International Journal of Dentistry and Oral Science (IJDOS)
ISSN: 2377-8075

Awareness about Medicinal application of Gold Nanoparticles among Dental Students

Research Article

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Abstract

Introduction: Gold nanoparticles offer a wide range of uses, but when monodispersity is required, practical limits become obvious. Over the last 40 years, significant progress has been made in the manufacturing of gold nanoparticles with monodispersity and regulated size. The application of gold nanoparticles in biological and pharmaceutical fields, such as ultrasensitive detection and imaging approaches for bio reorganizing processes, is particularly appealing due to their unique optical features.
Aim: This survey was conducted for assessing the awareness about medicinal application of Gold nanoparticles amongst dental students.
Materials and Method: A cross-section research was conducted with a self-administered questionnaire containing ten questions distributed amongst 100 dental students. The questionnaire assessed the awareness about Gold nanoparticles therapy in medical applications, their anti-cancer properties, biodelivery applications, photothermal effects, DNA detection and Gene Diagnostic properties. The responses were recorded and analysed.
Results: 18% of the respondents were aware of the medicinal applications of Gold Nanoparticles .15 % were aware of anticancer properties of Gold Nanoparticles, 13 % were aware of biodelivery applications of Gold Nanoparticles, 10 % were aware of photothermal effects of Gold Nanoparticles, 10% were aware of DNA detection properties of Gold Nanoparticles and, 8 % were aware of Gene Diagnostic properties of Gold Nanoparticles.
Conclusion: There is limited awareness amongst dental students about use of Gold nanoparticles therapy in medical applications. Enhanced awareness initiatives and dental educational programmes together with increased importance for curriculum improvements that further promote knowledge and awareness of Gold nanoparticles therapy.

Keywords: Awareness; Gold; Nanoparticles; Students; Medicinal.

Introduction

Nanobiotechnology is a rapidly developing field in the analytical and biological sciences for the development of ultrasensitive detection and imaging tools. In current sciences, the interaction of nanotechnology with biology, chemistry, physics, and medicine is extremely important . The increasing availability of nanostructures with controlled optical characteristics has sparked interest in diagnostic and biological imaging applications [1, 2].

Nanoparticles have a higher permeability and retention impact in tumour tissues than in healthy cells, resulting in higher nanoparticle accumulation in tumour tissues. In addition to diagnostic advancements, nanotechnology improves the therapeutic index in cancer therapy, which is a measure of benefit to risk ratio. Nanoparticles' high surface area to volume ratio is also useful for loading medicines, enhancing solubility, stability, and pharmacokinetic characteristics [3].

Gold nanoparticles offer a wide range of uses, but when monodispersity is required, practical limits become obvious. Over the last 40 years, significant progress has been made in the manufacturing of gold nanoparticles with monodispersity and regulated size. The preparation of gold nanoparticles of various sizes is accomplished by reducing gold in the presence of a stabilizing chemical that inhibits particle aggregation. Gold nanoparticles have plasma resonance and a large surface area, which distinguishes them from other types of nanoparticles such as organic,

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Received: September 12, 2021
Accepted: September 20, 2021
Published: September 21, 2021

Citation: Dhanraj Ganapathy, Martina Catherine. Awareness about Medicinal application of Gold Nanoparticles among Dental Students. *Int J Dentistry Oral Sci.* 2021;8(9):4355-4358.
doi: http://dx.doi.org/10.19070/2377-8075-21000886

inorganic, and protein-based nanoparticles. The application of gold nanoparticles in biological and pharmaceutical fields, such as ultrasensitive detection and imaging approaches for biore organizing processes, is particularly appealing due to their unique optical features (surface plasma resonance [SPR] absorption and resonance light scattering) [4, 5]. Nanotechnology, which involves biology, chemistry, medicine and engineering, has a great potential for diagnosis and treatment of cancer. Our research experience has prompted us in pursuing this research [6-17]. This survey was conducted for assessing the awareness about medicinal application of Gold nanoparticles amongst dental students.

Materials and Methods

A cross-section research was conducted with a self-administered questionnaire containing ten questions distributed amongst 100 dental students. The questionnaire assessed the awareness about Gold nanoparticles therapy in medical applications, their anti-cancer properties, biodelivery applications, photothermal effects, DNA detection and Gene Diagnostic properties. The responses were recorded and analysed.

Results

18% of the respondents were aware of the medicinal applications of Gold Nanoparticles (Fig 1). 15 % were aware of anti-cancer properties of Gold Nanoparticles (Fig 2), 13 % were aware of biodelivery applications of Gold Nanoparticles (Fig 3), 10 % were aware of photothermal effects of Gold Nanoparticles (Fig 4), 10% were aware of DNA detection properties of Gold Nanoparticles (Fig 5) and, 8 % were aware of Gene Diagnostic properties of Gold Nanoparticles (Fig 6).

Discussion

Human cells and biological molecules such as enzymes, receptors, and antibodies are larger than nanoparticles. These nanoparticles have an extraordinary interaction with proteins on the surface and inside the cell due to their size range, making them useful in cancer diagnosis and treatment. Surgery, chemotherapy, and radiation therapy are all common cancer treatments. Photothermal therapy

Figure 1. Awareness of the medicinal applications of Gold Nanoparticles.

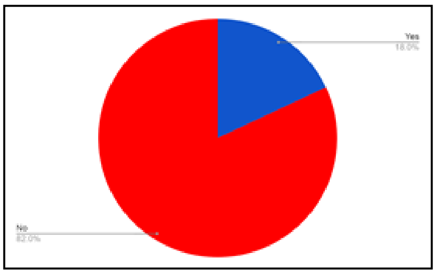


Figure 2. Awareness of the anti-cancer properties of Gold Nanoparticles.

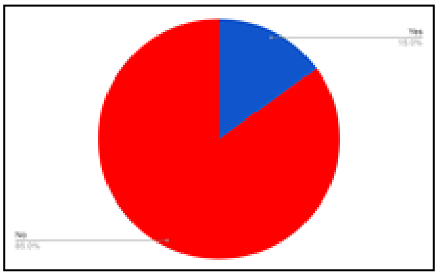


Figure 3. Awareness of biodelivery applications of Gold Nanoparticles.

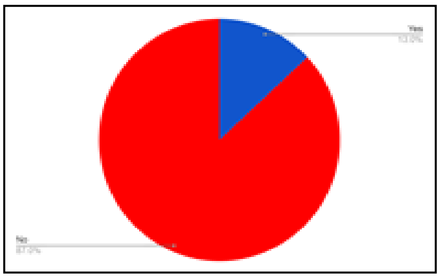


Figure 4. Awareness of photothermal effects of Gold Nanoparticles.

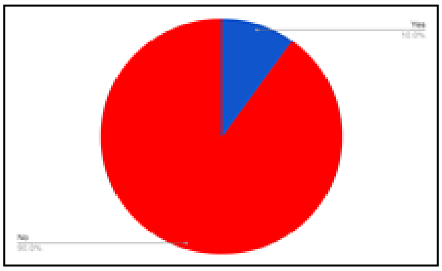


Figure 5. Awareness of DNA detection properties of Gold Nanoparticles.

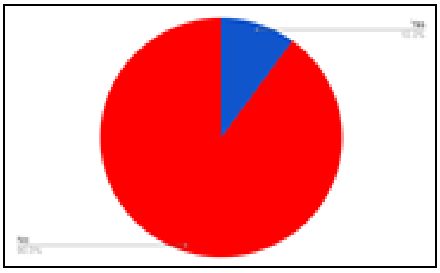
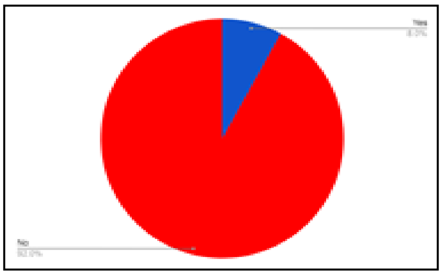


Figure 6. Awareness of Gene Diagnostic properties of Gold Nanoparticles



is used in gold nanoparticle-based cancer therapy to kill cancer and tumour cells. When bombarded with focussed big impulses of an appropriate wavelength, targeted gold nanoparticles can kill cancer cells [18, 19].

The formation of nanoclusters on the cell membrane was studied by Zharov *et al.,* When compared to normal cells without nanoclusters, it was discovered that the creation of nanoclusters increased local absorption and redshifting. The introduction of a near-infrared (NIR) laser resulted in a significant improvement in laser-induced cancer cell death [20]. Hirsch *et al.*, investigated the photothermally induced morbidity of human breast cancer cells cultured with gold nanoshells when exposed to near-infrared light [21].

In vivo studies showed that lower NIR light exposure caused a significant average temperature rise in solid tumours treated with gold nanoshells, which is capable of causing irreversible tissue damage, whereas controls exposed to NIR light had a much lower average temperature and appeared unaffected. In 2008, Zheng *et al.*, demonstrated that gold nanoparticles can increase radioactivity by increasing ionising radiation absorption, causing single- and double-stranded DNA to break [22].

Large macromolecules can be delivered using gold nanoparticles. They are effective for the delivery of biomolecules because of their adjustable size and functionality. Proteins could be delivered effectively using gold nanoparticles. According to Verma *et al.,* cationic tetraalkyl ammonium functionalized gold nanoparticles can identify the surface of anionic proteins and block their activity by complementary electrostatic interactions [23] . The activity was restored thanks to the release of free protein, which was achieved by using GSH to treat the protein-particle complex. This demonstrated that gold nanoparticles can function as protein transporters. Functionalized gold nanoparticles as insulin carriers were also proven by Bhumkar *et al.,* [24]. Chitosan, a harmless biopolymer, was used to coat the nanoparticles in order to stabilise them. Insulin adsorbs significantly on the surface of Chitosan Coated particles, making them useful for transmucosal administration.

When gold nanoparticles are irradiated with light, the excited conduction band electrons return to their ground state by releasing their energy as heat into the surrounding medium, making gold nanoparticles 'nanoheaters' . Depending on the laser power, time of irradiation, and concentration of gold nanoparticles in the spot size of the laser source, the temperature rises from 10C to approximately 1000C. The photothermal effect is the essential premise for gold nanoparticles' potential therapeutic utility, in addition to its delivery application. The use of gold nanoparticles in photothermal tumour ablation has been described by Huang *et al.,* [25].

The detection of DNA using gold nanoparticles has been widely reported and discussed . For the detection of DNAassay, some of the approaches are summarised here. Hill *et al.,* created a new bio-barcode test that uses blocking strands to prevent the target from rehybridizing and enables for the detection of double stranded genomic DNA [26]. Using gold nanoparticles and dynamic light scattering measurement, Dai et al. devised a one-step homogeneous DNA detection method with great sensitivity [27].

The use of gold nanoparticles in an electrochemical device allows for more accurate and efficient gene diagnostics. Wang et al. reported the use of colloidal gold nanoparticles for electronic DNA hybridization detection in 2001 [28]. They used high-sensitivity anodic stripping electrochemical measurement to capture gold nanoparticles on a hybridised target, followed by high-sensitivity anodic stripping electrochemical detection of the metal tracer. The detection limit of this approach is in the picomolar range. Gold nanoparticles have outstanding catalytic activity due to their high surface area to volume ratio. For the design and production of electrocatalysts, gold nanoparticles have been widely explored. Cell biomolecules such as glucose, norepinephrine, dopamine, catechol, epinephrine, and ascorbic acid can be investigated electrochemically using gold nanoparticles [29, 30].

Conclusion

There is limited awareness amongst dental students about use of Gold nanoparticles therapy in medical applications. Enhanced awareness initiatives and dental educational programmes together with increased importance for curriculum improvements that further promote knowledge and awareness of Gold nanoparticles therapy.

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