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Research Article

AWARENESS OF NANOTECHNOLOGY AMONGST POSTGRADUATES AND INTERNS-KNOWLEDGE, APTITUDE AND PRACTICE (KAP) SURVEY

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Abstract: ***Background:*** Nanotechnology is the future of orthodontic research .It has paved its way on advanced diagnostics, targeted drug delivery, biomaterials science and biosensors. *Aim:* The aim of the study is to evaluate the awareness of nanotechnology amongst dental students. ***Materials And Methods***: A questionnaire containing 14 multiple choice questions were virtually given to postgraduate students and interns on the awareness of nanotechnology in orthodontics through whatsapp. A total of 500 responses were recorded in a period of 3 weeks. ***Results:*** An average of 54% of dental questions had an awareness of usage of nanotechnology in orthodontics. *Conclusion:* Emphasis should be laid in the dental curriculum to advocate the usage of nanotechnology in dental practice, since nanoparticles is the future of dentistry.

Keywords: nanoparticles, nanocomosite, osseointegration.

INTRODUCTION

Nanotechnology is a boon to the field of medicine and dentistry (Govindankutty, D. 2015). Nanotechnology has an impact on advanced diagnostics, targeted drug delivery, biomaterials science and biosensors (Schleyer, T. L. 2000; Whitesides, G. M., & Love, J. C. 2001; & Kaehler, T. 1994). Nanodentistry combines the use of nanomaterials with tissue engineering and nanorobotics .Many pioneers like Richard P Feymann,who established the size of nanoparticles in 1959,introduced nanotechnology in dentistry (Park, B. 2007). Eric dexler coined nanotechnology" in 1986 (Feynman, R. P. 1960). Richard Zsigmondy studied extensively about nanomaterials in the early 20 th century and has published several studies on the topic (Drexler, K.E. 1980).

Nanotechnology has a wide range of applications in orthodontics ranging from orthodontic bonding to improve fixed orthodontic appliance bonding, induction of gene therapy to increase mandibular growth stimulation, nanofabricated ultrasound device to reduce external apical root resorption associated with orthodontic treatment, and exploration of nanomechanical sensors for orthodontic forces and measuring moments at intervals (Drexler, K.E. 1981; & Rodgers, P. 2006).

Nanoparticles have a wide range in the field of endodontics (Mirsasaani, S.S. *et al.*, 2011). Nanotechnology is also widely used in prosthodontics, such as the introduction of newly introduced antmicrobial impression material, which incorporates Vinylpolysiloxane with nanofillers (Singh Kaira, L. *et al.*, 2012).

The aim of the study is to assess the knowledge of interns and postgraduates on the applications of nanotechnology in orthodontics.

MATERIALS AND METHODS

Questionnaire

A google forms questionnaire containing 14 multiple choice questions, sent through Whatsapp Messenger App (Whatsapp Inc) to 600 students. The questions in this survey were assessed to evaluate the awareness of nanotechnology among dental students.Demographic details such as age and gender were also recorded (table 1).

Study Population

A descriptive cross sectional survey was conducted amongst the orthodontic postgraduates in Chennai, India and responses were recorded in July.A total of 500 responses were recorded with a mean age of 21-30 years in a span of 3 weeks

Inclusion criteria included both male and female patients.

STATISTICAL ANALYSIS

Statistical analysis was performed with Statistical Package for Social Sciences,IBM Corporation,SPSS Inc,Chicago(SPSS software). The level of significance in the present study was kept at $p<0.5$

1. **Who coined the term"nanotechnology " for the first time?**
   - Richard Feynmann
   - Norio Taniguchi
   - Foster
2. **Who was the first person who described molecular machines could be build with atomic precision?**
   - Richard Feynmann
   - Norio Taniguchi
   - Foster
3. **What technique is most applicable in nanotechnology?**
   - Top down technique
   - Bottom up approach
   - functional approach
   - biomimetic approach
   - all of the above
4. **Nanorobots-a boon to dentistry?**
   - yes
   - no
5. **Fullerene nanoparticles coated on the surface of archwire enhances?**
   - friction mechanics
   - frictionless mechanics
6. **What are the main advantages of nanocomposite?**
   - excellent optical properties
   - easy handling characteristics
   - superior polish
   - all of the above
7. **Are you aware of shape memory polymers in orthodontics?**
   - Yes
   - No
8. **Elastomeric ligatures coated with nanoparticles is?**
   - anticariogenic and anti-inflammatory
   - cariogenic and inflammatory
9. **What is the main use of Biomedical micromechanical systems?**
   - accelerated orthodontics
   - control of biofilm
   - therapeutic tool
10. **Do you think nanotubes enhances osseointegration?**
    - Yes
    - No
11. **What are the main uses of Low intensity pulsed ultrasound(LIPUS)?**
    - enhance bone growth near titanium-coated implant
    - reduces root resorption after orthodontic treatment
    - therapeutic tool
    - all of the above
12. **Do you think smart bracket with nanomechanical sensors allows the orthodontist to adjust the applied force with minimal side effects?**
    - Yes
    - No
13. **Nanoneedles-painless treatment for patients?**
    - Yes
    - No
14. **Nanocrystalline HAP (NHAP) in intrabony defects results in greater clinical attachment level gain when compared to open debridement flap?**
    - Yes
    - No

RESULTS AND STATISTICAL DATA

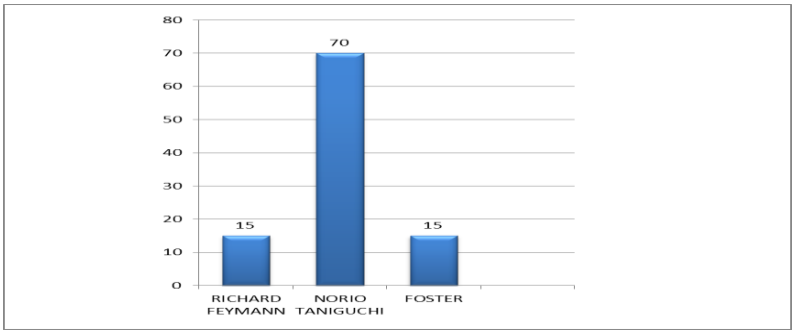
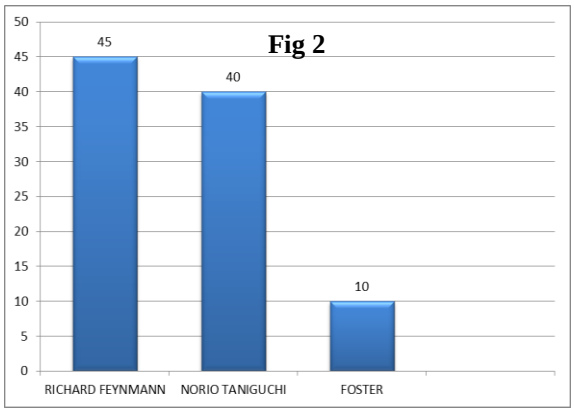


Fig 1



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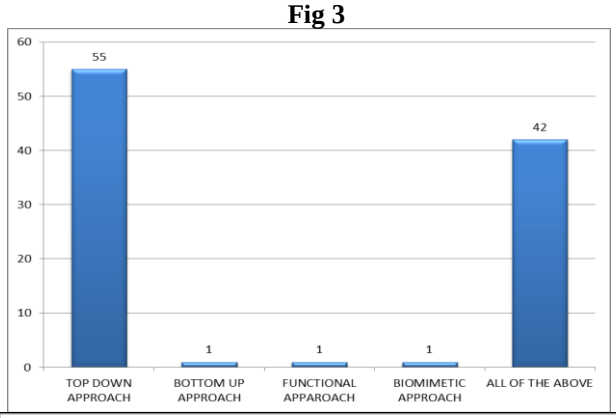

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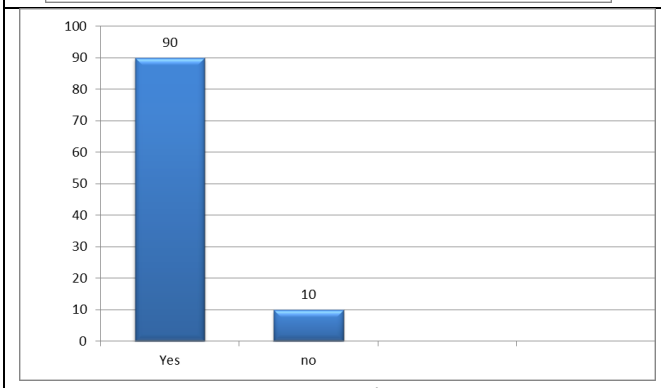

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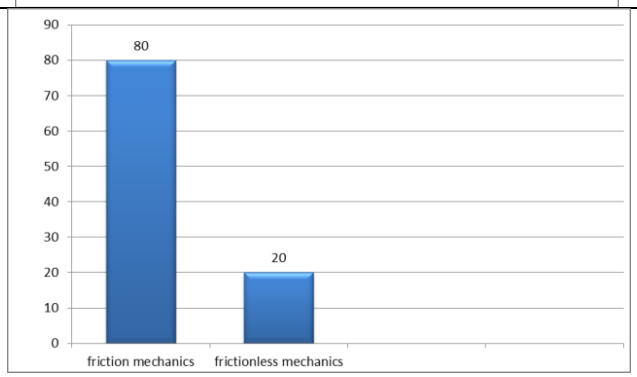

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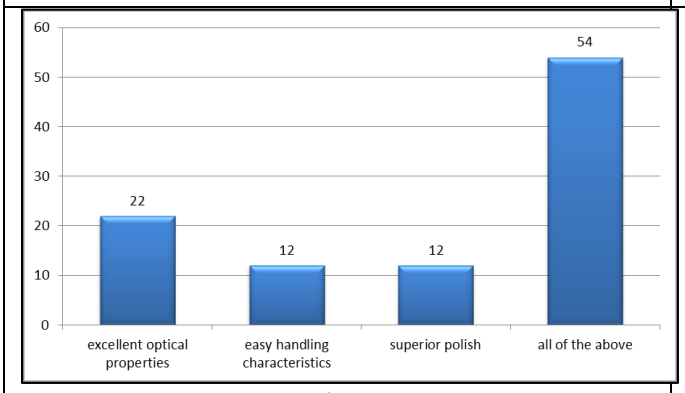

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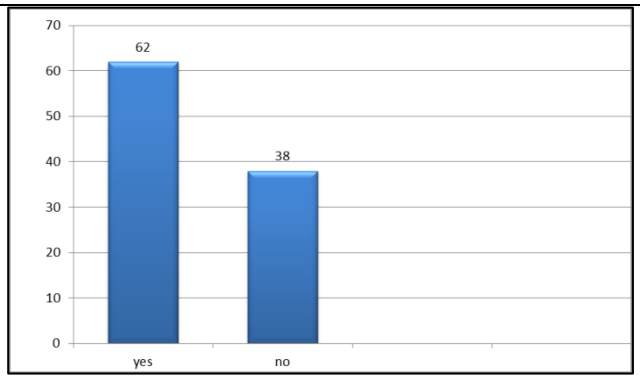

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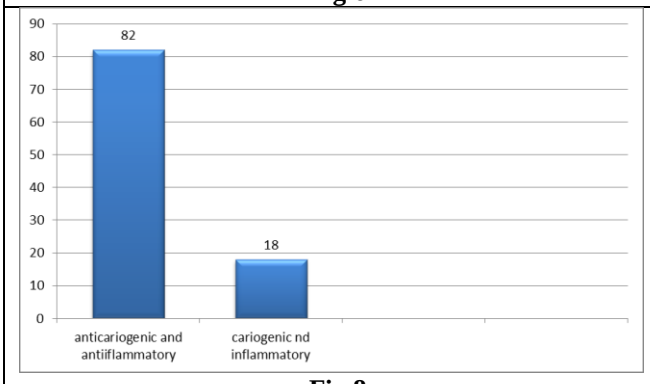

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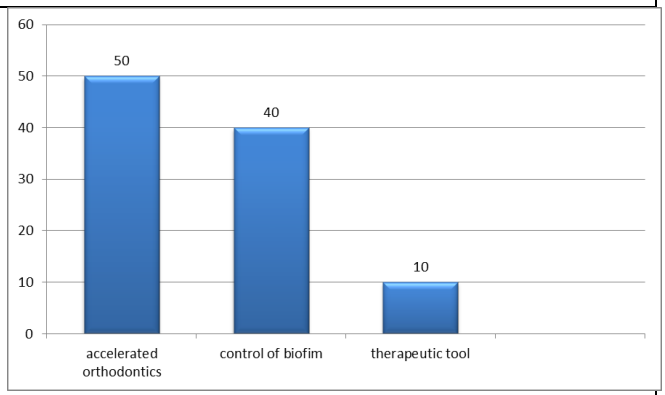


Fig 9

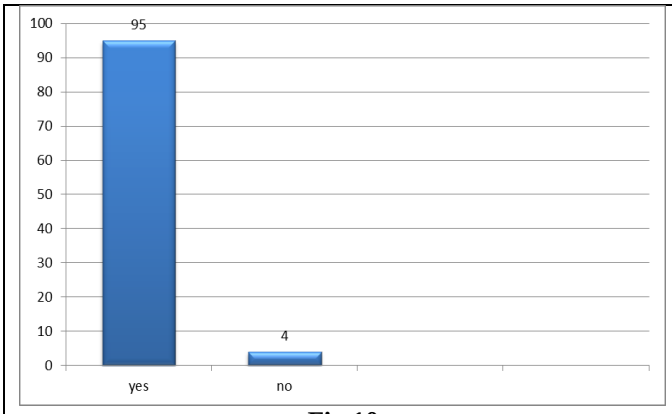
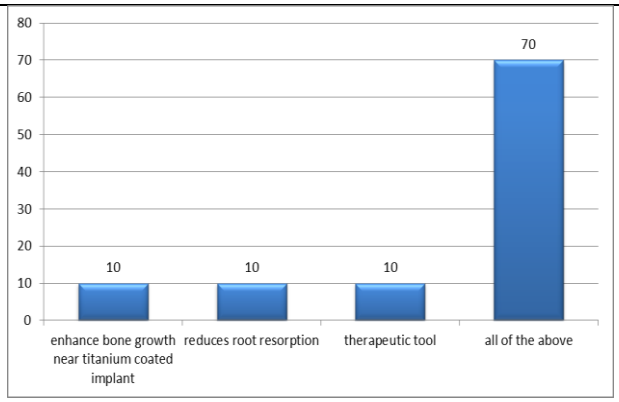


Fig 10



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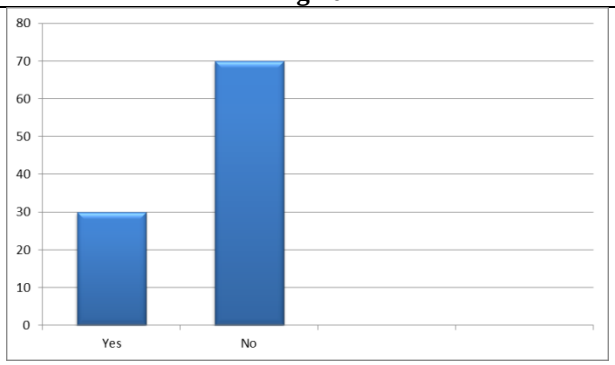

Fig 12

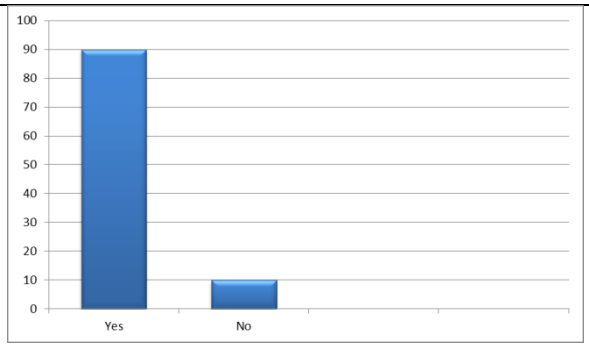

Fig 13

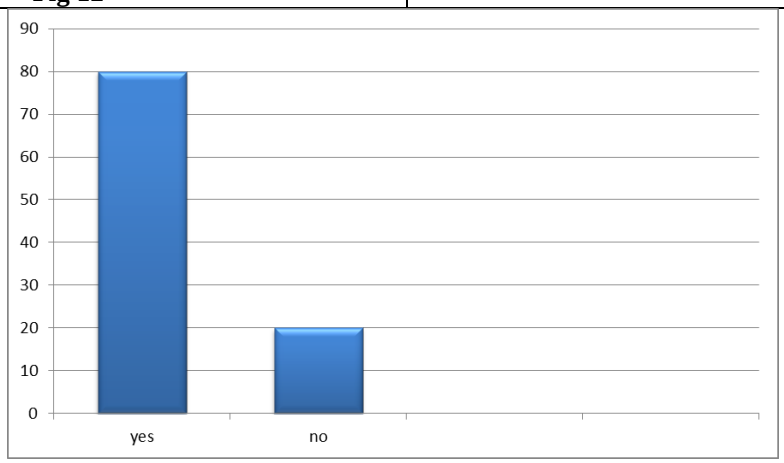

Fig 14

Table 1. Demographic Details

GENDER	FREQUENCY(n)	PERCENTAGE(%)
MALE	292	58.4
FEMALE	208	41.6
AGE(21-25years)	316	63.2
AGE(26-30 years)	184	36.8

Table: 2

Q number	mean	Standard deviation	range
1	33.33	31.75	55
2	35	20.27	35
3	20	26.41	54
4	36.6	46.18	80
5	50	56	80
6	25	19.88	42
7	50	16.97	24
8	50	45.25	64
9	50	63.63	90
10	24.5	47	94
11	50	28.28	40
12	50	56	80
13	50	56	80
14	50	7.07	10

From Fig 1,it is observed that 70% of dental students had marked "Norio Tanguchi" ,who coined the term nanotechnology.Only 15% of dental students marked the correct answer as "Richard Feymann".However 45% of dental students marked "Nori Taniguchi " and "Richard Feymann"each who described molecular machines can be built with atmospheric pressure,the correct answer being "Norio Taniguchi"(Fig 2).55% of dental students marked top down approach which was most applicable in nanotechnology,the correct answer being all of the above option(Fig 3).

90% of dental students felt nanorobots were a boon to dentistry (Fig 4).80% of dental students felt fullerene nanoparticles on the surface of arch wires enhances friction mechanics. Only 20% of dental students marked the correct answer as frictionless mechanics(Fig 5).54% of dental students marked excellent optical properties, easy handling properties and superior polish are the main advantages of nanocomposite (Fig 6).62% of dental students were aware of shape memory polymers in orthodontics(Fig 7).82% of dental students felt elastomeric ligatures coated with nanoparticles enhances anticariogenic and anti-inflammatory properties(Fig 8).82% of dental students marked the correct answer as accelerated orthodontics ,which was vital for biomedical micromechanical systems(Fig 9).95% of dental students marked nanotubes enhances osseointegration(Fig 10).

95% of dental students marked LIPUS could be used as therapeutic tool, enhances bone growth near titanium coated implant and reduces root resorption after orthodontic treatment (Fig 11).70% of students felt smart brackets would ease the work of orthodontist(Fig 12).90% of dental students marked nanoneedles are painless for the patients and NHAP in intrabony defects results in greater clinical attachment level gain(Fig 13 and Fig 14).

DISCUSSION

Nano composites are a breakthrough in dentistry in replacing missing tooth structure and enhancing tooth color and opacity.It also enhances facial esthetics to a great extent. Nanocomposites have high mechanical properties, lower thermal coefficient of expansion, lower dimensional change on setting, and high resistance to wear improving clinical performance (Craig, R.G. Editor. 1997).

Nano adhesives are used in orthodontic bonding. It is prepared by inducing nano sized filler paricles(filler-particle size of ≤ 100 nm) into composites by Flame pyrolysis.The other names being Flame spray pyrolysis or Sol-gel Process. There are two types of nanoparticles - nanoparticles or nanoclusters.Nanoclusters reduces polymerization shrinkage thereby enhancing the flexural strength of material (Maheshwari, S. *et al*., 2014).

Studies have compared the physical properties of nanofilled, universal hybrid and microfilled composites, and observed a higher elastic modulus with the nanofilled Composites.The microfilled composites seemed to exhibit lower mechanical properties (Bhardwaj, A. *et al.,* 2014). Titanium nanotubes have shown surprising results as it enhances osseointegration (Miyawaki, S. *et al.,* 2003; & Govindankutty, D. 2015). Studies also show an increased orthodontic tooth movement with the usage of nanoelectromechanical systems (NEMS) as it combines the properties of both mechanical forces with electricity.Research on animal experiments have highlighted that electric stimulation maximises synthetic and secretory processes associated with accelerated bone remodelling (Gourley, P. L. 2005; Davidovitch, Z. *et al.,* 1980; Davidovitch, Z. *et al.,* 1980; Kolahi, J. *et al.,* 2009; & Miyawaki, S. *et al.,* 2003).

One of the new advancements of accelerated orthodontic tooth movement is the addition of nanorobots.Nanorobots increases orthodontic tooth movement ,as it minimises human errors. It 12 remodells periodontal ligament, bone, cementum and gingival tissue for an enhanced tooth movement.Compared to human efficiency,leveling and alignment carried out by nanorobots are easy,fast and painless (Gambhir, R. S. *et al.,* 2013). An addition to the latest research with bracket systems,is a nanobracket with advanced features such as integrated microelectronic chip,multiple piezoresistive stress sensors for 3D force and measurement of moment associated with orthodontic force (Govindankutty, D. 2015). Studies reveal nanobrackets were designed 2.5 times higher the size of a conventional bracket ,incorporated with 32 stress sensors distributed over the chip area to evaluate its ability to accurately calibrate the externally applied force-moment systems (Lapatki, B. G. *et al*., 2007).

LIMITATIONS

The main limitations of this study are a small sample size and lack of previous studies on this topic.

CONCLUSION

This study implies an average of 54% of dental students had an awareness of usage of nanotechnology in orthodontics.Emphasis should be laid in the dental curriculum to advocate the usage of nanotechnology in dental practice, since nanoparticles are the future of dentistry.

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