversible (3). Thus, Padia et al. suggested that the  
15 transient changes seen at the periphery of IRE ablation zone on the early MR examinations were  
16 related to reversible effect of the treatment.  
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21 From our point of view, this explanatory hypothesis calls some comments. The biological effects of  
22 IRE on tissues are still unclear. Cell membrane electroporation leads to a swelling of the affected  
23 cells as well as a release of cellular materials, which generate edema and inflammation in the tissue  
24 (4). Such inflammation, visible with MRI disappears within few days (4, 5). On the other hand, it  
25 has been reported that reversible electroporation lasts several tens of minutes and any way much  
26 shorter that several hours (6). Interestingly, peripheral delayed enhanced zones have been also  
27 described with perfusion CT performed immediately after IRE in livers of pigs (7).  
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32 Histopathological analysis of livers harvested one day after showed a strong correlation between  
33 these peripheral zones and red zones which contained hepatocytes involved in terminal apoptotic  
34 process. Preliminary numerical simulations of IRE on tissue model showed also that the ablation  
35 zone induced is wider than its central necrotic part (8). Indeed, IRE is a multiprobe ablative  
36 technique requiring the placement of multiple electrodes into the tumor margin rather than in the  
37 centre of the lesion(9). In this setting, we suggest that the disappearance of peripheral delayed  
38 enhanced zones could be related to fast remodeling of apoptotic component of IRE ablation  
39 combining resolution of inflammation, phagocytosis and replacement of dead cells, and not  
40 necessarily to the recovery of basal membrane permeability of cells that were submitted to amount  
41 of energy bellow irreversibility threshold.  
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49 **References:**  
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- 52 1. Padia SA, Johnson GE, Yeung RS, Park JO, Hippe DS, Kogut MJ. Irreversible  
53 Electroporation in Patients with Hepatocellular Carcinoma: Immediate versus Delayed Findings at  
54 MR Imaging. *Radiology*. 2016;278(1):285-94.  
55 2. Edd JF, Horowitz L, Davalos RV, Mir LM, Rubinsky B. In vivo results of a new focal tissue  
56 ablation technique: irreversible electroporation. *IEEE Trans Biomed Eng*. 2006;53(7):1409-15.  
57 3. Davalos RV, Mir IL, Rubinsky B. Tissue ablation with irreversible electroporation. *Ann*  
58 *Biomed Eng*. 2005;33(2):223-31.  
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4. Mahmood F, Hansen RH, Agerholm-Larsen B, Gissel H, Ibsen P, Gehl J. Detection of electroporation-induced membrane permeabilization states in the brain using diffusion-weighted MRI. *Acta Oncol.* 2015;54(3):289-97.
5. Al-Sakere B, Andre F, Bernat C, Connault E, Opolon P, Davalos RV, et al. Tumor ablation with irreversible electroporation. *PLoS One.* 2007;2(11):e1135.
6. Marty M, Sersa G, Garbay JR, al. e. Electrochemotherapy—an easy, highly effective and safe treatment of cutaneous and subcutaneous metastases: results of ESOPE (European Standard Operating Procedures of Electrochemotherapy) study. *Eur J Cancer* 2006;Suppl(4):3–13.
7. Chung DJ, Sung K, Osuagwu FC, Wu HH, Lassman C, Lu DS. Contrast Enhancement Patterns after Irreversible Electroporation: Experimental Study of CT Perfusion Correlated to Histopathology in Normal Porcine Liver. *J Vasc Interv Radiol.* 2016;27(1):104-11.
8. Leguebe M, Silve A, Mir LM, Pognard C. Conducting and permeable states of cell membrane submitted to high voltage pulses: mathematical and numerical studies validated by the experiments. *J Theor Biol.* 2014;360:83-94.
9. Seror O. Percutaneous hepatic ablation: what needs to be known in 2014. *Diagn Interv Imaging.* 2014;95(7-8):665-75.