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Discovering Thoughts, Inventing Future

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Spongstan with Nasopharyngeal Pack: New Ordinary Procedure Manage the Adenoidectomy Bleeding

By Dr. A H M Delwar

Comilla Medical College

Abstract- Objective: To find out the frequency, prevalence, and epidemiological aspects of the adenoidectomy bleeding and share the new ordinary procedure to manage it by spongstan with the nasopharyngeal pack.

Study Design: Cohort retrospective study.

Setting: Academic tertiary care hospitals.

Subject and Methods: A total of 23 adenoidectomy children's demographic data collection and analyzed who suffered from complications of bleeding in the department of Otolaryngology and Head-Neck Surgery, Comilla Medical College Hospital, and Comilla Medical Centre, concerned Clinic of Central Medical College from 01 July 2016 to 31 June 2019.

Results: Incidence of adenoidectomy bleeding among total operative patients was 0.32%, adenoidectomy-Tonsillectomy patients 2.66%, and the yearly prevalence of 33.35%. Off them, the male was 09 (39.17%), and the female 14 (60.87%), 11-15 years children have highest bleeding complications was 17 (73.91%), commonest presenting features was nasal obstruction (91.30%), mouth breathing (82.61%), and hearing loss (78.26%).

Keywords: adenoidectomy, bleeding, children, spongstan, nasopharyngeal pack.

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Spongstan with Nasopharyngeal Pack: New Ordinary Procedure Manage the Adenoidectomy Bleeding

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Results: Incidence of adenoidectomy bleeding among total operative patients was 0.32%, adenoidectomy-Tonsillectomy patients 2.66%, and the yearly prevalence of 33.35%. Off them, the male was 09 (39.17%), and the female 14 (60.87%), 11-15 years children have highest bleeding complications was 17 (73.91%), commonest presenting features was nasal obstruction (91.30%), mouth breathing (82.61%), and hearing loss (78.26%). Maximum patient came from the village was 14 (60.82%). Laboratory investigations included complete blood count (CBC), Bleeding time (BT), Clotting time (CT), Prothrombin time (PT), and Activated partial thromboplastin time (APTT) for all children. Radiological investigations exhibited according to Cohen et al. grade-4 was highest presentation 12 (52.18%). I used St. Clair Thompson's adenoid curette to remove the adenoid tissue following the conventional method. The type of bleeding, Primary was 04 (17.39%), reactionary 18 (78.26%), and Secondary 01(4.35%). The primary and reactionary 22 (95.65%) patients treated by Spongstan and usual wet ribbon gauze pack, and secondary 01 (4.35%) patient managed by an only nasopharyngeal pack and changed the antibiotic.

Conclusion: Every surgical procedure has a common complication of bleeding. Adenoidectomy is one of the commonest surgery for the pediatric age group in which we blindly curette the adenoid-many options implicated to save the children's life from this risky complication. I introduced the simple process spongstan with a wet ribbon gauze pack placed at nasopharynx for 18 to 24 hours, which is enough to stop the bleeding.

Keywords: adenoidectomy, bleeding, children, spongstan, nasopharyngeal pack.

I. INTRODUCTION

denoid is а nasopharyngeal lymphoid aggregation of tissue which described by the Santorini and Wilhem Meyer in 17th and 18th century. The adenoid receives a rich arterial supply from branches of the facial and maxillary arteries and the thyrocervical trunk; venous drainage is to the internal jugular and facial veins [1]. From five months, it increases rapidly, most enlargements are seen in 07 years and after 15 years, it regresses [2]. As a part of Waldever's ring, adenoid has an important role in the development of antibodies and immunological memory [3]. Adenoidectomy between the ages of 04-10 years doesn't show any immunological deficiency [4]. Enlarged adenoids develop chronic nasal obstruction and obligate mouth breathing, causing the pathological manifestation of obstructive sleep apnea, rhinitis, rhinosinusitis, otitis media, otitis media with effusion and acute and chronic upper and lower respiratory tract infection [5]. A full pediatric ENT clinical history and excluding the family history of unusual bleeding or bruising, routine clotting screening may not confirm the mild Von willebrand disease [6]. Naso-endoscopy is the best process to assess the adenoid size, if not for the uncooperative children's adenoid size may be estimate by lateral x-ray of nasopharynx [7]. During surgery, mirror examination or palpation is a poor measurement of adenoid hypertrophy [8]. In the UK, 79.2% of surgeons use digital palpation and blind curettage, while only 8.1% use suction coagulation under direct vision [9]. Except for blind curettage and suction diathermy, other methods of adenoidectomy include coblation, microdebrider, and laser adenoidectomy, which has a high unit of cost [10] [11] [12]. The reactionary bleeding is which occurs within 24 hours rare, after adenoidectomy, showed less than 0.7% [13]. The management of reactionary bleeding is immediate transfer of the patient to operation theatre and postnasal packing, which left for 24 hours [14]. Due to aberrant ascending pharyngeal artery, secondary bleeding may occur, which is rare [15].

II. METHODS AND MATERIALS

During the three years period, 149968 patients attended in the out-patient department of

Author: MBBS, DLO, MCPS (ENT), MRCPS (Glasgow) UK, FMRC (USA), Associate Professor of Otolaryngology, Comilla Medical College, Comilla, Postcode-3500, Bangladesh. e-mail: mamun.delwar196@gmail.com

Otolaryngology and Head-Neck Surgery of the two tertiary care hospitals. Of them, 7099 patients got admitted to the hospitals for different types of operations, and adenoidectomy-tonsillectomy was 864. I did adenoidectomy-tonsillectomy of all patients. We followed the traditional method of adenoidectomy, digital palpation of the adenoid, and medialisation of the adenoid by finger dissection from both lateral sides. I used the proper size of St. Clair Thompson's curette for adenoidectomy in a neutral position without sand bag under the shoulder. After curette, I examined by finger palpation to see any residual tissue present in the nasopharynx; if present, I curette again and again up to tissue removal. I placed wet ribbon gauze in the nasopharynx and placed a sand bag under the shoulder to extend the neck. I removed the gauze and see the bleeding point by retraction of the soft palate and uvula with anterior pillar retractor. I used the diathermy sucker nozzle to cauterize the bleeding point. When bleeding stops, I again placed ribbon gauze in the nasopharynx and tonsillectomy completed by unipolar diathermy. After complete tonsillectomy, I remove the gauze from adenoid and again recheck the nasopharynx for bleeding. I got 23 patients bleeding from adenoid in which primary bleeding was 04, reactionary bleeding 18, and secondary 01. 22 primary and reactionary bleeding managed by spongstan which trade name is cutanplast made in Italy, with usual ribbon gauze pack, 01 secondary bleeding manged by ribbon gauze pack only.

The primary bleeding occurs in the operation table may be under anesthesia after complete the operation or reversal from anesthesia, noticed by the anesthetist. I again placed the Boyle-Davis mouth gag with a tongue blade and retracted the uvula and soft plate to see the bleeding point and trying to cauterize the bleeding point with diathermy sucker nozzle. If failed placed the spogstan in the nasopharynx, then wet ribbon gauze from choanae to every side of nasopharynx up to the soft palate, which creates pressure on nasopharynx to stop bleeding and cutting the rest of gauze piece. So externally, nothing is available to see. I counseled the parents that the child is breathing through the mouth, and they awake the whole night to see the child breathing normally or feeling any difficulties through the mouth or any bleeding coming through the angle of mouth or nose. If it occurs, they promptly notice it to the Nurse or Doctors. It didn't occur during the period of study. The patient stayed the whole night in the postoperative room. I removed the nasopharyngeal pack with spongstan after 18 to 24 hours without any bleeding.

The reactionary bleeding occurs up to 24 hours after the patient transfer from operation theatre usually occurs half an hour or one hour after the operation. The child instantly transfers to the operation theatre and again placed Boyle –Davis mouth gag as before and the management like the primary bleeding without anesthesia. The secondary bleeding is after 24 hours of operation up to the healing of the wound. In the secondary bleeding, the patient came at the 10th postoperative day. I suction, and clean the patient's nose, nasopharvnx and mouth to establish the bleeding point from tonsil or adenoid. After confirmation, I placed a ribbon gauze pack in the nasopharynx and removed after 24 hours. At the same time started the parental antibiotic, test the hemoglobin which showed 06 gm/dl and transfused one unit of blood. The following information collected about the patient: Gender, age, types of bleeding, presenting features, personal history, laboratory investigation, radiological grading of adenoid size, and treatment. Descriptive statistics used to calculate the data. Figures and tables cited by Microsoft office 2007.

III. Results

Incidence of adenoidectomy bleeding among total operative patients was 0.32%, adenoidectomy-Tonsillectomy patients 2.66%, and the yearly prevalence of 33.35%. Off 23, the male was 09 (39.13%), and the female 14 (60.87%), 0-5 years were 01 (4.35%), 06-10 years 05 (21.74%), 11-15 years 17 (73.91%), lowest age 05 years, highest age 15, mean age 11.04, and the standard deviation 2.061. The type of bleeding showed primary bleeding was 04 (17.39%), reactionary bleeding 18 (78.26%), and secondary bleeding 01 (4.35%). The presenting features revealed nasal obstruction was 21 (91.30%), mouth breathing 19 (82.61%), hearing loss 18 (78.26%), snoring 15 (65.22%), frequent cold attack 13 (56.52%), and infrequent earache 06 (26.09%). Personal history exhibited villagers was 14 (60.87%), slum dweller was 07 (30.43%), and urban 02 (8.70%). Laboratory investigations included: 1. Complete Blood Count, 2. Bleeding Time, 3. Clotting Time, 4. Prothrombin Time, 5. Activated Partial Thromboplastin Time. Radiological investigation exhibited according to Cohen et al. grade-2 was 03 (13.04%), grade -3 08 (34.78%) and grade-4 12 (52,18%). The primary and reactionary 22 (95,65%) patients treated by Spongstan and wet ribbon gauze pack, and secondary 01(4.35%) patient managed by only ribbon gauze pack, changed the antibiotic to parental route and one unit blood transfused the patient due to low hemoglobin 6mg/dl.



Figure-1: With Spongstan and Nasopharyngeal pack of an Adenoidectomy child after reactionary bleeding.



Figure-2: Usually used as a postnasal pack, twisted portion in nasopharynx and free portion anchored on cheek by micropore surgical tape.



Figure-3: Cutanplast and wet ribbon gauze.



Figure-4: 1.Gender distribution. 2. Age. 3. Type of bleeding. 4. Presenting features.





IV. DISCUSSION

Adenoidectomy is the most frequently performed surgical procedure. In the present study, the incidence of bleeding was 0.32% and 2.66 % in a differents point of view supported by Maniglia, Zwack, and Windfuhr et al. series showed incidence accordingly 1989 0.28%, 1997 0.98%, and 2005 1.5% [16] [17] [18].

Considering gender epidemiology, the females (60.87%) were higher than the males (39.13%) in our work held up by Arnolder C, and Rycza T et al. study reported accordingly 58% and 56.1% was female [19] [20]. Silva BSRD et al. series exhibits the males were 52.3 % and the females 47.7% against our research, but Colclasure JB et al. revealed there is no males females preponderance [21] [22]. It may be due to the female children of Bangladesh engage in household work like cleaning and washing causing the frequent attacks of cold and developing recurrent adenoiditis-Tonsillitis.

Regarding age, the incidence of bleeding highest in older children 11-15 years was 73.91% in our series kept up by Voltonen HJ showed more bleeding over ten years older children and Arnolder et al. reported over15 years of age bleeding was 2.19 % [23] [19].

The types of reactionary bleeding occurred within half and one hour after the operation in our presentation kept up by Rycza T, McCormick ME, and Windfuhr JP et al. series interpreted postoperative bleeding mostly occurred within 24 hours [20] [24] [25]. McCormick showed complication rate was 2-10% and mortality rates about 1 in 16000. Windfuhr JP exhibited secondary bleeding occur 7-10 postoperative days, held up our study, the patient came with bleeding at 10th postoperative day. Our secondary bleeding rate was 4.35% carried out by McCormick's work.

The presenting feature of adenoid children was 80% to 95% of nasal obstruction and mouth breathing, 60% to 80% hearing loss and snoring present in our study kept up by Tos et al. work, showed nasal obstruction and hearing loss above 90 % and other symptoms above 70% [26].

The personal history revealed most of our patient came from village and slum dweller accordingly 60.87 % and 30.43% carried out by Ajayan PV et al. series reported the majority of patient was poor class [27].

The laboratory investigation included for all 23 (100%) the patients was CBC, BT, CT, PT and APTT kept up by Ryczer T, Randall DA and Brum MR et al. study [20] [28] [29].

The radiological investigation X-ray nasopharynx lateral view showed the adenoid size reported by Cohen et al. research, which presented in our paper, grade-2 was 13.04%, grade-3 34.78%, and grade-4 52.18% near to Wormald PJ et al. report [30] [31].

About the postoperative bleeding, cauterization, and postnasal pack was recommended by various research works like Milosevic DN, Lowe D, and Tonkinson A et al. study, which showed the effective treatment to stop bleeding carried out by our study [32] [33] [34]. I added Spongstan or Cutanplast, which is absorbable hemostatic with gelatin sponge nasopharyngeal pack strengthening the work of pack. I used normal wet ribbon gauze, placing layer by layer in nasopharynx over the Spongstan from choanae to soft palate, which created sufficient pressure to stop the bleeding. Tzifa et al. study showed 87% surgeon of UK managed primary and reactionary bleeding by postnasal pack [14]. The postnasal pack sometimes made the children's parents and attendants feared and furious in our country. The nasopharyngeal pack and spongstan in adenoidectomy bleeding are safe for the surgeon, patient, and also patient's attendant.

The other procedure of adenoidectomy like coblation, microdebrider, and laser has a high cost, but less complication isn't cost-effective like our outlying tertiary care hospital [10] [11] [12]. The patient in Government Comilla Medical College Hospital may spend a maximum of 50 USD and in Private Clinic 150-300 USD for their operation.

V. Conclusion

The adenoidectomy operation is an ordinary procedure for surgeons. Complications are rare, but bleeding is hazardous both for surgeons, patient, and parents. Demographic data reproduced females and delayed adenoidectomy after ten years was risky for bleeding. Maximum surgeons of the world practiced the adenoidectomy by blind curettage method and management of bleeding by the postnasal pack which is also our practice. Except postnasal pack, I used nasopharyngeal pack and Spongstan in two tertiary care hospitals showed safe and authentic procedures both for surgeons and patients.

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Evaluation of Sealing Ability of Biodentine and Mineral Trioxide Aggregate in Permanent Molars using Dye Extraction Method-An Invitro Study

By Dr. Vidhya R & Dr. Kannan Vadakkepurayil

Abstract- Objective: The aim of this study was to compare the sealing ability of MineralTrioxide Aggregate (MTA) and Biodentine when used to repair the furcal perforations in permanent molars using dye extraction method.

Study design: Recently extracted permanent molars were collected and randomly sealed with MTA and biodentine, after preparing perforations in the furcation area by using a high- speed long shank round bur No:4. After setting of the material, specimens were kept in methylene blue dye for 24 hours to check the microleakage by the dye extraction method. Samples were then placed in vials containing 1ml of 65% nitric acid for three days for the extraction of the dye. The vials were centrifuged at 14000 rpm for 5 minutes to separate debris from the extracted dye. About 200 microlitres of the supernatant from each sample was then analyzed in a UV-visible spectrophotometer at 550nm wavelength using concentrated nitric acid as the blank, and readings were recorded as absorbance units.

Keywords: biodentine, furcation, mineral trioxide aggregate, UV spectrophotometer.

GJMR-J Classification: NLMC Code: WU 220

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Results: All teeth showed microleakage. But MTA gave higher UVspectrophotometric absorbance values than biodentine (mean absorbance 0.0556 and 0.0046).

Conclusion: Based on the results of this study, Biodentine showed better sealing ability compared to MTA and thus may be a good alternative to MTA.

Keywords: biodentine, furcation, mineral trioxide aggregate, UV spectrophotometer.

I. INTRODUCTION

aintaining the integrity of natural dentition is important for the proper function and aesthetics of an individual. Endodontic therapy can play a vital role in achieving this goal. Occasionally mishaps occur during endodontic treatment, one of them is perforation of the root canal wall and furcation, which can significantly impact the long term survival of the tooth. Perforations can be defined as the mechanical or pathological communications between the root canal system and the external tooth surface. These perforations can be repaired nonsurgically with suitable biocompatible, nontoxic, radiopaque and nonabsorbent material, thus preventing bacterial contamination. In permanent teeth, several materials have been suggested for perforation repairs such as amalgam, calcium hydroxide, reinforced zinc oxide-eugenol cement, mineral trioxide aggregate (MTA), calciumenriched mixture (CEM) cement, and Biodentine.

Author α: e-mail: vidhyachandran0@gmail.com

MTA is the commonly used material with a wide range of qualities. Since its introduction by Mahmoud Torabinejad in 1992, it gained an important role and emerged as a widely accepted material for various purposes.

MTA was introduced by Lee *et al.* in 1993 for the repair of lateral root perforations.[2] It consists of dicalcium silicate, tricalcium silicate, tricalcium aluminate, and tetra calcium aluminoferrite. Although MTA has certain drawbacks such as long setting time, difficulty in manipulation, relatively high price, it has a superior sealing ability compared to other restorative materials when used for repairing perforations.

In 2011 M/S Septodont introduced their new tricalcium silicate based restorative cement under the name, biodentine. It is mainly composed of highly pure tricalcium silicate, which regulates the setting reaction, carbonate (filler), calcium zirconium dioxide (radiopacifier), calcium chloride (setting accelerator), water reducing agent (superplasticizer), and water. It has been claimed that this material can be used for pulp capping, pulpotomy, apexification, root perforation, internal and external resorption, and also as a root-end filling material in periapical surgery. It is easy to handle, has a short setting time (12 minutes), has high alkaline Ph(12) and is a biocompatible material. These properties make it a favorable material for repair of perforation.

II. MATERIALS AND METHOD

A randomized controlled *in vitro* trial was planned, and the study was conducted in the Department of Pedodontics and preventive dentistry, Govt Dental College, Kozhikode, Kerala in collaboration with the College of Pharmaceutical Sciences, Govt Medical College, Kozhikode.

Five hundred twenty permanent molars were divided into two groups each having two hundred sixty teeth each.

Molars were amputated 3mm below the furcation area. Endodontic access cavity was prepared. Orifices of the canals were negotiated, and the temporary filling was placed over the orifices of each canal. Perforation was created between the orifices to the furcation area by using a high-speed long shank

round bur No:4. The tooth was completely covered, including cavity walls and pulpal floor by two successive layers of nail varnish except the area 1mm around the margin of the perforation.

Group 1: MTA was mixed according to the manufacturer's instruction and carried to the perforation site with the help of MTA gun and adapted to the perforation defect with the help of hand pluggers. Moist cotton pellet was placed over MTA to allow its setting for 24 hours.

Group 2: Biodentine was mixed according to the manufacturer's instruction and carried to the perforation site with the help of an amalgam carrier and adapted to the perforation defect with the help of a plugger.

After sealing of the defect and setting of the material, all specimens were kept in 100% humidity for 24 hours. 2% methylene blue dye was applied inside the access cavity of all the teeth for 24 hours to check the microleakage. Teeth were placed under running tap water for 30 minutes to remove all residual dye material.

Samples (10 teeth)) were then placed in vials containing 65% nitric acid for 3 days for the extraction of the dye. The vials were centrifuged at 14000rpm for 5minutes to separate debris from the extracted dye. About 2ml of the supernatant was then analyzed in a UV visible spectrophotometer at 550nm wavelength using concentrated nitric acid as the blank, and readings were recorded as absorbance units.



III. Result

Five hundred twenty teeth were selected. Of which 260 teeth were sealed with MTA and the remaining with biodentine. The absorbance value of 10 teeth were recorded at a time. 26 such such samples were evaluated. The data obtained were tabulated and computed statistically using independent T- test.

Mean and standard deviation were estimated for each group to evaluate the absorbance of MTA and biodentine.

Table 1: Mean value of absorbance for MTA and biodentin in permanent teeth:

GROUP	MATERIAL USED	Ν	MEAN ABSORBANCE
1	MTA	26	0.0556
2	BIODENTIN	26	0.0046

Table 2: Standard deviation and p- value of absorbance in permanent teeth:

GROUP	MATERIAL USED	Ν	STANDARD DEVIATION	P VALUE
1	MTA	26	0.0556	0.001
2	BIODENTINE	26	0.0046	0.001



Graph 1: Comparison of mean absorbance values of MTA and Biodentine

IV. Discussion

The success of the furcation repair depends on various factors like size and location of the defect, time and duration of exposure to contamination, the material used for repair, the possibility of sealing the perforation, etc. A factor that is under the control of the operator is the choice of material to be used that enhances treatment outcome. To obtain success, the perforation repair material should ideally trigger the formation of new bone, periodontal ligament and cementum. In the search of the ideal material, numerous sealing materials and techniques have been tested over the years with varying success. The search for alternative agents has been aimed to overcome the drawbacks of previously used materials to reduce the cost and to increase the feasibility of both professionals and patients. The present study is the first of its kind to compare the sealing ability of Biodentine and MTA in repairing the furcal perforation in permanent molars using the dye penetration technique.

There are several methods that can be employed to evaluate the sealing ability of repair materials other than dye penetration technique, like SEM, fluid filtration technique, bacterial and protein leakage model, etc. Recent methods include radioactive isotopes, artificial caries, neutron activation analysis and electrical conductivity. The present study has utilized methylene blue as a dye because it is inexpensive, easy to use, has a high degree of staining and a molecular weight even lower than that of bacterial toxins. With regard to dyes particle size, pH and chemical reactivity are believed to affect the degree of penetration. Biodentine is very similar to MTA in basic composition. The manufacturers claim that the addition of setting accelerators and softeners, in a new predosed capsule formulation for use in a mixing device predominantly improves the physical properties of the material, making it more user-friendly. Biodentine does not require two-step obturation as the setting is faster and thus has a lower risk of bacterial contamination making it superior to MTA.

Allwyn Samuel et al (2016) evaluated the sealing ability of biodentine and MTA in primary molars using SEM and concluded that biodentine showed significantly less leakage (0.149) compared to MTA(0,583).

Soundappan *et al* (2014) comparison with MTA and intermediate restorative material (IRM) using SEM. They conducted the study using thirty permanent central incisors and stated that in overall comparison, MTA and IRM were significantly superior when compared to Biodentine in terms of marginal adaptation when used as retrograde filling material.

El Choudary HM *et al* (2011) evaluated sealing ability of four calcium containing cements (MTA, Portland cement, biodentine and tech biosealer). The study showed there was no significant difference between the mean microleakage values obtained in the four tested materials after 24 hours, 1 month, 6 months and 1year. But the microleakage values for each individual material were significantly higher at 24 hours than at the other time intervals.

V. Conclusion

Artificially made furcal perforations in permanent molars were randomly sealed with MTA and Biodentine. The teeth were then evaluated for methylene blue dye leakage. The dye extracted using nitric acid was assessed in a UV spectrophotometer and the absorbance units were recorded. In this study, MTA showed higher microleakage and hence higher absorbance values than Biodentine. From the above inferences, the study concluded that Biodentine with better sealing ability compared to MTA and may be a good alternative to MTA in the management of furcal perforations in permanents molars, thereby increasing the longevity of the tooth.

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Conflicts of interest: There are no conflicts of interest.

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Appraisal of Thyroidectomy in Outlying Tertiary Care Hospital By Dr. A H M Delwar

Comilla Medical College

Abstract- Objective: To find out the prevalence, presentation, disease patterns, operations of the thyroid gland and facilitate the prevention of complications and a risk factors for it.

Study design: Cohort retrospective study.

Setting: Academic tertiary care hospital.

Subject and Methods: A total of 173 euthyroid benign and malignant goiter patient's demographic data, diagnosis, operations, complications, and management options collection and analyzed who attended in the department of Otolaryngology and Head-Neck Surgery, Comilla Medical College, and Comilla Medical Centre, concern Clinic of Central Medical College, Comilla, Bangladesh from 01 July 2016 to 31 June 2019.

Results: Incidence of euthyroid benign and malignant Goiter among outpatient was 0.12%, and the yearly prevalence of 33.34%. Out of 173, the male was 20 (11.56%), and the female 153 (88.44%), 30-39 years patients have the highest presentation was 60 (88.44%), 20-29 years 40 (23.12%), and 40-49 years 38 (21.97%), euthyroid benign goiter was 142 (82.08%), and malignant 31 (17.92%).

Keywords: hemithyroidectomy (HT), total thyroidectomy (TT), completion thyroidectomy (CT), selective neck dissection (SND), recurrent laryngeal nerve (RLN), hypoparathyroidism, RTL (rigid telescopic video laryngoscopy).

GJMR-J Classification: NLMC Code: WK 200

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Conclusion: Thyroidectomy is a criterion procedure for surgeons. The surgeon should know the anatomy, pathology, various indications for optimal surgery, and postoperative complications to maintain the successful outcome of it, which is tough.

Keywords: hemithyroidectomy (HT), total thyroidectomy (TT), completion thyroidectomy (CT), selective neck dissection (SND), recurrent laryngeal nerve (RLN), hypoparathyroidism, RTL (rigid telescopic video laryngoscopy).

I. INTRODUCTION

oiter uses to describe as a generalized enlargement of the thyroid gland. lodine deficiency is the leading cause of goiter in the world [1]. Goiter may be present from the third and fourth decade of life and may cause dysphagia and obstructive symptoms. In children, it may cause mental retardation and neonatal cretinism [2]. Nutritional International (NI) works with universal salt iodization in Bangladesh from 2000 and work is ongoing. The Wickham survey observed 15% of people existing with goiter in the iodine-exuberant area, and 7% of people attended with visible goiter [3]. Higher frequency of goiter found in women and the elderly [4]. Euthyroid glandular enlargement may be diffuse or nodular. The thyroid malignancy accounts for 1% of all other new malignancies [5]. Differentiated thyroid cancer papillary represents 72%-85%, and follicular 10-20% of all thyroid cancers, medullary 1.7-35%, anaplastic less than 1% and other carcinoma 1-4% [6]. Women are 5-10 times greater prevalence of nodular goiter, and cancer prevalence 1.5% in women, which comprises 0.5% in men [7]. The majority of patients remain asymptomatic, but sometime 30-80% patients may complain of dysphagia and dyspnoea [8]. Diagnosis of thyroid swelling confirmed by history, clinical examination and investigation, and even suspected cancer in some instances [9]. Initial laboratory investigation is FT₄, FT₃, and TSH of patients with thyroid swelling advocated by ATA and BTA [10]. Diagnostic imaging includes highresolution ultrasonography (USG), CT, MRI in which USG routinely uses for evaluation of thyroid nodule [11]. FNAB or FNAC (Fine Needle Aspiration Biopsy or Cytology) is the gold-standard investigation to the diagnosis of benign or malignant nodular goiter except follicular adenoma with carcinoma due to capsular and vascular invasion depends on histological criteria, and allowing accurate cell collection through USG guidance [12]. Preoperative laryngeal examination by FOL or RTL should complete on all patients [13]. Upon the principles of Kocker's surgical technique, usually practiced surgery was hemithyroidectomy, near-total thyroidectomy or Dunhill's thyroidectomy (NTT), total thyroidectomy (TT) with or without neck dissection (ND) [14]. The leading complications of surgery are injury to the external branch of the superior laryngeal nerve (EBSLN), RLN, and the parathyroid glands [15] [16]

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Author: MBBS, DLO, MCPS (ENT), MRCPS (Glasgow), UK, FMRC (USA), Associate Professor of Otolaryngology, Comilla Medical College, Comilla, Postcode-3500, Bangladesh. e-mail: mamun.delwar196@amail.com

[17]. Intraoperative neural monitoring (IONM) device is available in the developed country to save the nerve where it routinely used in total thyroidectomy and neck dissection [18]. If the parathyroid gland dissected, the sample collected and sent for frozen section analysis; if the parathyroid gland it should be implanted in sternomastoid muscle after sectioning it around 12 pieces [17].

II. METHODS AND MATERIALS

The study performed in two tertiary care hospitals. During three years period, 116128 patients attended in the outpatient department of the Government Comilla Medical College Hospital and 33840 in the private Comilla Medical Centre, Comilla, an outlying city of Bangladesh. Out of 149968, euthyroid glandular thyroid patients were 173. All patients were clinically diagnosed as euthyroid benign and malignant thyroid swelling and confirmed by history, examination. and investigations such as thyroid function test, serum calcitonin, USG of the neck, FNAC, or FNAB, and RTL to ensure vocal cord mobility, CT scan, and MRI whichever were needed. The following information collected about the patients: Gender, age, personal history, presenting features, investigations, disease pattern and surgical options, postoperative complications, and management. Descriptive statistics used to calculate the data. Microsoft office 2007 used to cite figures and tables.

III. Results

Incidence among outpatient was 0.12% and yearly prevalence of 33.34%. Out of 173, the male was 20 (11.56%), and the female 153 (88.44%), 0-9 years patient was nil, 10-19 years were 06 (3.47%), 20-29 years 40 (23.12%), 30-39 years 60 (34.68%), 40-49 years 38 (21.97%), 50-59 years 19 (10.98%), 60-69 years 07 (4.05%), and above 70 years 03 (1.73%), age range 17-75 years, mean age 39.22 and the standard deviation 12.275. Personal history revealed patient from endemic zone was 57 (32.95%), non-endemic zone 116 (67.05%), smoker 29 (16.76%), non-smoker 144 (83,24%), diabetic 26 (15.03%), non-diabetic 147 (84.97%), hypertensive 33 (19.08%), non-hypertensive 140 (80.92%), and goitrogenic food habit like onions, carrots, sweet potato, radishes, cauliflower, cabbage, kale and turnips was 173 (100%). Presenting features showed asymptomatic invisible or visible swelling (40ml or greater size) was 173 (100%), dysphagia and dysphoea 31(17.92%), difficulties to wear necklaces 23 (13.29%), signs of goiter according to WHO, grade o: impalpable/invisible was 00, grade 1a: palpable but invisible even in full extension 07 (4.05%), grade 1b: palpable in neutral position/visible in extension 32 (18.50%), grade2: visible but no palpation require to make diagnosis 41(23.70%) and grade3: visible at a distance 93 (53.75%). The common investigation did for all patients: 1. Serum FT₃, FT₄, TSH, 2. Serum Calcitonin. 3. USG of thyroid gland and neck, USG guided FNAB whichever were needed. 4. FNAC, 5.CT scan or MRI, if needed; 6. RTL did to ensure normal vocal cord mobility. Disease pattern exhibited euthyroid benign goiter was 142 (82.24%), and malignant goiter 31(17.92%). Out of benign 142, nodular goiter was 104 (73.24%), multinodular goiter 25 (17.61%), and follicular adenoma 13 (9.15%). Among malignant 31, papillary carcinoma was 29 (93.54%), carcinoma 01(3.23%), and follicular medullarv carcinoma 01 (3.23%). According to the 8th edition of AJCC, the staging of malignant tumor, stage-1 $T_1N_0M_0$ was 09 (29.03%), and $T_2N_0M_0$ 20 (64.51%), stage-2 $T_2N_1M_0$ was 01 (3.23%), and stage-3 $T_{4a}N_1M_0$ 01 (3.23%). The operation performed hemithyroidectomy was 136 (78.61%), total thyroidectomy 35 (20.23%), completion thyroidectomy 02 (1.16%), and selective neck dissection two, one with total thyroidectomy and another with completion thyroidectomy. Postoperative complications showed hemorrhage was 02 (1.16%), hematoma 05 (2.89%), wound infection 01(0.58%), keloid 01 (0.58%), RLN paralysis temporary/unilateral 35 (20.23%), permanent/bilateral paralysis 02 (1.16%), and temporary hypoparathyroidism 12 (6.93%). Management of complication exhibited 47 (81.03%) treated conservatively, and 11 (18.97%) surgically.

Hemorrhage after a thyroid surgery is medical emergency because it created tension hematoma of the causing respiratory distress. The patient neck, immediately transferred to operation theatre and removed all layers of the wound after stitch cutting-one patient's bleeding from a punctured anterior jugular vein and another from thyroid vein. We properly secured the bleeding point stitching by 2/0 vicryl. Five patients had a subcutaneous hematoma. We off one or two stitches, evacuate the collection and applied pressure bandage. One patient suffered wound infection, and we cut the stitch like hematoma, evacuate the pus, and change the antibiotic according to culture and sensitivity test. One patient came with a keloid on incision the line. We excised the keloid, and after wound healing, gave the Injection steroid in the lesion every fifteen days for three months. 35 unilateral RLN paralysis patients treated medically by steroid, multivitamin, and combination of B₁ (Thiamine), B_6 (Pyridoxin), and B_{12} (Cyanocobalamine). Thirty-two patients improved, and rest 03 gave Injection augmentation through the surgical procedure under general anesthesia. Two patients suffered bilateral RLN paralysis treated surgically by cordectomy. Temporary hypoparathyroidism diagnosed by Trousseau's sign or tetany. We added Tablet Rocal-D which contain calcium carbonate USP 1250 mg with equivalent to 500 elemental calcium, vitamin D₃ (cholecalciferol) USP 200 IU, two tablets three times daily, and Tab Sun D (Cholecalciferol) 1000 IU, one tablet two times daily after the postoperative period, and continued, for six months after the operation. If tetany sign continued we added Inj. Calcium Gluconate 50 ml in 500 ml normal saline eight hourly up to the tetany sign disappeared.



Figure-1: Nodular Goiter.



Figure-2: Multinodular (MNG) Goiter.



Figure-3: Papillary Carcinoma of thyroid.



Figure-4: Follicular carcinoma of thyroid. Table-1: Disease pattern and operations performed.

Serial	Disease	Number of patient	percentage	HT Right	HT Left	СТ	Π	SND
1.	Benign Goiter	142	82.08%	00	00	00	00	00
1.1	Nodular	104	7324%	63	41	00	00	00
1.2	MNG	25	17.61%	09	05	00	11	00
1.3	Follicular Adenoma	13	9.15%	06	07			
2.	Malignant Goiter	31	17.92%	00	00	00	00	00
2.1	Papillary carcinoma	29	93.54%	02	03	02	22	02
2.2	Follicular carcinoma	01	3.23%	00	00	00	01	00
2.3	Medullary carcinoma	01	3.23%	00	00	00	01	00
Total		173	100%	80	56	02	35	02

Table-2: Postoperative complications.

Serial	Complication	HT	TT+-SND	CT+-SND	Total	Percentage
1.	Hemorrhage	01	01	00	02	1.16%
2.	Hematoma	03	02	00	05	2.89%
З.	Wound infection	00	01	00	01	0.58%
4.	Keloid	01	00	00	01	0.58%
5.	RLN paralysis					
5.1	Temporary/ Unilateral	20	15	00	35	20.23%
5.2	Permanent/ Bilateral	00	01	O1	02	1.16%
5.3	Total	20	16	01	37	21.39%
6	Hyoparathyroidism					
6.1	Temporary	00	11	01	12	6.93%
6.2	Permanent	00	00	00	00	00
Total		25	31	02	58	33.53%



Figure-5: 1. Gender epidemiology. 2. Age distribution. 3. Personal history.



Figure-6: 1. Presenting feature according to WHO. 2. Staging of Malignant tumor by AJCC 8th edition. 3. Management of complications.

IV. DISCUSSION

Goiter or thyroid swelling is mention when it exceeds the normal volume, which is 25 ml for men and 18 ml for women. The incidence of thyroid swelling among outpatient in our study was 0.12%, and the yearly prevalence of 33.34%. Ansar MAJ reported clinically evident thyroid prevalence was 10%, and subclinical hypo and hyperthyroidism was 10%, total 20% prevalence in Bangladesh, which is near to our work [19]. Weigle et al. also described 3.95% of Indian people suffering from thyroid origin disease, which is near to all Asian countries like Bangladesh [20]. Volzke et al. study showed that the prevalence was 35.9% in the endemic iodine deficiency area than the nonendemic area consistent with our research [21]. Considering gender epidemiology, females were predominant in our study showed females, males ratio has gaps in 7.65: 1 supported by Altaf et al. study represented 5.49:1 female, male ratio, and Vanderpump MPJ study reported a higher prevalence in females [22] [23]. Hegedus et al. work also held up our result exhibited frequency higher in the elderly and female [4]. Hu et al. study showed female, the male ratio was 6.79: 1carried out of our paper [24].

Regarding age, in our work displayed maximum age incidence was 3rd to 5th decade, age range 17-75 years and mean age 39.22 years consistent with Rajkhowa et al. series, reported maximum age incidence was 3rd to 4th decade [25]. Hu et al. study showed the mean age was 52 years and the age range 9-87 years against our presentation [24].

About personal history, in the present study, 32.95% of patient came from iodine-deficient endemic zone, which was the most common cause of hypothyroidism and goiter worldwide supported by Delange et al. [26]. 100% of patient in our series had goitrogenic food habits contain thiocyanate, drugs such as paraaminosalicylic (PAS) acid and antithyroid drugs interfere with the oxidation of iodide and binding of iodine to tyrosin. A large amount of iodides are goitrogenic [27]. Smoker (29), diabetic (26), and hypertensive (33) patients need and gave especial anesthesia, attention during operation, and postoperative period.

The presenting features are important for preoperative assessment and giving the proper direction on how to approach the surgical procedure supported by Chen et al. study [28]. The present study showed asymptomatic invisible or visible swelling was 100%, dysphagia, and dyspnoea 17.92%, and difficulty to wear necklace 13.29% held up by Shin and Stang et al. exhibited dysphagia to solid foods, globus sensation and dyspnoea [29] [30]. According to WHO, grade-1_a was 4.05%, grade-1_b 18.50%, grade-2 23.70%, and grade-3 53.75% near to Chen et al. paper [28].

About the investigation serum FT₃, FT₄, and TSH determination is an essential first step of investigation to know the functional status of goiter, whether it is hypo, hyper, or euthyroid, to take medical or surgical decision held up by Chen et al. paper [28]. Serum calcitonin measurement is one of the indicators of medullary carcinoma kept up by Toledo et al. work [31]. To assess any kind of thyroid swelling high-resolution USG, and USG guided FNAB or FNAC is benchmark procedure to give the features of microcalcification, irregular margin, extrathyroidal hypoechogenicity, extension, hypervascularity, and abnormal lymph node carried out by Radecki and Fish et al. research [32] [33]. CT scan and MRI help to detect the nodal disease, irregular borders or microcalcification, and tracheal compression kept up by Cooper et al. presentation [34]. If any suspicion of malignancy intravenous contrast should avoid which delay the RAI treatment carried out by Leung et al. paper [35]. FNAC or FNAB has excellent patient compliance, and diagnosis including colloid nodules, thyroiditis, papillary carcinoma, medullary carcinoma, anaplastic carcinoma, and lymphoma except follicular adenoma and follicular carcinoma not due to cytological but histological characteristics of capsular and vascular invasion kept up by Cibas et al. study [36]. Preoperative laryngoscopy is essential to assess the vocal cord mobility is normal or restricted due to invasion of RLN by thyroid malignancy held up by Randolph et al. work [37].

Disease pattern showed euthyroid benign goiter was 142 (82.08%) and euthyroid malignant goiter 31(17.92%) near to Pacini et al. study showed the incidence of malignancy of thyroid swelling was 10% [38]. Out of benign goiter, nodular was 73.24%, MNG 17.61%, and follicular adenoma 9.15% against our work by Vanderpump MPJ, and Altaf et al. study showed MNG was 37.3%, nodular goiter 23.2% [23] [22].

Thyroid malignancy in our study showed papillary carcinoma was 93.54%, follicular carcinoma 3.23%, and medullary carcinoma 3.23% near with Altaf et al. work showed papillary was 83.1%, medullary 9.9%, and follicular 6.9% [22]. Plauche and Al-Salamah et al. also exhibited papillary carcinoma was highest of all other thyroid malignancy 57-89% consistent with our study [39] [40].

The surgical procedure revealed in our study hemithyroidectomy 78.61%, total thyroidectomy 20.23%, completion thyroidectomy 1.16 %, and selective neck dissection (SND) performed in two patients, one with total thyroidectomy, and another with completion thyroidectomy. We did hemithyroidectomy, 136 patients, in which nodular goiter was 104, MNG 14, follicular adenoma 13, and low-risk papillary carcinoma 05. About nodular goiter, MNG (Clinically one side was micronodular), and follicular adenoma (one lobe), hemithyroidectomy was perfect operation supported by Mehanna and Kandil et al. study [41] [42]. Hemithyroidectomy of low-risk papillary carcinoma needs long term to follow up essential to understanding the patient carried out by Udelsman and Shrime et al. work [43] [44]. We did total thyroidectomy 35 patients in which MNG was 11, papillary carcinoma 22, follicular carcinoma 01, and medullary carcinoma 01 consistent with Bron and Udelsman et al. study [45] [46]. We did completion thyroidectomy for two patients in which one patient was incidental diagnosis of high-risk papillary carcinoma with tumor size >4 cm and age >55 years. Another case of low-risk papillary carcinoma, in follow up she presented with lymph node metastasis need completion thyroidectomy with selective neck dissection to provide adjunct RAI ablation carried out by Barney and Simo et al. [47] [48].

About postoperative complications in the present study showed hemorrhage was 02 (1.16%), hematoma 05(2.89%), wound infection 01 (0.58%), keloid 01(0.58%), temporary/unilateral RLN paralysis 35 (20.23%), permanent/bilateral RLN paralysis 02 (1.16%), and temporary hypoparathyroidism 12 (6.93%) near to Ignjatovic and Derby et al. series [49] [50]. IONM was not available in our surgical set up due to the high cost, and the maximum of our patients came from the poor class held up by Al-Qurayshi et al. paper [51].

V. Conclusion

Thyroid operation is now a regular procedure for surgeon and should maintain some rules and regulations. The informed written consent from the patient and attendant should include before thyroidectomy. The potential complications discussed with the patient, and the probable surgical option disclose for the patient preferences. After the selection of the patient for thyroidectomy, all investigation should complete to diagnose the swelling is benign or malignant. If malignant swelling, carefully find out the staging of the malignant tumor to select the operational procedure. Thyroid surgery is a team work for surgeons and assistants to attain successful thyroid surgery without any complications.

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Investigation of Ceramic Dental Prostheses based on Zrsio4 – Glass Composites Fabricated by Indirect Additive Manufacturing

By Marlon Wesley Machado Cunico, Ph.D.

Abstract- Technologies for dental prosthesis and restoration have been developed during the past years. Despite the advantages of additive manufacturing, CAD/CAM technologies lead prostheses fabrication. Therefore, the main goal of this work is to investigate the fabrication of dental prosthesis based on ZrSiO4-glass composites applying the indirect fused deposition modelling. In order to achieve this goal, we used filaments filled by 90% of ZrSiO4 and 50µm glass spheres in order to fabricate prosthesis. We also applied multivariable approach to scan the feasibility of the proposed process. Holding temperature, holding time, heating rate and cooling rate were considered the control factors while shrinkage, flexural strength, process feasibility were the study responses. It was possible to see the proposal feasibility for holding temperatures between 700 and 800°C and holding time between 1 and 4 hours. Additionally, the materials flexural strength was found between 25 and 85MPa, while shrinkage fluctuated between 10 and 25%.

Keywords: FDM ceramic sintering, additive manufacturing, ceramics.

GJMR-J Classification: NLMC Code: WU 500

INVESTIGATIONOFCERAMICDENTALPROSTHESESBASEDONZRSIO4GLASSCOMPOSITESFABRICATEDBY INDIRECTADDITIVEMANUFACTURING

Strictly as per the compliance and regulations of:



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I. INTRODUCTION

uring the last years, additive manufacturing (AM) technologies started playing an important role in several segments (Cunico and de Carvalho, 2016). In addition, development of dental materials and applications points to digital fabrication whereas dental implants are majorly fabricated by CAD/CAM techniques in collaboration with 3D scanning (Sulaiman, 2020, Li et al., 2014).

Table 1 shows the most common techniques which are used in accordance with the type of dental prosthesis. Therefore, it is possible to see that CAD/CAM is currently the most used technique in prosthodontics (Karthick et al., 2019). On the other hand, additive manufacturing is still used for medical/dental models and temporary dentures, whereas there are not long clinical records and mechanical strength is usually lower than CAD/CAM technologies (Sulaiman, 2020, Li et al., 2014, Gali and Sirsi, 2015, Karthick et al., 2019).

Author: e-mail: marloncunico@yahoo.com.br

Table 1:	Mapping	of Prosthodonti	cal technologies
			0

		Classic Dentistry Technologies			A	\dditive r	nanufact	uringTeo	hnologie	s		
		Sintering	slip casting and Casting	Hot-pressed/ Injection Molded Ceramics	UV resin molded	CAD/CAM	IMITS	STS	Bindlet Direct or infiltrated	Multijet	SLA / DLP - Direct or Wax-like crastrable	FDM / Extrusion based
	Crown and bridges	,[7]	[2],[7]	[2]		[1], [2], [3],[4],[7],[8]	[3],[8]	[8]				
	Denture	,[7]	[2]	[2]		[1], [2], [3],[4],[7],[8]	[3],[8]	[8]				
5	Denture holder	,[7]		[2]		[1], [2], [3],[4],[7],[8]	[3],[8]					
Application	Copings	,[7]	[2]			[1], [2],[4],[8]	[3],[8]					
ચ	casting patterns /lost wax	,[7]		,[7]		[1], [4]				[3],[8]	[3],[8]	
	provisional / temperary crown					[1]		[6]		[5]	[3],[5]	
	dental model					[1]				[3] ,[5], [6]	[5], [3]	
	surgical guide					[1],[3]				[3],[6]	[3]	1
	surgical guide plate					[1],[3]		[5]	[5]	[5]	[5]	[3]
	splints					[1]				[3],[5]	[3],[5]	1
	Prosthetic Constructions					[1]						
	All-Ceramic	1	1	[2]		1,[6]		[6]				
	Porcelaine	1		[2]		1, [6],[7]						, [6]
	Y-TZP	1				1 , [6],[7]						
FIA	Metallic		1			1 ,[6]	[1],[5]					
б В	glass-ceramic	1	1	[2]		1,[6]		1,[6]	1	[6],[8]		
~	Polymer-Ceramic Composite	1	1			1, [6],[7]		1	1		[3],[4],[5],[8]	
	Metal-Ceramic Composite	1	1			1,[6]		1				
	Polymeric material		ſ			1		1	1	(31,[8]	[3],[4],[51,[8]	

1 - (Lin et al., 2019) ; 2- (Denry, 1996); 3-(Lin et al., 2019); 4- (Li et al., 2014); 5- (Sulaiman, 2020); 6- (Denry and Kelly, 2014); 7-(Anusavice, 2013); 8-(Torabi et al., 2015)

In spite of that, CAD/CAM techniques also show some disadvantages, such as:

- Requirement of high trained professional to operate 5 axes CNC.
- High cost of raw material
- Excessive waste generation
- High cost of maintenance
- Short life time of tooling

On the other hand, additive manufacturing might bring the fabrication of dental prosthesis to the next level, increasing automation, flexibility, shape freedom and fabrication speed. Nevertheless, material and technology restrictions, such as mechanical strength, type of material, bio reactivity and cost are still challenges to be overcome (Lin et al., 2019).

For that reason additive manufacturing technologies are widely used for:

Provisional crown and bridge restorations, casting patterns, dental models, surgical guide and splints. On the other hand, AM technologies still need to be developed in order to apply in dental implants, crown and bridges denture and prosthetic constructions.

Therefore, the main goal of this work is to propose and investigate the feasibility of a novel dental prosthesis fabrication method which is based in ZrSiO4-glass composite, as illustrated in Figure 1.



Figure 1: Schematic of ceramic dental prostheses based on ZrSiO4 – Glass composites fabricated by indirect Additive manufacturing

In this method, the collapsible ZrSiO4 mould of negative of crown or bridge is fabricated by additive manufacturing based on fused filament. Therefore, the negative cavity is filled by Lanthanum glass powder in order to be subsequently sintered. By the end, the pieces are heated in order to debind the negative structure and then create sintered composite pieces.

In order to evaluate the feasibility of this technique, we applied multivariable techniques to investigate the main effect of control factors on responses. Holding temperature, holding time, heating rate, cooling rate and shrinkage chamber were the control factors while shrinkage, flexural strength, process feasibility were the study responses. We have also kept the fabrication parameters, materials formulation, flexural testing specimen shape and crown shape constant.

As a consequence, it was possible to identify whether the proposed process has potential feasibility to make dental prosthesis.

II. MATERIAL AND METHODS

In order to investigate the feasibility of the proposed process in addition to the main effect of control factors on responses, we applied a 2^{k} multivariable methodology (full design with body central point) where: Holding temperature (T_{h}), holding time (t_{h}), heating rate (R_{h}) and cooling rate (R_{c}) were the control factors. In addition, we also defined 3 step screening in augmented design approach in order to minimize the holding time and maximize densification and mechanical properties.

The levels and values of each control factor is presented in Table 2, where it is possible to see that the

values of holding temperature are between the activation temperature of glass and ZrSiO4 (700°C) and the melting temperature of glass (1078°C).

It is also possible to indicate that the cooling time enhance two types of heat treatment (Quenching for fast cooling and annealing for slow cooling). Therefore, it is possible to see the effect of such treatments on, crystallization level, mechanical strength and geometry distortion.

On the other hand, holding time and heating rate are expected to affects the sinterization parameters, such as nucleation, grain growth and diffusion.

			Level	
	Control Factors	-1	0	1
	sintering/kiln			
	heating rate(Hr) (°C/min)	2	3.5	5
	Holding temperature (Th) (°C)	700	800	900
step	holding time(th) (h)	1	2.5	4
1st :	cooling rate (Cr) (°C/min)	2		30
g	sintering/kiln			
d St	Holding temperature (Th) (°C)	700	750	800
2n	holding time(th) (h)	1	1.75	2.5
읍	sintering/kiln			
러러	Holding temperature (Th) (°C)	700	725	750
35	holding time(th) (h)	2.5	2.875	3.25

Table 2: Experiment Design

For the sintering process, we used a 2000W electrical Furnace PID controller with 4 ramps curves and insulation muffle. The main control parameters are

illustrated in Figure 2 in addition to the schematic sintering temperature curves that we applied in this study.



Figure 2: Illustration of sintering temperature curves and control factors: Holding Temperature (T_{hold}), holding time (t_{hold}), cooling rate (k) and heating rate (Hr)

The performed in flexural testing was accordance with ISO 6872 in an EMIC DL10000 universal testing machine.

For the image processing, we used the software MATLAB, while the image acquisition was performed by the optic microscope Digital Avangard Optics AN-E500 (AVANGARD 2011). This optical microscope provides until 500x of amplification magnitude. For the gravimetric analysis (drying monitoring), we used a 0.005g error scale.

In order to identify the specimen dimensional we used 0.05mm calliper besides distortions, computational image processing and MATLAB software to evidence the geometrical variation of object external contour.

In order to measure feasibility response, we established a scale from 0 to 1. In this scale, 1 level indicates that object has no significant distortions and is feasible to be used. In addition, 0.75 levels expose minor distortion which corresponds to 5% of distortion. Likewise, 0.5 feasibility level indicates that the object has 10% of distortion.

It is important to note that although shrinkage is a sort of volumetric distortion, feasibility response only analysed non volumetric distortions.

For specimens fabrication, we used a FDM process and filament filled by 90% of ZrSiO4. The main process parameters were remained constants, where extrusion temperature was 220°C, layer thickness was 0.1mm; distance between filaments was 0.2 mm; and nozzle diameter was 0.4mm. Additionally, we have also considered no support material and no retract to build the specimens. In all the cases, the extrusion temperature and chamber temperature were also kept constants, while no bed temperature was established. The fabrication environment was also controlled in 25°C of environment temperature and 50% of relative humidity.

III. Results and Discussions

In general lines, the evaluation of concept feasibility was satisfactory, whereas a feasible process window was identified. From geometric point of view, the crown was obtained in low sintering temperatures while high levels of temperature distorted the geometry because of excessive melting and high shrinkage. With regards to the main effect of control factors on the feasibility, mechanical strength and shrinkage, Figure 3 indicates that holding temperature causes the strongest effect on the feasibility and flexural strength in comparison with the other control factors. On the other hand, holding time is the factor that affects shrinkage the most.

In this diagram, it is possible to see that holding time and holding temperatures are the most relevant factors for the augmented design. Therefore, the second screening round focused in increase the detail of feasible areas.

The flexural strength was also affected by heating rate, indicating that densification of material might have reduced the strength of material.



Fitted Mean Effects

Figure 3: Main effect of control parameter on feasibility, flexural strength and shrinkage

With regards to the feasibility of proposed concept, the main effect diagram (Figure 4) indicated that high level of temperature implies on the unfeasibility of concept apart from time holding, cooling rate and heating rate. It is also possible to see that holding temperature is the most relevant parameter for the feasibility, being followed by holding time. In contrast, heating and cooling rates were found not to affect feasibility.

Continuing analysing the concept from the geometric point of view, it was possible to see that the shrinkage varied from 13.4% to 27% into the feasible area. The lowest value of shrinkage was found for heating rate equal to 5°C/min, holding temperature of 700°C, holding time equal to 3.25h and cooling rate of 30°C/min. Likewise, the highest value found resulted from heating rate equal to 2°C/min, holding temperature of 700°C, holding time equal to 4h and cooling rate of 2°C/min.



Figure 4: Standardized Main effect of control factors on Feasibility, Flexural strength and shrinkage

In this case, Figure 4 indicates the main effect of control parameter shrinkage. It is possible to see that holding temperature is the factor which is the most relevant for the shrinkage, while heating rate presented the smallest effect among the control parameters.

With respect to material mechanical strength, Figure 4 also indicates the main effect of control parameter on flexural strength. It is possible to see that temperature and heating rate are the most relevant factors for the mechanical strength, while cooling rate presented the smallest effect among the control parameters.

The mean values of flexural strength varied from 25 to 82MPa, where the lowest values were found in low holding temperatures (700°C) and short holding time (1h). On the other hand, the highest values were obtained by long hold time (1h) and 800°C of holding temperature.

It is also important to indicate that this process does not evaluate the effects of neither heating treatment nor material, therefore. Further studies still need to be done in order to apply stronger materials and heating treatments in this concept.

Additionally, Figure 5 indicates a comparison diagram of geometrical concept feasibility as a function of holding temperature and holding time. In this figure, it is possible to see a feasibility line that separates the results which were considered feasible and unfeasible from the geometrical point of view.

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Figure 5: Comparison diagram of concept feasibility as a function of Holding temperature and holding time

We also separated the feasibility in 2 areas, whereas high grain growth is obtained in low temperature (700°C) during long holding time (4h). In these areas, it is possible to see a specimen with high densification. On the other hand, low grain growth is obtained in low temperatures (700°C) during short periods of time (1h), where the specimen presented low densification. Noteworthy, the centre point of the study indicated a limit of feasibility so that the sintering process can be directed correlated to the absorbed energy as a function of time and Temperature.

The unfeasible area is highlighted by high densification, and excess of deformation because of viscosity decrease. In addition, this reduction implied on mould infiltration and subsequent incrustation of collapsed mould on object surface.

It was seen that the material obtained in high temperature and long holding time implied on high densification and grain size which are bigger than grain in material from low temperatures. This situation can be seen in Figure 6, where the comparison of material densification and grain size is presented.



Figure 6: Comparison between low (a) and high (b) densification

In order to better understand the behaviour of material properties as a function of holding temperature and holding time, Figure 7 exposes contour diagrams of feasibility, shrinkage and flexural strength. Additionally, this figure also presents an overlap diagram which indicates the process window where high values can be obtained.



Figure 7: Contour diagrams of Flexural strength, feasibility, shrinkage and the overlap diagram with combination of high values

According to this figure, high values of feasibility flexural strength and low values of shrinkage are obtained by holding time around 750°C and holding temperature around 1.5h. In this case, values of flexural strength fluctuate around 65MPa, while shrinkage values do around 15%. In this case, feasibility ratio was considered higher than 0.9.

This concept has been shown to work and open a new possibility to fabricate glass-ceramic materials by AM technologies. However, further studies are still needed to improve mechanical strength, diversify the glass-ceramic materials and applications.

IV. Conclusions

To sum up, this work evidenced the feasibility of the glass-ceramic fabrication based on collapsible additive manufactured mould of ZrSio4. The working proof of this concept generates new perspectives to AM in dentistry, ceramics and medical applications, whereas this collapsible AM mould supports up than 2300°C.

This study identified that the holding temperature was the factor that mostly influences the feasibility, strength and shrinkage, being followed by holding time. In this case, holding time directly affects the material densification and grain growth. As consequence, long time and high temperatures

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increases the densification and soften the material so that the geometry is distorted and the process become unfeasible.

On the other hand, flexural strength fluctuated between 25 and 82MPa, and has been highly affected by heating rate and cooling rate. However, this study did not analyse heating treatment. Therefore, further studies are still needed to be done in order to apply new materials, heating treatments and increase mechanical and geometrical properties.

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10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. *Know what you know:* Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. *Multitasking in research is not good:* Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. *Never copy others' work:* Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. *Think technically:* Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



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Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- o Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- o Report the method and not the particulars of each process that engaged the same methodology.
- o Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- o If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- o Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- o Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- o In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- o Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- o Do not present similar data more than once.
- o A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- o Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

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Topics	Grades		
	А-В	C-D	E-F
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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