NON-THERMAL PLASMA INDUCTION OF PRE-
PROGRAMMED CELL DEATH IN MONOCYTIC 
LEUKEMIA CELLS*

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The need for new and effective mechanisms to induce 
programmed cellular death (apoptosis) in cancerous cells is of 
great importance in cancer research. Application of direct as 
well as indirect exposure of plasma for cancer research is still in 
the exploratory stage and there remain several unanswered 
questions. We have developed a portable non-thermal resistive 
barrier based air plasma source that can be operated in both 
direct and indirect exposure modes [1]. We are investigating 
the effects of indirect exposure of non-thermal air plasma on 
monocytic leukemia cancer cells (THP-1) and deciphering the 
mechanisms that modulate cellular induction of apoptosis. The 
phenotypes of interest were cells demonstrating death 
morphologies of apoptosis or necrosis. This is important since 
cells undergoing necrosis can initiate an inflamed immune 
response that can be detrimental to a treated individual. The 
type of morphological cell death that occurred in THP-1 for 
various plasma treatment dosages (plasma power, flow and 
distance) was investigated and the results will be reported. We 
were able to demonstrate a preference for apoptosis in plasma 
treated THP-1 cells under particular plasma parameters and 
dosage levels. The THP-1 cells were identified as apoptotic 
utilizing a fluorescent dye conjugated with annexin V 
followed by identification of the cells through fluorescent 
microscopy and flow-cytometry diagnostics. Further, DNA 
fragmentation assays, for late detection of apoptosis, 
correlated with are fluorescence data demonstrating patterns of 
apoptotic events. However, the data also revealed that higher 
plasma dosages presented with undesired necrotic 
morphologies in the THP-1 cells. The presented variabilities in 
the death morphologies by plasma treated THP-1 cells signify 
the need for further investigation on the cellular mechanisms 
induced by the indirect plasma exposure. Along with taking 
into account other death processes such as autophagy, a 
catabolic process involving the degradation of a cell's own 
components through the lysosomal machinery. The results 
obtained from this research indicate great potential for the use 
of our portable non-thermal resistive barrier based indirect 
plasma treatment method as an inexpensive and less invasive 
method for treating leukemia and other cancerous lesions.

[1.] Thiyagarajan, M, et. al. "THP-1 Leukemia Cancer 
Treatment Using a Portable Plasma Device." Health 

*Work supported by U.S. Army Medical Research & 
Materiel Command (USAMRMC) and the Telemedicine & 
Advanced Technology Research Center (TATRC) and NSF-
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