Viability of a Digital Workflow for NAM Appliances when compared to Traditional NAM Appliance Techniques

G. Garza, DDS[1]; B. Acharya, BDS, MPH[1]; M. Thompson, DDS[2]; F. Kasper, PhD[3]; B. Chiquet, DDS, PhD[1,4]

UTHealth Houston [1]Department of Pediatric Dentistry, [2]Department of General Practice, and [3]Department of Orthodontics; [4]University at Buffalo School of Dental Medicine, Department of Pediatric and Community Dentistry

ABSTRACT

Purpose: to compare traditional vs digital workflows of nasoalveolar molding (NAM) appliance fabrication, including subjectively assessing ease of NAM fabrication when compared to traditional techniques by monitoring complications with fabrication and objectively measuring the time required to complete each fabrication pathway.

Methods: Fifteen de-identified cleft lip and palate casts were utilized. Traditional casts were digitally scanned. All scans were digitally planned and 3D printed NAM appliances were produced. Traditional casts were utilized to create hand-fabricated NAM appliances. The times required to fabricate the NAM appliances was recorded and compared. The fit of each NAM appliance (digital and traditional) to the corresponding cast was assessed.

Results: Traditionally and digitally fabricated casts had a mean fabrication time of 742.7 seconds and 446.6 seconds respectively ($p<0.001$). Finishing times for the traditional pathway and digital pathway were 696.9 seconds and 89.9 seconds respectively ($p<0.001$). Overall time was significantly less for the digital workflow ($p<0.001$). Complications in the traditional method included two appliances which had to be remade due to large voids during polymerization of the material as well as smaller voids noted generally on the other NAM appliances. Complications for the 3D printed appliances included having sprues come too close together in areas certain areas and difficulty in adding bock out wax in the cleft space with the designing software. The 3D printed appliances were notably smoother when compared to the traditionally made ones.

Conclusions: Digital workflow NAM appliances were produced significantly faster, with less severe complications, and with a smoother final product than traditional ones. Costs were difficult to compare due to multiple potential uses of materials.

BACKGROUND

- The modern NAM appliance was introduced in 1975 and has been shown to mold the developing alveolar segments and alter soft tissue of the lip and nose, resulting in a less invasive corrective surgery with more aesthetic outcomes.(1)
- With the emergence of digital dentistry technologies, digital impressions and 3D printing, there is great potential of altering the future of NAM utilization; while some have shown the efficacy of technology in NAM fabrication, there remains a lack of comparison to the traditional method.(2,3)
- One benefit of digitization of the NAM workflow is a reduction of adverse events, especially when obtaining an impression on a newborn.(4)

We hypothesize that a digital workflow will produce NAM appliances in less time, with less complications, at a similar expense, and of better quality than those produced by traditional methods.

METHODS

- This study was approved by the UTHealth Houston Institutional Review Board (HSC-24-0584).
- 15 de-identified casts of patients with unilateral CLP were selected for the study.
- Casts were scanned to produce digital impressions copies.
- The following data was collected:
  1. Time required to (a) fabricate and polish each traditional appliance and (b) design, print, and polish each digital appliance.
  2. Cost of materials to fabricate each appliance.
  3. Complications during each workflow.
- After fabrication, fit of both the traditional and 3D printed NAM appliances tested on original casts.
- Data was collected in Microsoft Excel and analyzed using paired Students t-test, with p-values less than 0.05 considered significant.

RESULTS

- Figure 1 shows the fabrication of the traditional NAM. Figure 2 shows the fabrication of the digital NAM.
- Fabrication/design, finishing, and overall time to create a NAM appliance digitally was faster than the traditional method ($p<0.001$; Table 1).
  - The printing time was not included in the total fabrication time as this can be completed automatically without practitioner oversight (i.e. can be printed overnight or throughout the day.
- Table 2 compares the differences of cost per appliance using either the traditional or digital methods.
  - For the traditional method, lab setup costs such as the dental vibrator, lathe, and polishing drill/drill bits were not included in this cost as these supplies are necessary for any office and are utilized for many other procedures.
  - For the digital method, there is an associated cost for the dental design software (TRIOS Design Studio) although the software can be used for many applications in the dental office and thus cannot be added to the total cost at face value for comparisons.
- Complications experienced:
  - Traditional NAM: voids in acrylic during polymerization process, variation in thickness of appliance.
  - Digital NAM: Fracture in one appliance due to sprue placement/removal during polishing, blocking out cleft space during digital planning was tedious.
- Subjectively, the appliances produced by 3D printing were notably smoother than those produced by traditional methods.
- Control for the thickness of the appliances was also easier to maintain for 3D printed appliances.
- ***Both methods produced NAMs with adequate fit on the corresponding casts.***

FIGURES, TABLES, and REFERENCES

Figure 1. Traditional NAM fabrication.

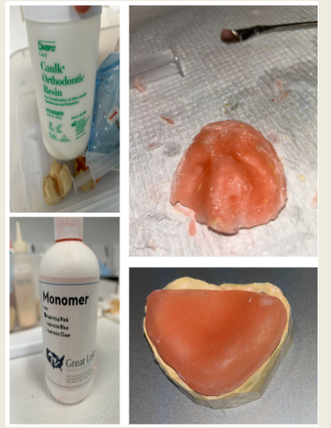

Figure 2. Digital NAM fabrication.

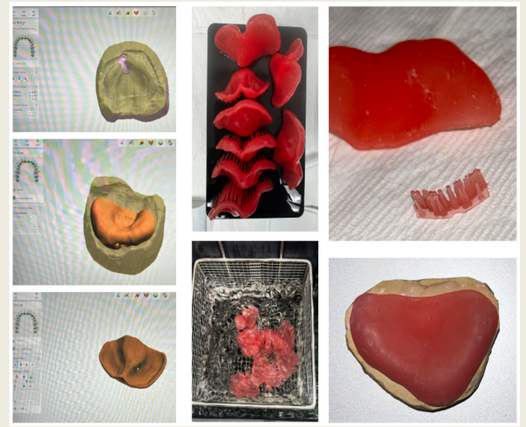

Table 1. Mean times (in seconds) for NAM appliance creation

Timepoint	Traditional	3D Printing	p-value
Fabrication	742.7	446.6	<0.001
Finishing	696.9	89.9	<0.001
Overall	1439.7	536.5	<0.001

Table 2. Cost comparison of NAM appliance creation

Method	Item/Cost	Total Cost
Traditional	Dental Stone ($1) Monomer/Polymer ($6.58)	$7.58*
3D Printing	Liquid Resin ($3.34) Asiga Max Dental Tray ($0.40) TRIOS Design Studio ($1,450/year)	$3.74**

*Does not include cost of lab set-up. **Does not include cost of TRIOS Dental Studio

REFERENCES

CONCLUSIONS

- Digital NAM fabrication and finishing was significantly faster than the traditional methods.
- Cost comparisons were similar (excluding set-up costs).
- Subjectively, it was found that the digital NAMs which were produced were of better quality and produced with less complications than the traditionally made ones.
- The fit of both the digitally made NAMs as well as the traditional ones on the existing casts were acceptable with no noticeable differences in adaptation.
- ***This study supports the utilization of 3D printing in NAM fabrication.***
- Future studies should evaluate the placement of attachments (elastic band button, nasal stent) and incorporation into patient care.