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Three dimensional Reconstruction and finite element modelling of middle ear in the study of middle ear biomechanics for clinical applications

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ABSTRACT--*Three Dimensional Reconstruction and finite element modelling of middle ear in the study of middle ear biomechanics for clinical applicationsComputerised models are more commonly being used for understanding the acoustics of middle ear, pre-op planning and simulation of clinical situations, especially when dealing with tiny complex anatomical regions like the middle ear. One technique used to analyse the mechanics of complex models is the method of finite element model formation, whereby the system of interest is divided into varios number of small simple elements. (1-2)To study middle ear mechanics in normal stateTo study middle ear mechanics in diseased stateTo study the effect of various surgical interventions namely-mastoidectomy,grafting,tympanic membrane grafting, ossicular reconstruction as well as lowering of posterior canal wall- on middle ear biomechanics.(4)Building of a simple modelThe FE modelling approach will be divided into three parts:Computerised modelling of the geometry of middle ear (19)Construction of a working finite element model Calibration of the working model in real time with human ears to obtain the final finite element model. (3) Computerised geometric modelling by HRCT of temporal boneHRCT scan will be performed in this study , in a normal adult with no hearing loss and no other comorbidities. Ear examination and pure tone audiometry (PTA) will be performed prior to High Resolution CT scans. (18) Images of the temporal bone procured will be used for evaluation and reconstruction. This geometric model will be used to identify the characteristics of the middle ear. To conform the validity of the study , it will be compared with the published data.(3)We plan to devise a 3D model of the middle ear, which is made of smaller mesh particles, which vibrate with different frequencies, which is simple and mimicks the various pathological processes and reconstructive methods for clinical applications.(17)We also plan to study the effect of material properties of various graft materials used in various types of tympanomastoidectomy (8) non dynamic behaviours of the middle ear using the FE model. This would include TM thickness, thickness of graft in Short columella in Type – III tympanoplasty, Long Columella Type III tympanoplasty with cartilage, in canal wall down and canal wall up mastoidectomy, effect of middle ear volume, etc. (7) FE model will help in investigating the characteristics of the middle ear system and improving our understanding of its mechanical function. Furthermore, FE modelling of the middle ear would be used to simulate and evaluate the pathological changes in the conditions of middle ear disorders, like Tympanic membrane perforations, of different sizes and sites, tympanosclerosis, Middle ear fluid (8), ossicular discontinuity, Ossicular fixation.(16) It would be*

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possible to predict how the function of middle ear is affected by different kinds of middle ear pathologies and to understand the differences in middle ear structures which can impact hearing function prior to surgery.

Keywords--*middle ear model. Hrct temporal bone. Hearing gain and hearing loss. Pure tone audiogram*

I. INTRODUCTION

Understanding the physiology of hearing is important to understanding the various changes due to pathological processes. Hence appropriate reconstructive methods can be undertaken to depict the same. The middle ear is like a transformer to cause increment in the sound pressure at the stapes footplate in conrast to that at the tympanic membrane, at the cost of a reduction in stapes volume velocity as opposed to the tympanic membrane velocity. (1) At frequencies above 1000 Hz, the patterns of vibration become more complicated, with tympanic membrane breaking up into smaller vibrating portions.

Computerised models are increasingly being used for understanding the acoustics of middle ear.(15) One of the techniques used to analyse the mechanics of complex models is the Finite-element method whereby the system of interest is divided into a large number of small simple elements. (2)

Other models, that have been created to simulate middle ear are the lumped parametric models and multibody models.

These days, the fields of engineering, biomedical and biomechanical analysis are increasingly using FE analysis to simulate human body systems to extrapolate the results in diseased state. Funnell and Laszlo were the first ones to devise an FE model of cat ear drum. Since then, middle ear biomechanics alongwith 3D model has turned into a rapid growing area of research. (5). The functions defined over each element represents the mechanical properties and the applied forces, and thus mechanical response of the whole system can then be computed. Few investigators have already devised such a model of the human eardrum and middle ear (9). The advantage of this model is such, that it records phase-shift measurements and thus it precisely defines the shape of the eardrum. This model will allow an improved comprehension of the mechanics of the human middle ear and simulates various pathological conditions, as well as it assists in the design of ossicular prosthesis. (5)

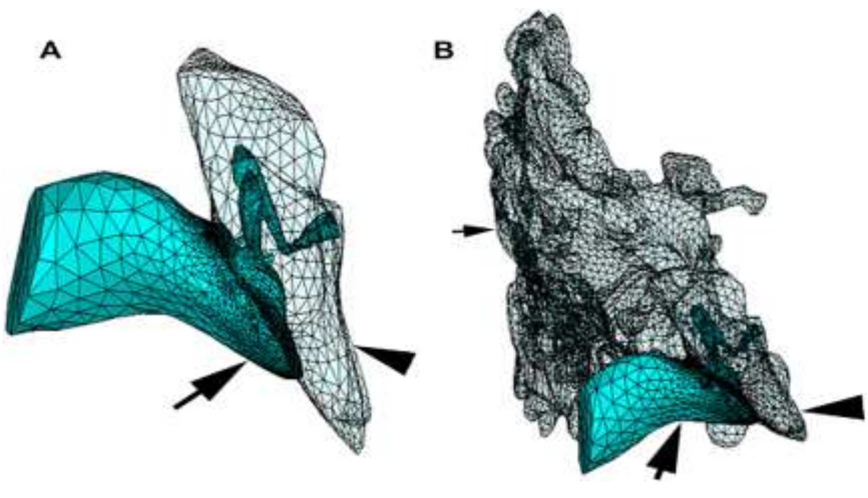

Figure 1: 1A AND 1B- (2)

II. OBJECTIVES

1.To study middle ear mechanics in normal state

2.To study middle ear mechanics in diseased state

3.To study the effect of various surgical interventions namely- canal wall up and canal wall down mastoidectomy, (10) grafting, tympanic membrane grafting, ossicular reconstruction as well as lowering of posterior canal wall- on middle ear biomechanics. (4)

III. METHODS

Study design: Experimental

Setting: The study will be conducted in the department of otorhinololaryngology , Jawaharlal Nehru Medical College , Datta Meghe Institute of Medical Sciences (14)

Variables: Poisson's ratio – 0.3

Data sources/ measurement: Pure tone audiograms and HRCT temporal bone will be used for analysis and implementation of the model (13)

Quantitative variables- Pure tone audiograms

Statistical methods:

Acoustic structural coupled analysis and Non –linear transient analysis using Finite Element Method (FEM) will be done.

The acoustic analysis in the computerised program involves modelling of the fluid media and its surrounding structures . It takes the fluid structure interaction into consideration. The wave equation will help us in determining the acoustic pressure in fluid media.

Expected Outcomes/Results:

1. It will help in deciding the best reconstructive options in middle ear surgery in the form of graft material, graft thickness in cases of tympanic membrane perforation and ossicular reconstruction

2. It will help define the role of ideal middle ear volume in middle ear reconstruction for best acoustic gain

Participants-

FE meshes of the ear will be developed using this model. The TM will be meshed using eight-node hexahedral solid elements, because one of prerequisites of the analysed coupling is that the tympanic membrane should be a 3D solid structure. Finally, a mathematical model would be used to compute the vibration amplitudes. Accordingly, meshing of tympanic annulus will be done using four layers with various hexahedral solid elements. (6)

Outcome data: To assess hearing gain and hearing loss through the model which can be quantified by pure tone audiograms (11)

IV. EXPECTED RESULTS

Main results:

With this model, it would be possible to predict the functioning of middle ear and its pathologies and the affect of middle ear structures in the outcome of surgery. The process of validation is a very important step in verifying the significance of the FE model, for proper identification that the model is simulating pathological and physiological conditions of the middle ear appropriately. Alongwith that, the process of , validation of finite element model will be used to identify the material properties and unknown parameters used in surgeries. Investigation of the properties of the middle ear will also be facilitated using the same.

Generalisability:

The model could be extrapolated to various population groups including young and elderly and can be verified by further evaluations.

V. DISCUSSION

Various articles were reviewed to find the details of relevant associated factors in this study (22-77). Acoustic transformer is one, which elevates either the pressure or volume velocity while reducing the other, thereby equalizing the sound power at the input and output. Middle ear is like a transformer in the sense that it increases the sound pressure at the stapes footplate relative to that at the tympanic membrane at the cost of a reduction in stapes volume velocity(3). Measurement of the actual middle ear sound pressure gain of human middle ear performed in normal physiological temporal bones show that pressure gain is frequency dependent ,(12) with a maximum gain of only 20 dB at 1000 Hz , with lower gains at other frequencies.(1) Cholesteatoma and osteoma – one of the rare combinations of tumor in ear can also be studied using this model (10). The geometric model will be used to measure the dimensions of middle ear and make predictions regarding the diseases.

REFERENCES

1. Merchant SN, Rosowski JJ. Acoustics and Mechanics of the Middle Ear. In A. Julianna Gulya, lloyd B. Minor/ Dennis S. Poe, editors. Glasscock Shambaugh Surgery of the Ear 6th edition. Peoples medical publishing house USA Shelton, Connecticut 2010: p 49-72.
2. S.I. Chen, M.H. Lee, C.M. Yao, P.R. Chen, Y.F. Chou, T.C. Liu, Y.L. Song, C.F. Lee, Modeling sound transmission of human middle ear and its clinical applications using finite element analysis. Kaohsiung Journal of Medical Sciences 29, 133-139 (2013)
3. E. Skrodzka, J. Modlawska, Modal analysis of the human tympanic membrane of middle ear using the finite element method. Archives of Acoustics 31, 23-28 (2006) 3.
4. B. Feng, R.Z. Gan, Lumped parametric model of the human ear for sound transmission. Biomechan Model Mechanobiol 3, 33-47 (2004)
5. Andrzej Mitura and Rafal Rusinek. Numerical research of biomechanical system with SMA prosthesis. MATEC Web Conf., 157 (2018) 02031

6. R.Z. Gan, B. Feng, Q. Sun. Three-dimensional finite element modeling of human ear for sound transmission. Ann Biomed Eng, 32 (2004), pp. 847-859
7. Lee CF, Chen PR, Lee WJ, Chen JH, Liu TC. Three-dimensional reconstruction and modeling of middle ear biomechanics by high-resolution computed tomography and finite element analysis. Laryngoscope 2006;116: 711e6.
8. Jain, Shraddha, P. T. Deshmukh, Pooja Lakhoba, Sanika Kalambe, Deepshikha Chandravanshi, and Mohnish Khatri. "Anatomical Study of the Facial Recess with Implications in Round Window Visibility for Cochlear Implantation: Personal Observations and Review of the Literature." INTERNATIONAL ARCHIVES OF OTORHINOLARYNGOLOGY 23, no. 3 (July 2019): E281–91. https://doi.org/10.1055/s-0038-1676100.
9. Jain, Shraddha, Pragya Singh, Disha Methwani, and Sanika Kalambe. "Role of Eustachian Dysfunction and Primary Sclerotic Mastoid Pneumatisation Pattern in Aetiology of Squamous Chronic Otitis Media: A Correlative Study." INDIAN JOURNAL OF OTOLARYNGOLOGY AND HEAD & NECK SURGERY 71, no. SUPPL 2, 2, SI (November 2019): 1190–96. https://doi.org/10.1007/s12070-018-1259-x.
10. Mahalle, Shrikant. "Osteoma of External Auditory Canal Associated with External Auditory Canal Cholesteatoma and Exuberant Granulation Tissue in Mastoid Air Cell System: A Rare Association." INDIAN JOURNAL OF OTOLARYNGOLOGY AND HEAD & NECK SURGERY 71, no. SUPPL 2, 2, SI (November 2019): 1505–7. https://doi.org/10.1007/s12070-019-01643-9.

11. Balwani, Manish, Umesh Godhani, Vivek Kute, H. L. Trivedi, and Pankaj Shah. "Anti MICA (Major Histocompatibility Complex Class I) Related Antibody, Whether to Treat or Avoid in Renal Transplantation?" TRANSPLANTATION 101, no. 2 (August 2017): S72. https://doi.org/10.1097/01.tp.0000525091.17858.3e.
12. Balwani, Manish, Jitender Goswami, and Mohan Patel. "INTENSIVE CARE UNIT SCORING SYSTEMS AND OUTCOME OF CKD PATIENTS ADMITTED IN INTENSIVE CARE UNIT: A SINGLE CENTER STUDY." NEPHROLOGY DIALYSIS TRANSPLANTATION 32, no. 3 (May 2017).
13. Balwani, Manish, Mohan Patel, Jitendra Goswami, Vivek Kute, H. L. Trivedi, and Pankaj Shah. "Awareness and Beliefs Towards Organ Donation in Chronic Kidney Disease Patients: A Single Center Experience." TRANSPLANTATION 101, no. 2 (August 2017): S102. https://doi.org/10.1097/01.tp.0000525137.07556.46
14. Agrawal, Abhijit, Sunil Kumar, and Jahanvi Bhagwati. "Correlation of Platelet Indices with Clinical Profile in Elderly Patients: A Study in Rural Teaching Hospital." ANNALS OF MEDICAL AND HEALTH SCIENCES RESEARCH 8, no. 3 (June 2018): 163–69.
15. Anjankar, Shailendra D. "Urethral Protrusion of the Distal End of Shunt." JOURNAL OF PEDIATRIC NEUROSCIENCES 13, no. 3 (September 2018): 371–72. https://doi.org/10.4103/jpn.JPN_54_18.
16. Bagri-Manjrekar, Kriti, Minal Chaudhary, Gokul Sridharan, Satyajit Raje Tekade, Amol Ramchandra Gadbail, and Komal Khot. "In Vivo Autofluorescence of Oral Squamous Cell Carcinoma Correlated to Cell Proliferation Rate." JOURNAL OF CANCER RESEARCH AND THERAPEUTICS 14, no. 3 (June 2018): 553–58. https://doi.org/10.4103/0973-1482.172710.

17. Balwani, Manish, Charulata Bawankule, Vishal Ramteke, and Amit Pasari. "Hepatitis C Virus, Directly Acting Antivirals and Guillain-Barre Syndrome." SAUDI JOURNAL OF KIDNEY DISEASES AND TRANSPLANTATION 29, no. 5 (October 2018): 1237–39. https://doi.org/10.4103/1319-2442.243969.
18. Acharya, Sourya, Samarth Shukla, and Anil Wanjari. "Subclinical Risk Markers for Cardiovascular Disease (CVD) in Metabolically Healthy Obese (MHO) Subjects." JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH 13, no. 6 (June 2019): OC1–6. https://doi.org/10.7860/JCDR/2019/41317.12890.
19. Agarwal, Anchal, Nitin Bhola, Rajanikanth Kambala, and Rajiv M. Borle. "Touch Imprint Cytology: Can It Serve as an Alternative to Frozen Section in Intraoperative Assessment of Cervical Metastasis in Oral Squamous Cell Carcinoma?" JOURNAL OF ORAL AND MAXILLOFACIAL SURGERY 77, no. 5 (May 2019): 994–99. https://doi.org/10.1016/j.joms.2019.01.011.
20. Aryal, Nirmal, Pramod R. Regmi, Erwin Martinez Faller, Edwin van Teijlingen, Chan Chee Khoon, Adrian Pereira, and Padam Simkhada. "Sudden Cardiac Death and Kidney Health Related Problems among Nepali Migrant Workers in Malaysia." NEPAL JOURNAL OF EPIDEMIOLOGY 9, no. 3 (2019): 788–91. https://doi.org/10.3126/nje.v9i3.25805.
21. Balwani, Manish R., Charulata P. Bawankule, Prakash Khetan, and Amit Pasari. "Awareness about Kidney and Its Related Function/Dysfunction in School Going Children: A Survey from the Central India." *SAUDI JOURNAL OF KIDNEY DISEASES AND TRANSPLANTATION* 30, no. 1 (February 2019): 202–7.
22. Munjal R, Mudey G. Nasal carriage of Staphylococcus aureus among undergraduate medical students: Prevalence and antibiogram including methicillin resistance, inducible clindamycin resistance, and high-level mupirocin resistance. J Datta Meghe Inst Med Sci Univ 2018;13(2):91-94.
23. Mittal V, Jagzape T, Sachdeva P. Care seeking behaviour of families for their sick infants and factors impeding to their early care seeking in rural part of central India. J Clin Diagn Res 2018;12(4):SC08-SC12.
24. Choudhary S, Tarafdar P, Jawade S, Singh A. A point to note in pili torti. Int J Trichology 2018;10(2):95-97.
25. Madke B, Gardner JM. Enhanced worldwide dermatology-pathology interaction via Facebook, Twitter, and other social media platforms. Am J Dermatopathol 2018;40(3):168-172.
26. Girish M, Rawekar A, Jose S, Chaudhari U, Nanoti G. Utility of Low Fidelity Manikins for Learning High Quality Chest Compressions. Indian J Pediatr 2018;85(3):184-188.
27. Goswami J, Balwani MR, Kute V, Gumber M, Patel M, Godhani U. Scoring systems and outcome of chronic kidney disease patients admitted in intensive care units. Saudi J Kidney Dis Transpl 2018;29(2):310-317.
28. Mohite PM, Anjankar AJ, Patnod S. Organo pHOSPHORUS pOISONING: Prognostic value of GCS score and other clinical indicators in assessing the final outcome. J Indian Acad Forensic Med 2018;40(2):197-205.
29. Mathur K, Ninave S, Patond S, Ninave S, Wankhade P. A comparative study of estimation of stature by Bertillon's system among individuals of different regions of India. J Indian Acad Forensic Med 2018;40(3):301-306.

30. Kumar S, Bhayani P, Hathi D, Bhagwati J. Hyponatremia initial presenting feature of normal pressure hydrocephalus in elderly patient: A rare case report. J Gerontology Geriatrics 2018;66(3):156-157.
31. Jaiswal S, Banait S, Daigavane S. A comparative study on peripapillary retinal nerve fiber layer thickness in patients with iron-deficiency anemia to normal population. J Datta Meghe Inst Med Sci Univ 2018;13(1):9-11.
32. Deshpande P, Gupta V, Bhake A. Methylation pattern of retrotransposons: Biomarker for human cancer. J Datta Meghe Inst Med Sci Univ 2018;13(1):66-70.
33. Deshpande S, Phatak S, Marfani G, Gupta N, Daga S, Samad S. Sonographic evaluation of painful shoulder and its comparison with clinical diagnosis. J Datta Meghe Inst Med Sci Univ 2018;13(1):12-15.
34. Singh P, Jain S, Methwani D, Kalambe S, Chandravanshi D, Gaurkar S, et al. Study of correlation of pre-operative findings with intra-operative ossicular status in patients with chronic otitis media. Iran J Otorhinolaryngol 2018;30(5):273-281.
35. Papalkar P, Kumar S, Agrawal S, Raisinghani N, Marfani G, Mishra A. Heterotaxy syndrome presenting as severe pulmonary artery hypertension in a young old female: Case report. J Gerontology Geriatrics 2018;66(2):59-61.
36. Rawlani SM, Bhowate R, Kashikar S, Khubchandani M, Rawlani S, Chandak R. Morphological evaluation of temporo-mandibular joint in Indian population. Braz Dent Sci 2018;21(1):44-53.
37. Modi L, Gedam SR, Shivji IA, Babar V, Patil PS. Comparison of total self-stigma between schizophrenia and alcohol dependence patients. Int J High Risk Behav Addict 2018;7(3).
38. Rajan R, Gosavi SN, Dhakate V, Ninave S. A comparative study of equipotent doses of intrathecal clonidine and dexmedetomidine on characteristics of bupivacaine spinal anesthesia. J Datta Meghe Inst Med Sci Univ 2018;13(1):4-8.
39. Rajan R, Gosavi S, Dhakate V, Ninave S. A comparative study of equipotent doses of intrathecal clonidine and dexmedetomidine on characteristics of bupivacaine spinal anesthesia. J Datta Meghe Inst Med Sci Univ 2018;13(1):4-8.
40. Phatak S, Marfani G. Galactocele ultrasonography and elastography imaging with pathological correlation. J Datta Meghe Inst Med Sci Univ 2018;13(1):1-3.
41. Swarnkar M, Agrawal A. Kimura's disease. Formosan J Surg 2018;51(1):26-28.
42. Chiwhane A, Pradeep. Study of rhythm disturbances in acute myocardial infarction. J Assoc Phys India 2018;66(January):54-58.
43. Gupta V, Bhake A. Assessment of Clinically Suspected Tubercular Lymphadenopathy by Real-Time PCR Compared to Non-Molecular Methods on Lymph Node Aspirates. Acta Cytol 2018;62(1):4-11.
44. Anjankar S. Askin's tumor in adult: A rare clinical entity. J Datta Meghe Inst Med Sci Univ 2018;13(1):54-57.
45. Jain J, Banait S, Tiewsoh I, Choudhari M. Kikuchi's disease (histiocytic necrotizing lymphadenitis): A rare presentation with acute kidney injury, peripheral neuropathy, and aseptic meningitis with cutaneous involvement. Indian J Pathol Microbiol 2018;61(1):113-115.
46. Jain V, Waghmare L, Shrivastav T, Mahakalkar C. SNAPPS facilitates clinical reasoning in outpatient settings. Educ Health 2018;31(1):59-60.
47. Bains SK, John P, Nair D, Acharya S, Shukla S, Acharya N. Aptitude of medical research in undergraduate students of a medical university - Miles to go before we sow. J Clin Diagn Res 2017;11(12):JC07-JC11.

48. Taksande A, Meshram R, Yadav P, Lohakare A. Rare presentation of cerebral venous sinus thrombosis in a child. J Pediatr Neurosci 2017;12(4):389-392.
49. Choudhari MS, Charan N, Sonkusale MI, Deshpande RA. Inadvertent diversion of inferior vena cava to left atrium after repair of atrial septal defect - Early diagnosis and correction of error: Role of intraoperative transesophageal echocardiography. Ann Card Anaesth 2017;20(4):481-482.
50. Swarnkar M, Jain SC. Heterotopic subserosal pancreatic tissue in Jejunum-an incidental rare finding. J Krishna Inst Med Sci Univ 2017;6(4):105-108.
51. Taksande A, Meshram R, Yadav P, Borkar S, Lohkare A, Banode P. A rare case of Budd Chiari syndrome in a child. Int J Pediatr 2017;5(10):5809-5812.
52. Gupta V, Bhake A. Diagnosis of clinically suspected and unsuspected tubercular lymphadenopathy by cytology, culture, and smear microscopy. Indian J Tuberc 2017;64(4):314-317.
53. Gupta V, Bhake A. Clinical and cytological features in diagnosis of peripheral tubercular lymphadenitis – A hospital-based study from central India. Indian J Tuberc 2017;64(4):309-313.
54. Sharma SK, Chaubey J, Singh BK, Sharma R, Mittal A, Sharma A. Drug resistance patterns among extra-pulmonary tuberculosis cases in a tertiary care centre in North India. Int J Tuberc Lung Dis 2017;21(10):1112-1117.
55. Jyoti J, Nitin V, Shashank B, Pradeep D. Gamma glutamyl transferase levels in patients with acute coronary syndrome: A cross-sectional study. J Cardiovasc Dis Res 2017;8(4):121-125.
56. Saoji V, Madke B. Use of low-dose oral warfarin in three cases of livedoid vasculopathy. Indian J Dermatol 2017;62(5):508-511.
57. Dhamgaye TM, Bhaskaran DS. An unusual pulmonary metastatic manifestation of gestational choriocarcinoma: A diagnostic dilemma. Lung India 2017;34(5):490-491.
58. Jagzape A, Jagzape T, Pathak S. Medical education terminologies: Do these really percolate to the level of medical students? A survey. J Clin Diagn Res 2017;11(9):JC01-JC05.
59. Taksande A, Meshram R, Lohakare A. A rare presentation of isolated oculomotor nerve palsy due to multiple sclerosis in a child. Int J Pediatr 2017;5(8):5525-5529.
60. Behere PB, Mansharamani HD, Kumar K. Telepsychiatry: Reaching the unreached. Indian J Med Res 2017;146(August):150-152.
61. Belekar V. A comparative study to evaluate the efficacy of butorphanol as an adjuvant to epidural analgesia for rib fractures. J Datta Meghe Inst Med Sci Univ 2017;12(3):166-169.
62. Sahu S, Kher KS, Wagh DD, Swarnakar M, Pandey P, Agnihotri I. Endoscopic evaluation of patients presenting with dysphagia at rural hospital AVBRH. J Datta Meghe Inst Med Sci Univ 2017;12(3):196-205.
63. Roy M, Gajbe UL, Singh BR, Thute P. Morphometric measurement of fetal femur length for the prediction of gestational age in the iind and iiird trimester of pregnancy by ultrasonography. J Datta Meghe Inst Med Sci Univ 2017;12(3):187-190.
64. Nitnaware AS, Vagha J, Meshram R. Clinical profile of pediatric head injury. J Datta Meghe Inst Med Sci Univ 2017;12(3):191-195.
65. Taksande K, Chatterjee M, Jain V. A case report of prolonged apnea during electroconvulsive therapy in a patient with suicidal attempt by organophosphorus poison. J Datta Meghe Inst Med Sci Univ 2017;12(3):223-225.

66. Jham R, Shukla S, Acharya S, Dhote S, Tamhane A, Bhake A. Correlation of the proliferative markers (AgNOR and Ki-67) with the histological grading of the glial tumors. J Datta Meghe Inst Med Sci Univ 2017;12(3):211-217.
67. Modi L, Shivji IA, Behere PB, Mishra KK, Patil PS, Goyal A. A clinical study of self-stigma among the patients of schizophrenia and alcohol dependence syndrome. J Datta Meghe Inst Med Sci Univ 2017;12(3):161-165.
68. Taneja S, Pande V, Kumar H, Agarkhedkar S. Correlation of various maternal factors with exaggerated hyperbilirubinemia of the newborn. J Datta Meghe Inst Med Sci Univ 2017;12(3):218-222.
69. Singhania S, Singhania A, Khan S, Kumar V, Singhania P. Prenatal diagnosis of cross-fused renal ectopia: Still a dilemma. Donald Sch J Ultrasound Obstet Gynecol 2017;11(3):225-226.
70. Jain S, Sharma SK. Challenges & options in dengue prevention & control: A perspective from the 2015 outbreak. Indian J Med Res 2017;145(June):718-721.
71. Gupta V, Bhake A. Molecular Diagnosis of Tubercular Lymphadenopathy from Fine-Needle Aspirates in Pediatric Patients. Acta Cytol 2017;61(3):173-178.
72. Varghese LA, Taksande K. A comparison between intrathecal dexmedetomidine with hyperbaric bupivacaine and intrathecal fentanyl with hyperbaric bupivacaine in lower abdominal surgeries: A prospective double-blinded study. J Datta Meghe Inst Med Sci Univ 2017;12(2):99-109.
73. Khan KI, Jalgaonkar PD, Agrawal S. A case of phenytoin induced multiple toxicities. J Datta Meghe Inst Med Sci Univ 2017;12(2):157-158.
74. Bhalerao NS, Modak A, Belekar V. Comparison between magnesium sulfate (50 mg/kg) and lignocaine (2 mg/kg) for attenuation of intubation response in hypertensive patients. J Datta Meghe Inst Med Sci Univ 2017;12(2):118-120.
75. Phadnis P, Kamble MA, Daigavane S, Tidke P, Gautam S. Prevalence and risk factors – Hemoglobin A1c, serum magnesium, lipids, and microalbuminuria for diabetic retinopathy: A rural hospital-based study. J Datta Meghe Inst Med Sci Univ 2017;12(2):121-132.
76. Ali S, Ghewade B, Jadhav U, Cladius S. Study of serum interferon gamma in tubercular pleural effusions. J Datta Meghe Inst Med Sci Univ 2017;12(2):93-98.
77. Methwani DA, Deshmukh PT. Comparative study of type I tympanoplasty with or without mastoidectomy in tubotympanic type of chronic suppurative otitis media patients. J Datta Meghe Inst Med Sci Univ 2017;12(2):85-88.