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RESEARCH ARTICLE

IMPACT OF DIAGNOSTIC RADIATION ON THYROID AND GONADS - A STRUCTURED REVIEW.

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Abstract

Objective: To know about the current state of knowledge in diagnostic radiation safety which is uppermost in mind of all the dental clinicians.
Methods: A total of 301 references were reviewed using standard search engines Pubmed and Google. Twenty-two, were selected as relevant by all the authors, for our area of inquiry. The temporal status of these studies were from 2008 to 2017. Two categories of research was identified, those with anthropometric phantoms and those with real patients.
Results: Initially we divided them into Phantom based studies (17) 77.27% and the patient-based studies were (5) 22.73%. There is paucity of actual patient studies due to noncooperation by patients for radiation-based study and also because of severe restriction by ethical committee to give permission for such study.
Conclusion: The extensive Phantom based studies and specific patient studies of radiation measurement in diagnostic dental domain has suggested to a large extent that this is a safe mode of tool of treatment selection. The risks are very minimal and unnecessary radiography must be avoided and each radiographic session must be customized.

Introduction:-

The use of ionizing radiation in dentistry is relatively safe. The NCRP paper by Miles DA and Langlais RP mention some recommendations which state that

1. It is not mandatory to use lead shielding for all patients if all other safety protocol is being followed.
2. The children at least upto 18 years of age must use thyroid shield
3. All pregnant women should be shielded from radiation and must follow ALARA- as low as reasonably achievable.

When you look at the research in radiation we find that phantoms with dosimeter implanted in them have been extensively used. In Sweden we find the sophisticated QUART DidoSVM or solid state dosimeter is being used. Many other researchers also used TLD in anthropomorphic head and neck phantoms. In Europe the RANDO® with dosemeter was used for research in dental and panoramic machines.

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The Korean workers used the OSLD (optically stimulated luminescence dosemeters) for their research and found the cephalometric studies showed considerable dose reduction.

So in conclusion three types of dosimeters were the tools of data collection in various studies the solid state dosemeter, the TLD and the OSLD.

Materials and Methods:-

In this report we have selected the salient references from all over the world , sticking with the latest ten years as far as possible. If an outlier reference is used it is selected only on merit of its being unique in some aspect.

Results:-

Table No. 1:-The summarization of the primary references used in the discussion. Tabulated for easy reference for other investigators who want to glean data for their work.
[Al Suwat MH, Bailoor DN et al 2017]

Name	Country	Measuring tool	Brief summary	Authors comment
Schulze RKW et al. (2017) [1]	Mainz, Sweden	QUART DIDO SVM [Solid state]	Lead apron did not reduce the thyroid dose.	General lead apron is ineffective for thyroid dose reduction
Han SC et al. (2017) [5]	Seoul, Korea	OSLD	dose reduction using multileaf collimator (MLC)	dose reduction during cephalometric radiology was feasible and effective
Yepes JF et al. (2017) [6]	Indiana, US	OSLD	thyroid gland dose was 578 μSv	child receives more radiation than adults including the thyroids
Nikneshan S et al. (2016) [2]	Tehran, Iran	TLD	According FOV filed of view the doses varied considerably	Thyroid and Parotid were exposed significantly
Granlund C et al. (2016) [3]	Gothenburg, Sweden	TLD	that similar higher dose maybe received by thyroid and other adjoining organs	IOPA digital radiography for specific tooth is safer than doing panoramic radiograph for routine bases
Hoogeveen RC et al. (2016) [4]	Amsterdam , Netherlands		In the upper anterior region IOPA, the dose was high.	use of thyroid shield is very critical specially during upper anterior radiography
Nejaim Y et al. (2015) [8]	Sao Paulo, Brazil		14 radiographs with each x-ray machine using long cone paralleling techniques in an anthropomorphic phantom	using of lead foil is effective in reduction of radiographic dose to thyroid and parotid glands.
Johnson KB et al. (2014) [7]	US		compare circular collimator and universal rectangular collimator	rectangular collimators reduced the thyroid dose very effectively as compared to circular collimators.
Han GS et al. (2013) [9]	Beijing, China	TLD	study effect of thyroid collar for digital panoramic radiography.	thyroid collar was very helpful in direct digital panoramic system to reduce thyroid gland exposure.
Choudhary AB et al. (2012) [10]	Nagpur, India		efficiency of lead thyroid collar in study of cephalometric landmarks.	lead shielding dose not effect landmarks measurements and that it must be using on routine bases.
Koivisto J et al. (2012) [11]	Finland	MOSEFT dosimeter	using 20 MOSEFT dosimeters in 8 most radiosensitive organs in the maxillofacial and neck area	this constitutes a feasible method for dose assessment in CBCT units.

Grünheid T et al. (2012) [12]	USA	TLD	using i-CAT CBCT machine and compared with orthopantomograph OP-100 digital x-ray in head and neck phantom	even though CBCT provides additional diagnostic information it exposes patients to significantly higher doses as compared with OPG.
Theodorakou C et al. (2012) [13]	Manchester, UK	TLD	Estimated the doses of dental cone beam Ct using anthropomorphic phantoms. Highest doses was received by salivary glands and thyroid glands was showered by four-fold increase.	Dental CBCT exam is not to be ordered as a routine procedure but only in cases where it will significantly contributed to treatment decision making.
Endo A et al. (2012) [14]	Tokyo, Japan	OSLD	Using of OSLD in dose calculations in panoramic radiology.	these dosimeters are very reliable and useful in strip form.
Jadu F et al. (2012) [18]	Canada	TLD	doses of CBCT on parotid and submandibular glands where similar to those calculated for plane radiograph sialography. They used RANDO® phantoms.	so they opined that there was no significant increase in the dose at CBCT in multidimensional sialography
Zenóbio EG et al. (2012) [19]	Brazil	TLD-100	Measuring the dose of radiation in parotid gland, submandibular gland and thyroid gland in human patients selected for dental implant surgery.	submandibular gland were most irradiated organs and next was thyroid.
Sansare KP et al. (2011) [15]	India		using of thyroid collars in cephalometric radiology	they reduce thyroid dose significantly and hence they recommend routine cephalometric radiography use.
Pauwels R et al. (2010) [16]	Belgium	TLD-100 and TLD-100 H	Used two Alderson Phantoms with TLD dosimeters. 14 different CBCT machines used	Conclusion is that there is 20 fold increase in radiation to sensitive tissues by CBCT of all varieties tested.
Qu XM et al. (2010) [17]	China		similar results in there research with ProMax 3D CBCT	when scanning was done with lower resolution setting it reduced radiation dose to a significant level.
Memon A et al. (2010) [20]	UK		classical case control study used logistic radiation analysis. The control patient studied were age and sex matched in Kuwait	that there study show an increase risk of thyroid cancer and that further study must be attempted.
Sheikh S et al. (2010) [21]	India		120 patients who underwent full mouth IOPA radiographs	digital pocket dosimeter (PD-4507).
Ludlow JB et al. (2008) [22]	USA	TLD	the panoramic, the full mouth and ProMax Planmeca showed exposure as calculated in head phantom.	They recommended strongly that without radiologist prescription no advanced machine be used, rectangular collimation instead of round collimation to be preferred

Discussion:-

Many of the studies mentioned below were done using anthropomorphic phatoms in which the dosimeter were strategically placed in region of sensitive regions. Only couple of studies have dealt with actual patients and human beings due to the very sensitive nature of research and many of the patients will not allow themselves to be irradiated or allow measurements during diagnostic radiology.

Phantom Based Studies :

Schulze RKW et al. (2017) in their study from Sweden using paired Wilcoxon test found that skin dose in thyroid region of phantom was very high and was not reduced by using of lead apron. The measurement was done using QUART didoSVM (solid-state dosimeter) which is highly sensitive and a comparison of five different CBCT devices. (1)

Nikneshan S et al. (2016) in their study from Iran using TLD (thermoluminescent dosemeter) of three machine (NewTomVGi,NewTom 5G , and Promax 3D). They calculate absorbed and effective dose for both thyroid and parotid. They used Kruskal-Wallis, Mann-Whitney U and Wilcoxon tests to do the analysis and they found that the doses for small and large FOVs (field of views) where considerably different and statistically significant. (2)

Granlund C et al. (2016) from Sweden did a comparative analysis of digital full mouth intraoral and panoramic radiography. They used TLD (thermoluminescent dosemeter) in an anthropomorphic head and neck phantom. The dose to salivary gland and oral mucosa was 15 μSv and for panoramic radiography, it was 19-75 μSv. We can conclude that similar higher dose maybe received by thyroid and other adjoining organs. This conclude that it is safer to do IOPA digital radiography for specific tooth rather than doing panoramic radiograph for routine bases. (3)

Hoogeveen RC et al. (2016) from Netherland using RANDO® (phantom with a dosemeter) using a three way ANOVA statistics to measure radiation in different IOPA positions. In the upper anterior region IOPA, the dose was high and use of thyroid shield reduce it by 75%. So, they mention clearly that use of thyroid shield is very critical specially during upper anterior radiography. (4)

Han SC et al. (2017) from Korea worked with OSLD (optically stimulated luminescence dosemeters) and evaluated the dose reduction using multileaf collimator (MLC) and found that dose reduction during cephalometric radiology was feasible and effective. (5)

Yepes JF et al. (2017) from USA using OSLD (optically stimulated luminescence dosemeters). They used a child phantom model (pediatric phantom) on CBCT Kodak 9000 and found that thyroid gland dose was 578 μSv and concluded that child receives more radiation than adults including the thyroids. Mandibular scan was 1-3 times and maxillary scan 2-10 times. (6)

Johnson KB et al. (2014) compare circular collimator and universal rectangular collimator and found that rectangular collimators reduced the thyroid dose very effectively as compared to circular collimators. They use both adult and child phantoms for this study. (7)

Nejaim Y et al. (2015) from Brazil using lead foil to reduce radiation dose in different IOPA examination. They used four machine comparison: (PSP; VistaScan ,PSP plus lead foil , CMOS; DIGORA , and CMOS plus lead foil). They took 14 radiographs with each x-ray machine using long cone paralleling techniques in an anthropomorphic phantom and they found that there was 32% reduction in PSP and 95% in CMOS system and they conclude that using of lead foil is effective in reduction of radiographic dose to thyroid and parotid glands. (8)

Han GS et al. (2013) from China they study effect of thyroid collar for digital panoramic radiography. They used four models and all measurements were done using TLD (thermoluminescent dosemeter) in an anthropomorphic phantom. They conclude that thyroid collar was very helpful in direct digital panoramic system to reduce thyroid gland exposure. (9)

Grünheid T et al. (2012) from USA used i-CAT CBCT machine and compared with orthopantomograph OP-100 digital x-ray. They used TLD in head and neck phantom and they found that even though CBCT provides additional diagnostic information it exposes patients to significantly higher doses as compared with OPG.(12)

Jadu F et al. (2012) from Canada found that effective doses of CBCT on parotid and submandibular glands where similar to those calculated for plane radiograph sialography. They used RANDO® phantoms and TLD. There findings was 65 μSv for parotid and 156 μSv for submandibular salivary gland so they opined that there was no significant increase in the dose at CBCT in multidimensional sialograohy.(18)

Qu XM et al. (2010) from China found similar results in there research human equivalent phantom with ProMax 3D CBCT that when scanning was done with lower resolution setting it reduced radiation dose to a significant level.(17)
Pauwels R et al. (2010) from Belgium used special Alderson radiation therapy () anthropomorphic phantoms loaded by TLD-100 and TLD-100 H and determined that salivary glands were exposed to 24% and thyroid glands exposed to 21%. In the whole picture they found 20 fold increase in the dose in large field CBCT scanners hence the caution that the exposure parameters and field size should be matched with diagnostic requirements to the case otherwise patients may be exposed to large radiation dose of radiation unnecessary.(16)

Endo A et al. (2012) from Tokyo, Japan used OSLD to standardize dose calculations in panoramic radiology using anthropometric phantoms. They concluded that these dosimeters are very reliable and useful in strip form.(14)
Theodorakou C et al. (2012) from Manchester, UK estimated the doses of dental cone beam Ct using anthropomorphic phantoms. They use adolescents' phantoms and TLD. Highest doses was received by salivary glands and thyroid glands was showered by four-fold increase. This study concluded that dental CBCT exam is not to be ordered as a routine procedure but only in cases where it will significantly contributed to treatment decision making.(13)

Koivisto J et al. (2012) from Finland used MOSEFT (metal-oxide semiconductor field-effect transistor dosimeter). They used 20 MOSEFT dosimeters in 8 most radiosensitive organs in the maxillofacial and neck area in head phantoms . They found that this constitute a feasible method for dose assessment in CBCT units.(11)

Ludlow JB et al. (2008) from USA found in there study that the panoramic, the full mouth and ProMax Planmeca showed exposure as calculated in head phantom and using TLD that the values were 32 to 42 % higher than dose permitted by 1990 ICRP guidelines. They recommended strongly that without radiologist prescription no advanced machine be used, rectangular collimation instead of round collimation to be preferred.(22)

Patient based study:
Choudhary AB et al. (2012) from India evaluated efficiency of lead thyroid collar in study of cephalometric landmarks in 100 patients of which 50 with shielding and 50 regular . They found that lead shielding dose not effect landmarks measurements and that it must be using on routine bases. (10)

Sansare KP et al. (2011) from India mentioned using of thyroid collars in cephalometric radiology and found that while they mask few landmarks but overall they reduce thyroid dose significantly and hence they recommend routine cephalometric radiography use.(15)

Zenóbio EG et al. (2012) from Brazil used TLD-100 in human patients 19 in number in parotid gland, submandibular gland and thyroid gland in patient selected for dental implant surgery. They determined that thyroid and eye lens doses lower than 21% in all dental radiology exams. They concluded submandibular gland were most irradiated organs and next was thyroid.(19)

Memon A et al. (2010) from UK did a classical case control study using 313 patients and used logistic radiation analysis. The control patient studied were age and sex matched in Kuwait. They concluded that there study show an increase risk of thyroid cancer and that further study must be attempted.(20)

Sheikh S et al. (2010) from India studied 120 patients who underwent full mouth IOPA radiographs and dose was measured using digital pocket dosimeter (PD-4507). Their conclusion was that thyroid and gonads received doses within NCRP safe limits.(21)

Conclusion:-

X-ray is important during routine dental visits but it has some effects on the human bodies. Because of that it should takes some protective measures. Our research is focusing on thyroid and gonads. They have some exposure to x-ray

during dental visits and it should be protected by using Lead shield or some protective materials to avoid cell mutation that may lead to establish the cancer as well as thyroid cancer.

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