A step closer to treating oral cancer without surgery

Researchers in Mumbai have moved a step closer to treating surface tumours such as oral, breast and cervical cancer and other tumours such melanoma and colon cancer through photothermal ablation using gold-polymer nanoparticles and near infrared light. The researchers from Mumbai's Indian Institute of Technology (IIT) Bombay and Tata Memorial Centre have synthesised hybrid polymer-gold nanoparticles as photothermal agent to ablate solid tumours.

The near infrared light heats up the nanoparticles and the heated nanoparticles, in turn, can kill the cancer cells. Unlike other agents tried out by others, the hybrid nanoparticles used by the Mumbai team has no toxicity, is biodegradable and gets cleared from the body through urine.

The team led by Prof. Rohit Srivastava from the Department of Biosciences and Bioengineering at IIT Bombay and Dr. Abhijit De from the Molecular Functional Imaging Lab at ACTREC, Tata Memorial Centre used a thermoresponsive polymer (poly(N-vinyl caprolactam)) nanoshell which can be loaded with an anticancer drug. The polymer nanoshell is coated with gold nanoparticles.

Besides killing the cancer cells through thermal ablation, the polymer degrades at about 43 degree C and releases the drug to completely kill the tumour. Cancer cells get killed above 42 degree C.

"The gold nanoparticle coating is important. In its absence the temperature of the polymer does not rise to 43 degree C when we shine near infrared light," says Deepak S. Chauhan from the Department of Biosciences and Bioengineering at IIT Bombay and the first author of the paper published in the journal *RSC Advances*. "The polymer shrinks and disintegrates when ablated and releases the drug efficiently."

"We are pretty confident that the heat generated by the gold-polymer nanoparticles alone [when we shine laser] is sufficient to kill the cancer cells. Addition of a drug is possible but complicates the nanoparticle-production process," says Dr. De.

Studies carried out using breast cancer cell lines have been very encouraging. Preliminary studies on mice for breast cancer photoablation have also shown promising results. The cancer cells (cell lines and in animals) were killed using heat alone; no anticancer drug was used.

Phase I trial

"We are planning to carry out clinical trials (Phase I) on people with oral cancer," says Dr. De. "We have already carried out trials in animals and the efficiency is really encouraging. We were able to burn out the tumour in animals."

"We have already started all the process towards a Phase I trial. If no company or entity comes forward to produce the hybrid nanoparticles for the Phase I trial then we will set up a GMP facility ourselves at IIT Bombay," says Prof. Srivastava.

"If phototherapy alone is not 100% efficient then we can load the polymer nanoparticle with a drug to kill cancer cells," says Prof. Srivastava. "Oral cancer is largest subset of cancer in India. If we can make photoablation work it will be a simple therapy that can be used as outpatient procedure — inject the nanoparticles and just shine laser. There will be no need for surgery. I see tremendous potential using this technology." Besides oral cancer, breast and cervical cancers can also be treated the same way.

Quicker and safer

Unlike surgery, the thermal ablation procedure takes very less time. Once the nanoparticles are injected at the site of the tumour, one has to wait for 15-30 minutes for the nanoparticles to settle and spread in the cancer cells before shining the laser for 3-5 minutes. “In 30-40 minutes we can deliver effective treatment to individuals and thus as an outpatient service one can treat up to 15-20 patients a day easily,” says Dr. De.

Deep-seated tumour can also be treated with photoablation using catheter that can carry light. Right now the cable that delivers the laser is thicker. “Once we miniature it then can reach deeper tumours,” says Dr. De.

Contrast medium

The hybrid nanoparticles can be injected into the blood and need not be injected directly into the tumour. The nanoparticles are able to reach the tumour cells through enhanced permeability and retention effect.

Since the hybrid nanoparticles absorb light and can automatically reach the cancer cells when injected into blood, they can also be used as a contrast medium. Unlike the conventionally used iodine contrast medium for CT scan, the nanoparticles produce better contrast due to higher absorption coefficient (due to higher electron density) and at one-fifth the concentration.

Also, the gold nanoparticles get accumulated in tumour cells and so the contrast increases with time. Additionally, the gold nanoparticles have longer half-life and circulate in the body for a longer time and so imaging can be done for a longer time.

Lifestyle-related risk factors are being cited, compounded by an inadequate number of treatment centres in the region

Without policies to stop the worrying spread of antimicrobial resistance, the mortality rate could be disturbing

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