

Fabrication of Athletic Mouthguards and Facemasks

OCTOBER 8, 2026

CORYDON PALMER DENTAL SOCIETY CONTINUING EDUCATION

LARRY J GESSNER, DDS

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ADA Statistics

- ▶ Up to 200,000 injuries are prevented annually by high school and college athletes wearing mouthguards.
- ▶ Facemasks redistribute the forces that cause injury and primarily protect the player's nasal, zygomatic, and periorbital regions to allow the player to continue play even during the recovery period.

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Reasons for Mouthguard Use:

- Protection
- Prevention
- How Far Would You Be Willing To Walk?

3

Mouthguard Functions

- ▶ Hold lips and cheeks away from teeth
- ▶ Cushion and distribute forces from direct frontal blows
- ▶ Prevent upper and lower teeth from violent contact
- ▶ Support mandible, absorb impacts which might cause fracture
- ▶ Perhaps prevent concussions
- ▶ Protect against neck injuries
- ▶ Psychological asset

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Mouthguards

- ▶ Is it worth the effort?
- ▶ Interscholastic football injury classification began in 1929. Statistics showed that over 25% of all football injuries were dental injuries. ("football smile")
- ▶ 1954 study- Among over 15,000 football players, 2.27% suffered dental injuries.
- ▶ 1977: 279 rugby players- 45% lost or fractured teeth during their careers.
- ▶ 1968: NHL-62% lost one or more teeth due to hockey injuries.

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WHY?



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IF ONLY THERE WERE A HOCKEY SHIELD
WITH MORE PROTECTION...



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A More Current Hockey Injury:
Jack Hughes



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Before and After Views:



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Table 12.1 Relation between the incidence of dental injuries and the use of face masks, and dental guards.
From ROBERTS, *s* 1970.

Year	Protection status	No. of players	No. of dental injuries
1954	No face masks and no dental guards	15,714*	356 (2.27%)
1955	Face masks but no dental guards	15,714*	288 (1.83%)
1959	Face masks mandatory but few dental guards	22,969**	275 (1.20%)
1960	Face masks mandatory but few dental guards	24,177**	301 (1.25%)
1961	Face masks mandatory; about 1/3 dental guards	26,507**	272 (1.03%)
1962	Face masks mandatory; about 1/3 dental guards	28,747**	292 (1.02%)
1963	Face masks and dental guards mandatory	30,357**	143 (0.47%)
1964	Face masks and dental guards mandatory	31,259**	129 (0.41%)
1965	Face masks and dental guards mandatory	31,459**	126 (0.40%)
1966	Face masks and dental guards mandatory	34,298**	112 (0.33%)
1967	Face masks and dental guards mandatory	34,059**	97 (0.28%)
1968	Face masks and dental guards mandatory	35,801**	105 (0.29%)

*Controlled experiment.

**Number of football players in Benefit Plan.

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Table 12.2 *Incidence of dental injuries among males in interscholastic high school sports in Wisconsin.*
 From ROBERTS,⁵ 1970, and JONES,⁶⁷ 1979.

Year	Type of sport	No. of players	No. of dental injuries
1964-65	Football	31,259	129 (0.41%)
	Basketball	15,000*	126 (0.84%)
	Wrestling	11,000*	136 (1.24%)
1966-67	Football	34,298	112 (0.33%)
	Basketball	15,000*	135 (0.90%)
	Wrestling	11,000*	104 (0.95%)
1968-69	Football	35,801	105 (0.29%)
	Basketball	16,000*	150 (0.94%)
	Wrestling	16,000*	105 (0.66%)
1976-77	Football	23,426	55 (0.23%)
	Basketball	18,202	100 (0.55%)
	Wrestling	11,326	101 (0.89%)
1977-78	Football	16,961	27 (0.16%)
	Basketball	13,362	47 (0.35%)
	Wrestling	8,079	70 (0.87%)

* Estimated number of participants.

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Table 12.3 *Incidence of dental injuries in all contact sports in North Dakota schools for the ten years from autumn 1968 through spring of 1978.*
 From FITZNER,⁶⁸ 1979.

	Football	Basketball	Wrestling	Hockey
No. of students	81,205	133,555	24,168	3,977
No. of dental injuries	162	444	167	57
Incidence of injuries	0.20%	0.33%	0.69%	1.43%

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More Current Research Regarding Mouthguards and Performance

- ▶ Is there enough evidence that mouthguards do not affect athletic performance? Ferreira, et al., Brazil
- ▶ “Overall, custom-made mouthguards did not interfere with or improve athletes’ performance when compared with the control group (no mouthguard). Custom-made mouthguards showed the smallest range of changes in players’ performance compared with other types of mouthguards.”
- ▶ International Dental Journal, February, 2019

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And:

- ▶ Influence of different types of mouthguards on strength and performance of collegiate athletes: a controlled-randomized trial Duddy, et al. University of Washington
- ▶ Custom mouthguard vs. boil’n’bite (Under Armour O-Flow Max)
- ▶ Custom mouthguards: no detrimental effects on strength and performance, comfortable, no difficulty breathing
Boil’n’bite: uncomfortable, breathing difficulties
- ▶ Dental Traumatology 2012

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And:

- ▶ Influence of mouthguards on the physical performance of soccer players, Queiroz, et al. Brazil
- ▶ Custom mouthguards: much better performance compared to Type I or II (Stock and Boil'n'bite). Custom gave even better performance than no mouthguard.
- ▶ Dental Traumatology 2013

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And:

- ▶ Mouthguards in sports activities: history, physical properties and injury prevention effectiveness, Knapik ,et al., US Army Center for Health Promotion and Preventive Medicine
- ▶ History: mouthguards first used by boxers in 1920's, ADA led to mandating mouthguard use for high school football in 1962
- ▶ Evidence that mouthguards prevent concussion was inconsistent, no conclusion regarding effectiveness of mouthguards in preventing concussion can be drawn at present
- ▶ Sports Medicine, 2007

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Who Is At Risk? Everyone in Sporting Activities! Including:

Baseball, Basketball, Biking, Boxing, Cheerleading, Equestrian Sports, Field Hockey, Football, Gymnastics, Ice Hockey, Kickball, Lacrosse, Martial Arts, Motocross, Racquetball, Rugby, Skateboarding, Skiing, Soccer, Softball, Tetherball, Tennis, Trampoline, Volleyball, Wrestling, Weightlifting, Water Polo

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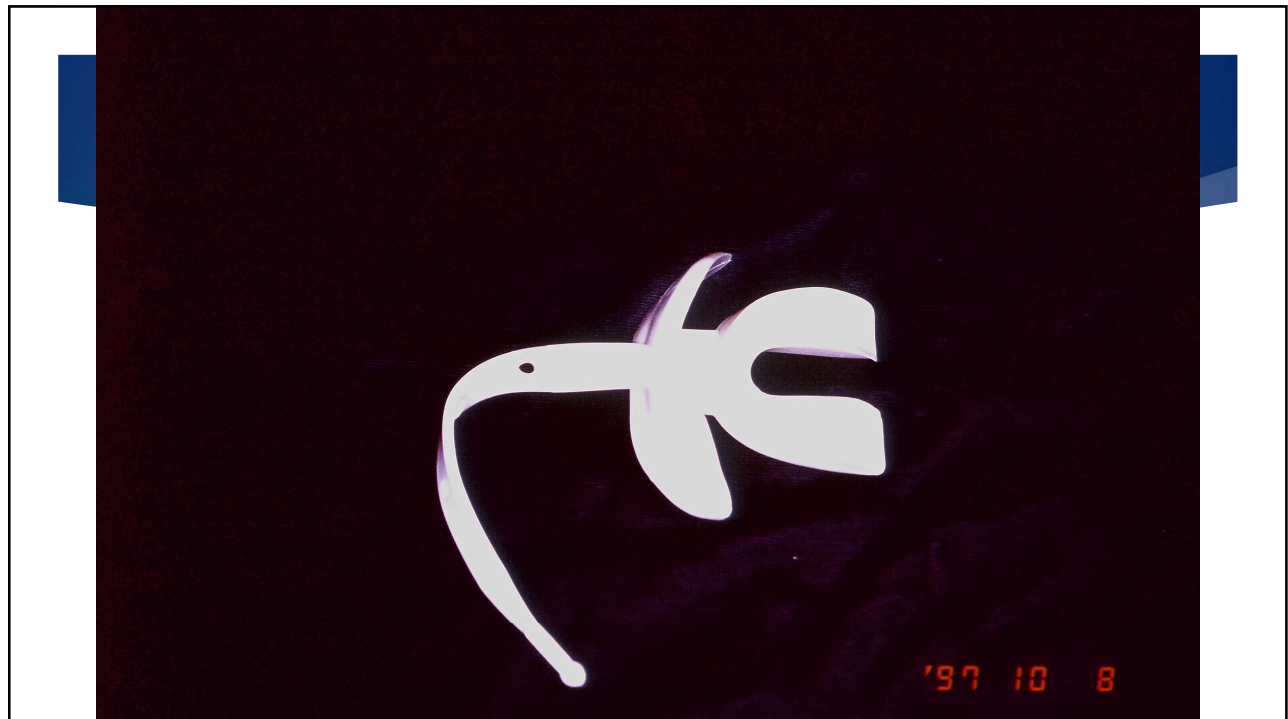
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Types of Mouthguards

- STOCK
- MOUTH-FORMED (BOIL AND BITE)
- CUSTOM-MADE



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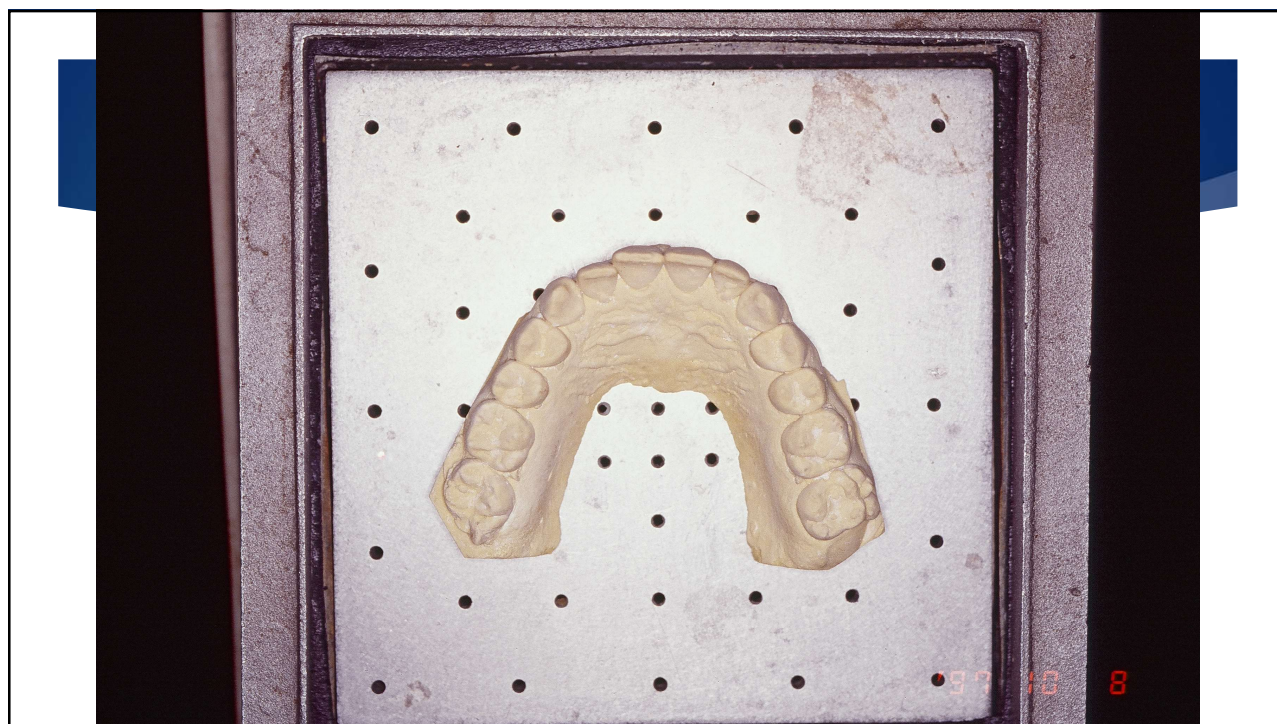




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“Just because you CAN do something...”
or “Because you’ll believe anything”

- ▶ 3D Chain Jewel Max Airflow Football Mouthguard
- ▶ \$39.99 by Shock Doctor (Stock mouthguard)
- ▶ “Take a deep breath with 10% more flow capacity via our AirFlow channel. The updated design and platform relax the jaw and prevent the teeth from blocking the breathing channel, adding more flow capacity.”

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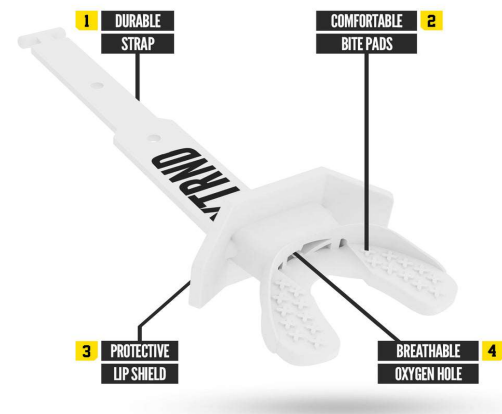
Other “Too good to be true” claims

- ▶ Bulletproof Mouthguards: Disclaimer- “This mouthguard is not designed to and will not protect you from bullets.”
- ▶ “Custom fit, ultrathin design and FreeFlow Air System allows you to breathe freely to maximize the oxygen to your brain and muscles to improve your performance.”
- ▶ Video testimonial for another boil and bite mouthguard: “This mouthguard has all these holes in it which is really nice for when I’m breathing in there. If it didn’t have those it would be harder for ventilation.”

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Oxygen Fixation?

- ▶ NXTRND TWO stock mouthguard:



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LeCool: "...maximum airflow for increased oxygen intake."



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Battle Oxygen Lip Protector Mouthguard
"Maximum Oxygen Supply"



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The Inviolable Mouthguard Hierarchy

NOTHING < STOCK < BOIL 'N' BITE < CUSTOM

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IMH First Corollary

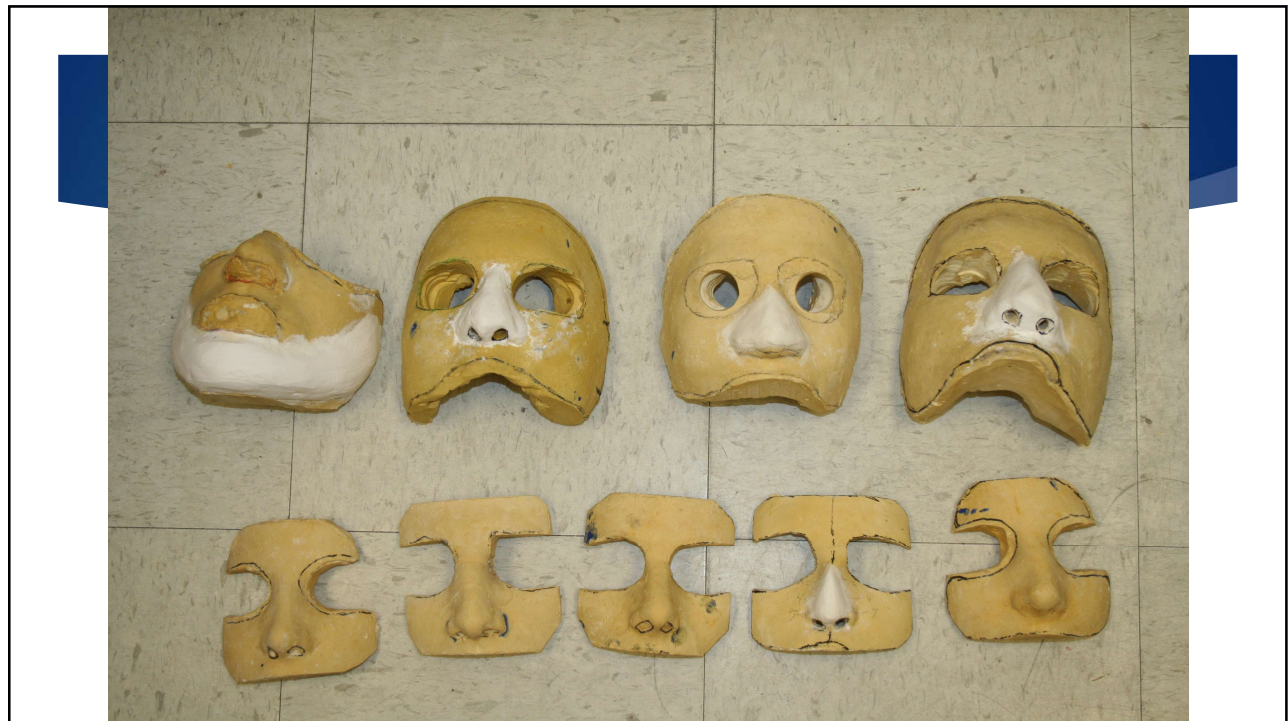
▶ ANYTHING > NOTHING!!!

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Facemasks: Necessity is the Mother of Invention

-REACTIVE RATHER THAN PROACTIVE
-THE 5" X 5" LIMITATION

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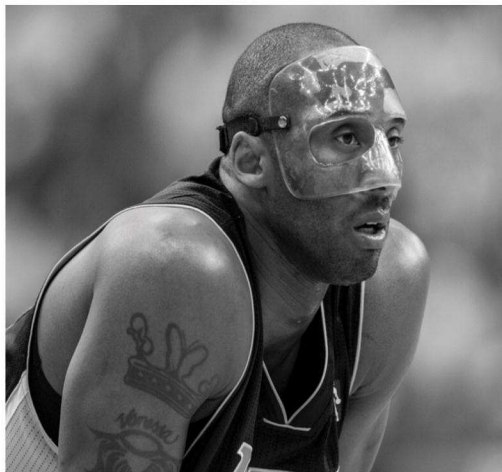
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Facemask Research

- ▶ *Laryngoscope*, 2016 May; 126(5): 1054-60.
- ▶ Facemasks and basketball: NCAA Division 1 consumer trends and a review of over-the-counter face masks.
- ▶ 254 programs responded. 46% preferred custom-made masks. Disadvantages included high cost and slow manufacture turnaround time. Only 20% used strictly generic brands.

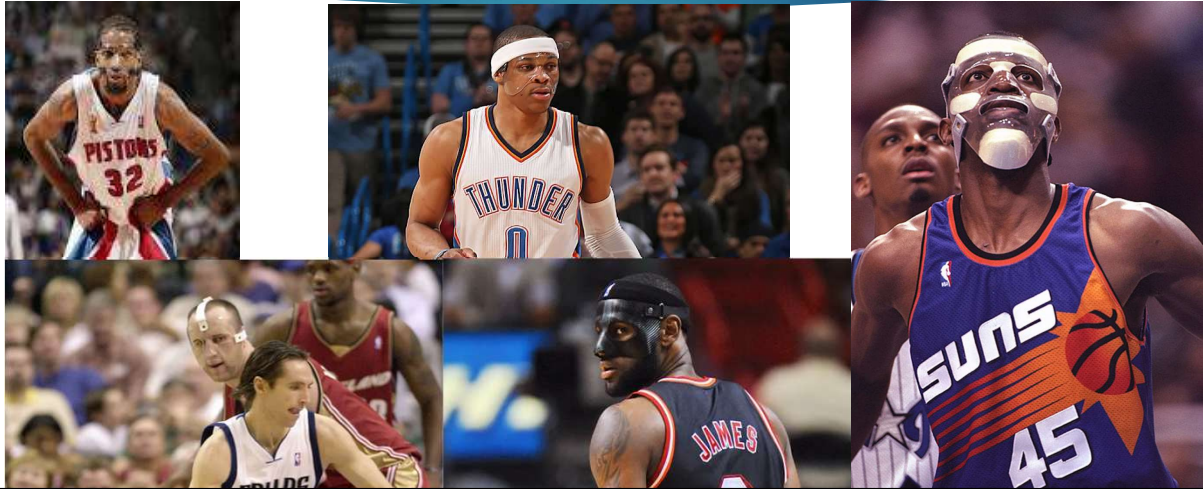
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Kobe with Facemask-likes and dislikes



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More NBA Masks



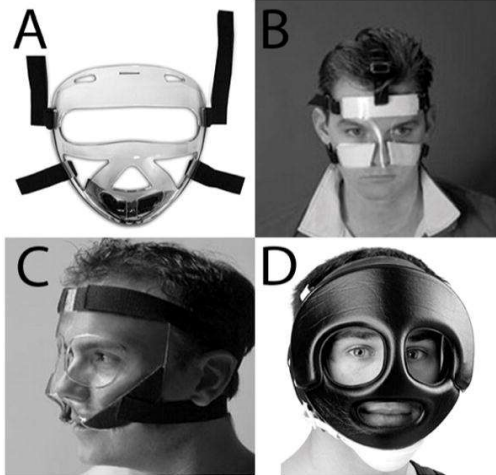
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Newer Masks



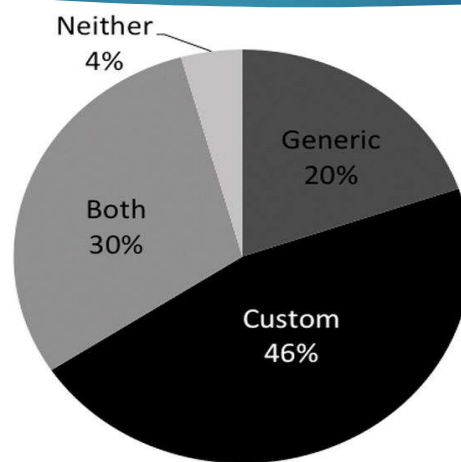
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Over-the-Counter Facemasks- likes and dislikes

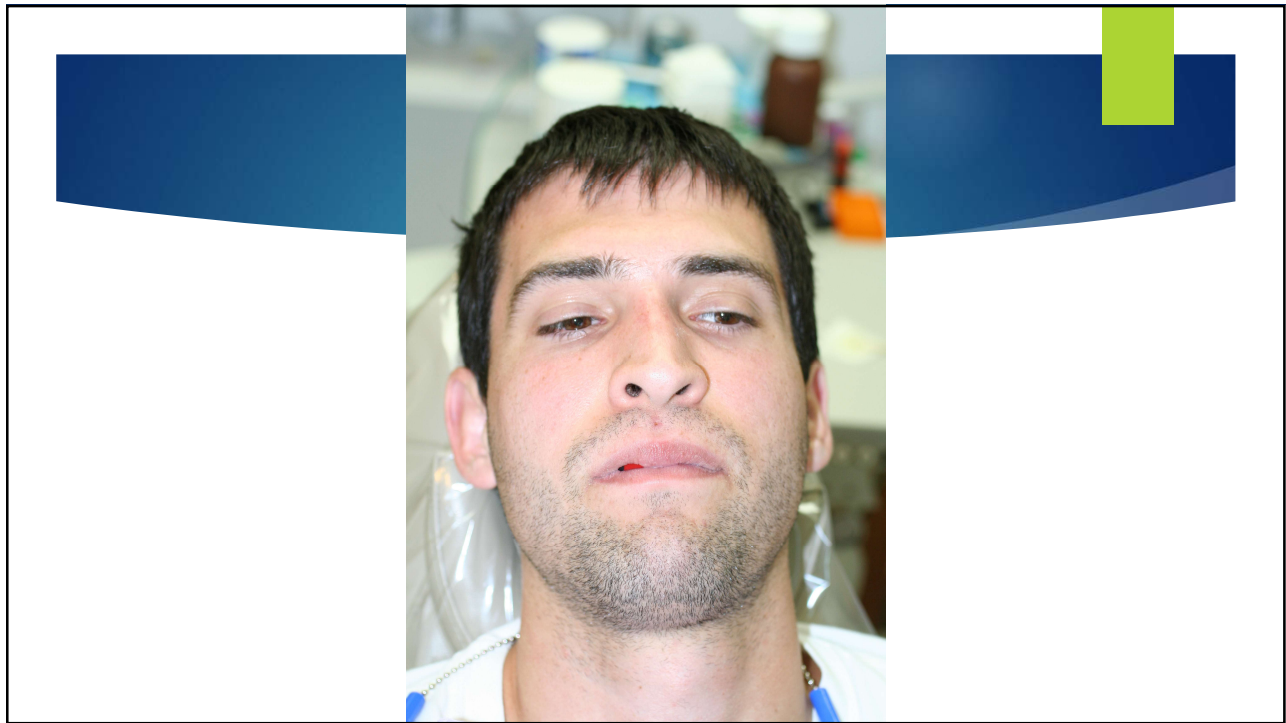


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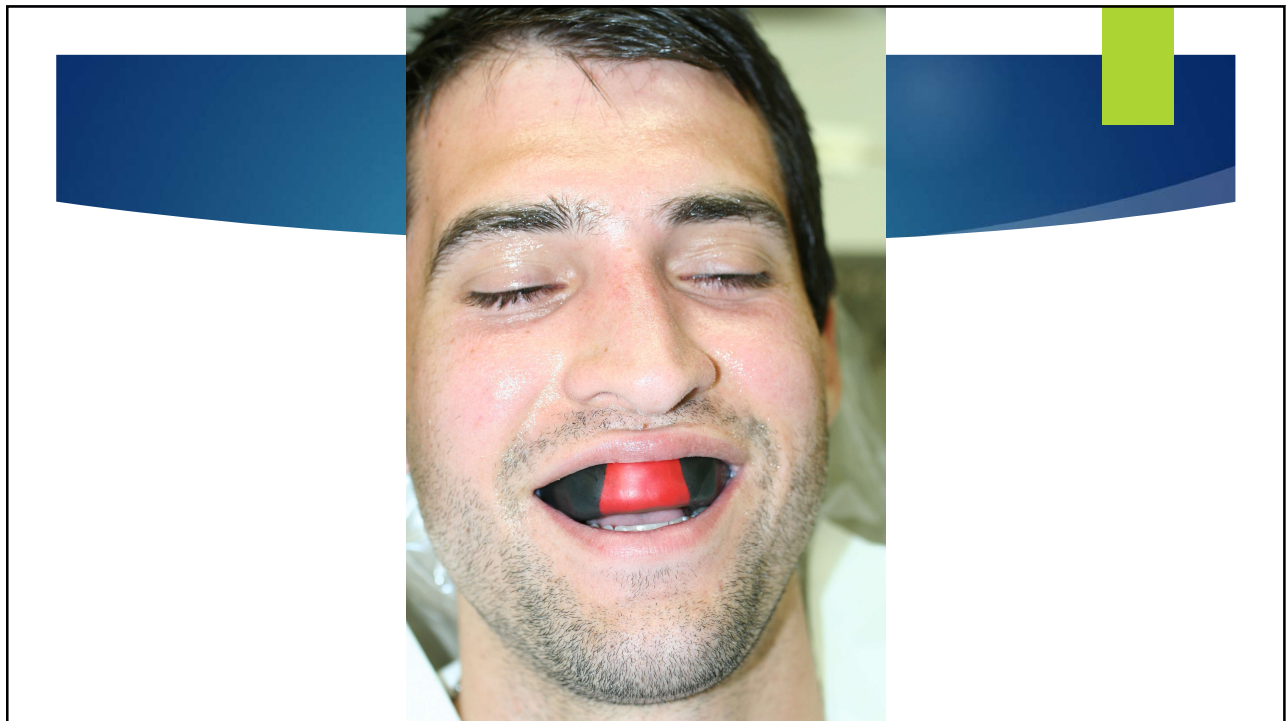
NCAA Division 1 Basketball- 254 programs



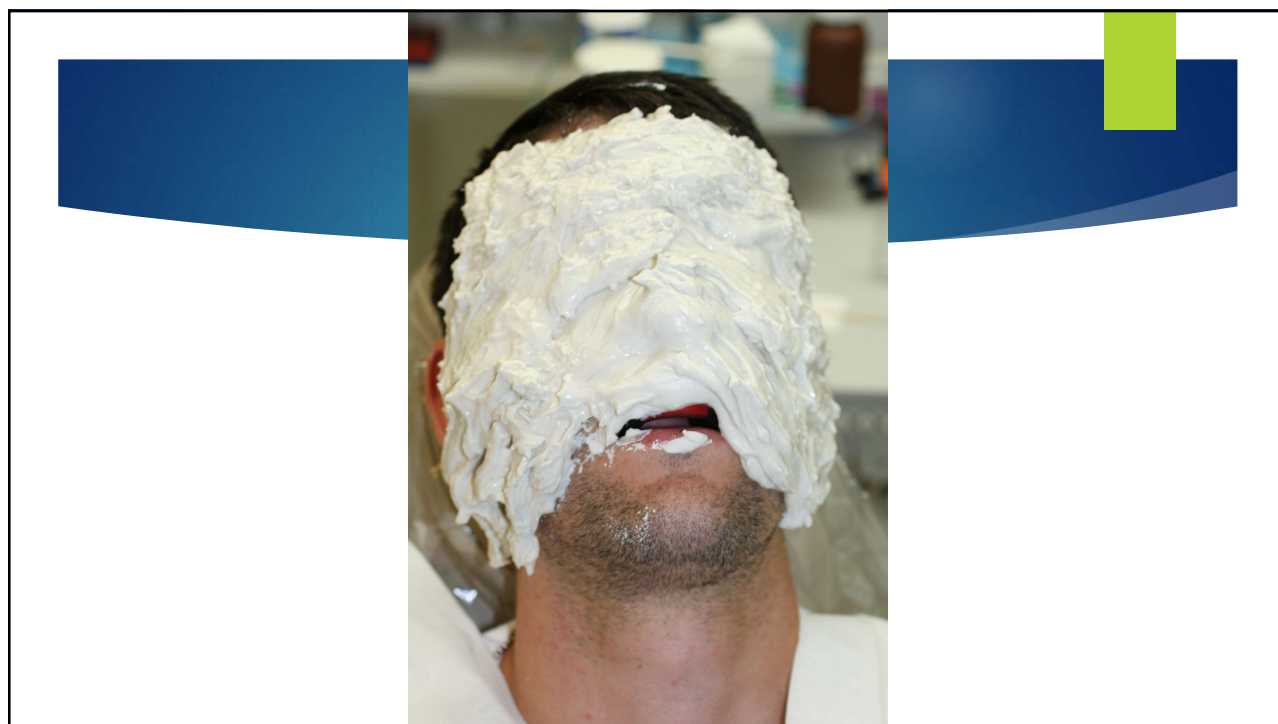
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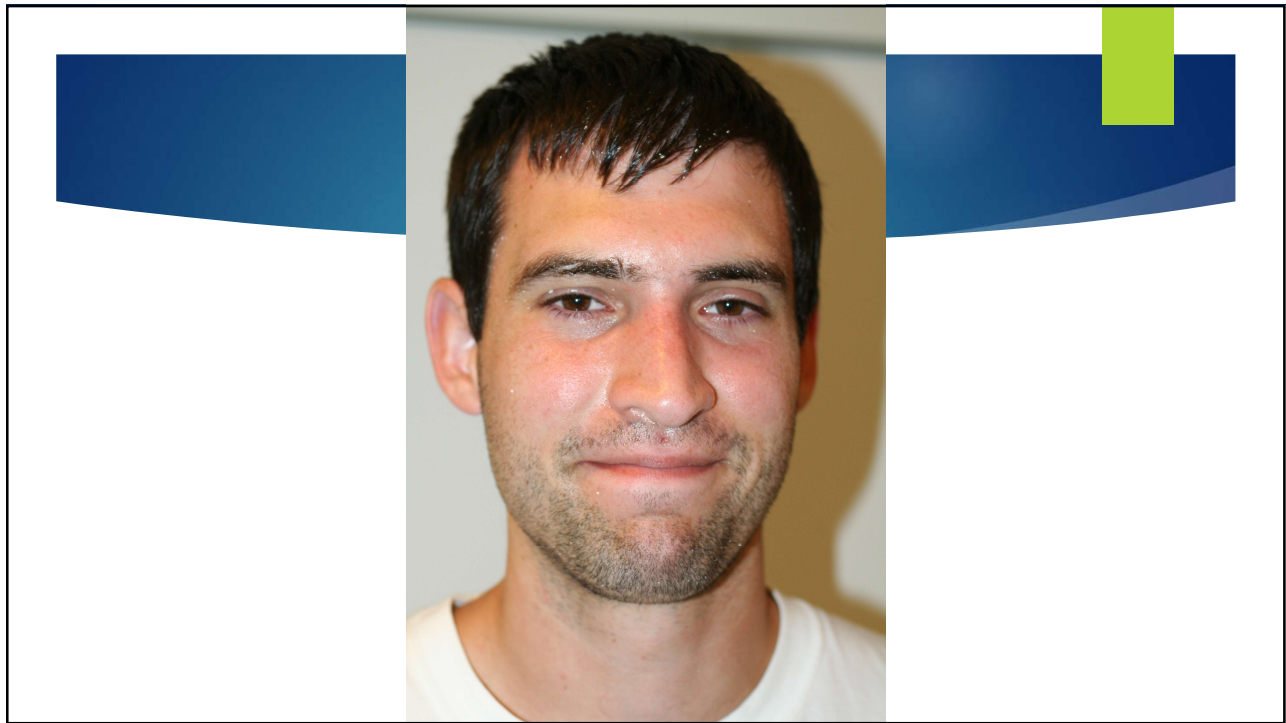
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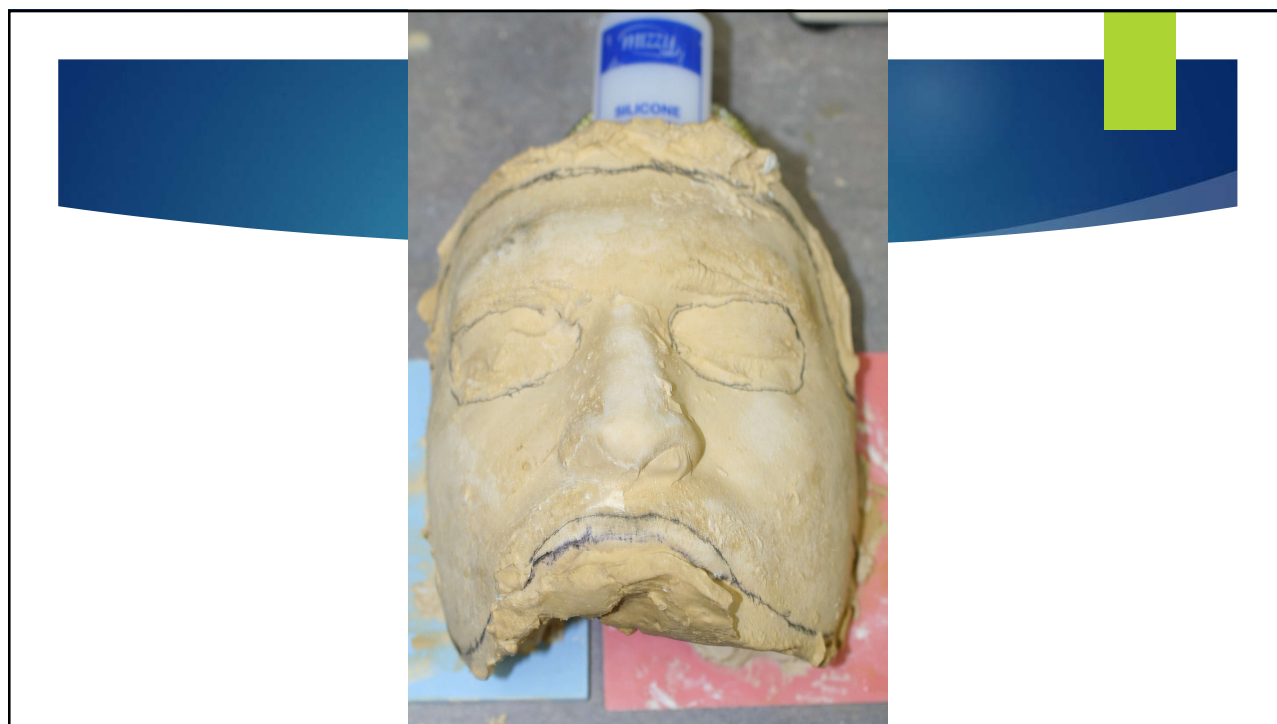
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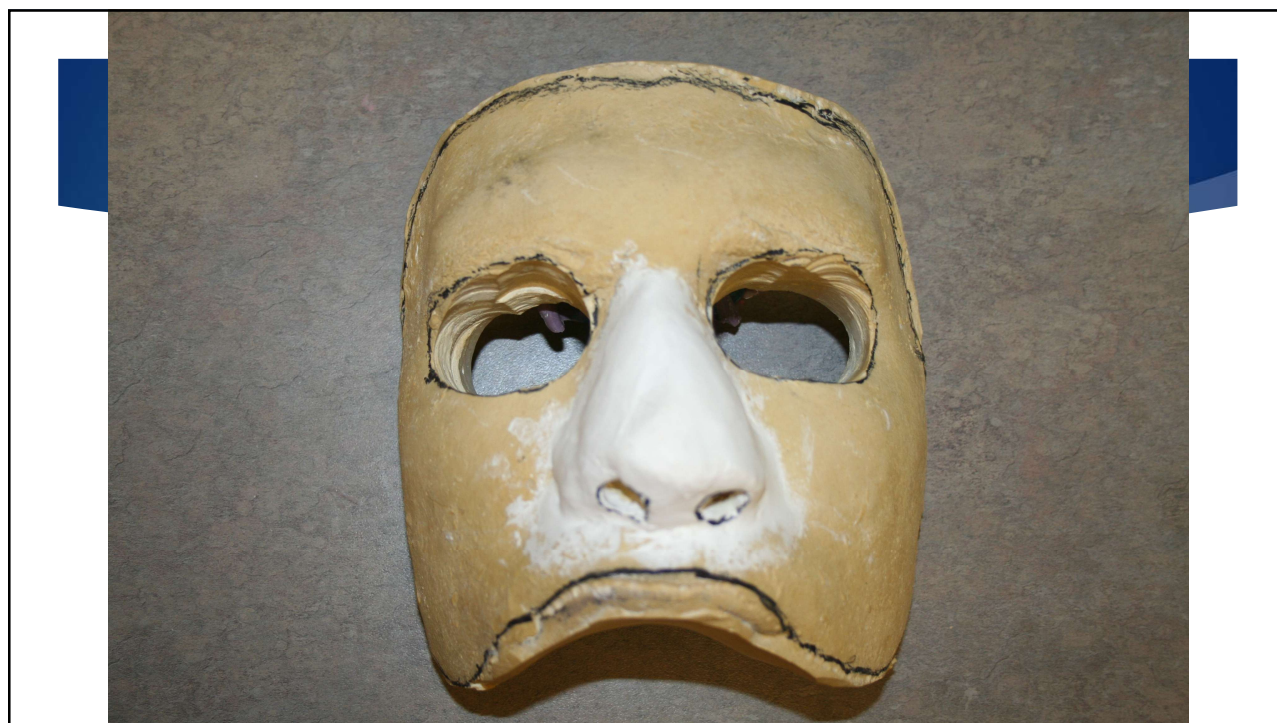
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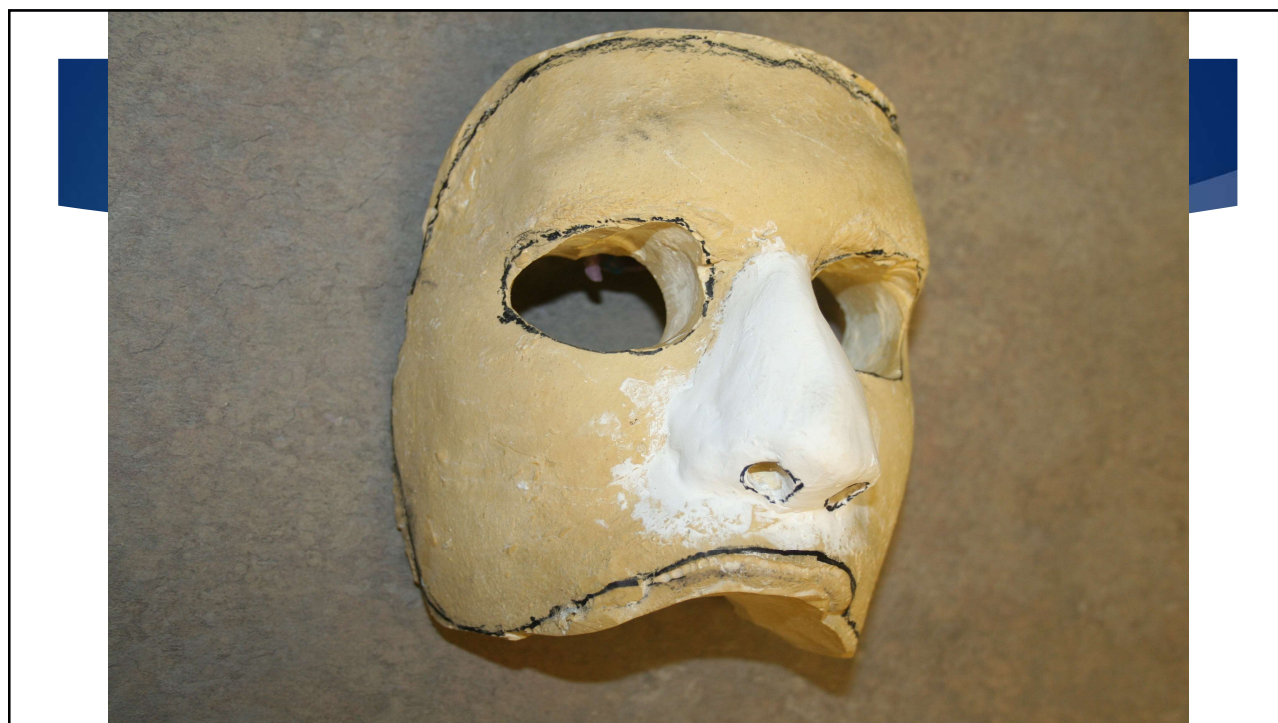
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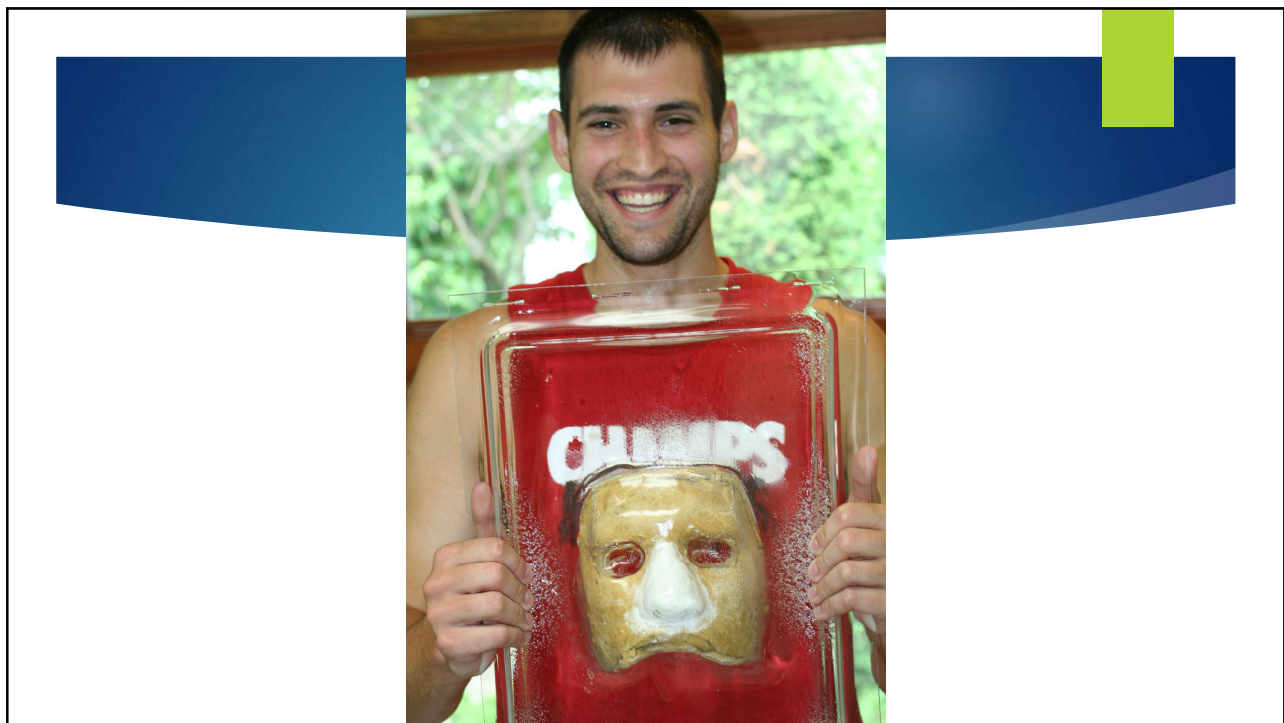
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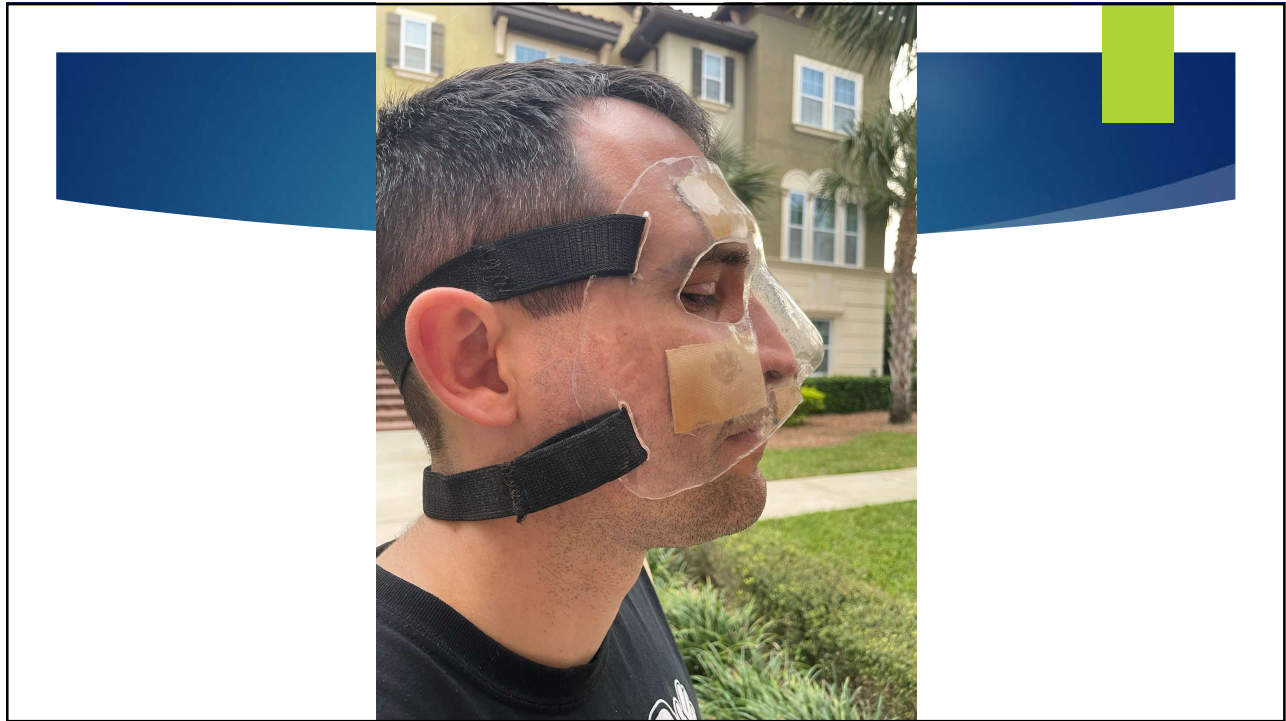
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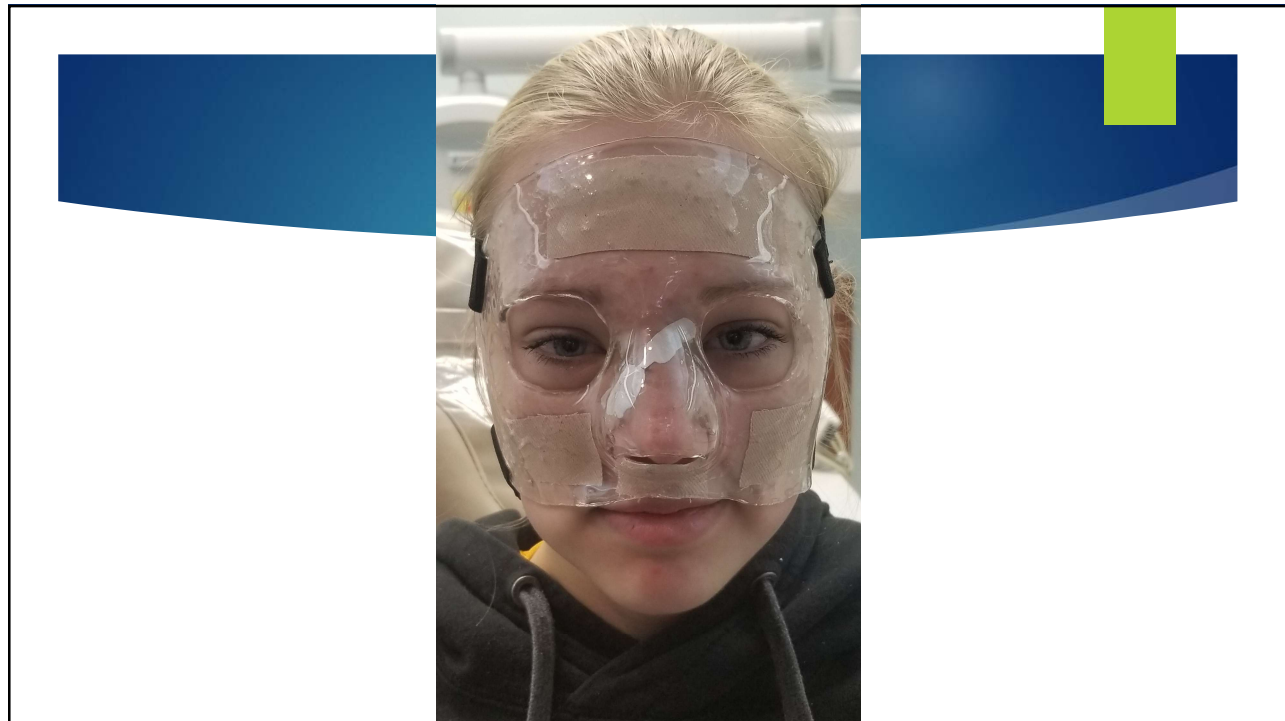
14 Year Follow-Up Adjustment



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My Favorite Facemask Picture:



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Favorite YSU Men's Mask:



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(But Isn't That Me?)



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Just Because Damian's a Nice Guy:

HISTORY MAKERS

Penguins outscore CIT 1st round

By MIC SCALZO
Staff Writer

YOUNGSTOWN
In a game full of firsts, only one thing mattered to Youngstown State women's basketball coach Jerry Allen — that it wouldn't be his last.

Allen, 42, coached his first game with seven players, helped the Penguins break the school single-season record for 3-pointers and reached 1,000 career points as Division I school, beating Oakland 99-87 on Tuesday at Beeghly Center.

"It feels really good to be a part of history," said Allen, who finished with 27 points and five assists. "When we got the invite to the tournament, we wanted to take it as far as we could take it."

From a personal standpoint, we have a possibility of playing four more games. I'd love to play all four of those.

Playing in front of a fairly, but smaller than announced crowd of 1,050, YSU made 19 of 25 pointers — four more than the previous school record — and put five players in double figures.

"Wow," YSU coach Jerry Allen said, when he saw his team attempted 35 pointers, 15 more than the average. "I don't know who their shooting coach is, but he did a heck of a job."

Who's the shooting coach?

"Me," he said, laughing.

Junior forward Perry, who made his first start since Feb. 17, added 21 points, eight rebounds and five assists for the Penguins (10-12), who last played in the postseason in 1977, when they were in Division II.

When you play, you always want to make your mark," said Perry, who has been having an injured knee. "You always want



Youngstown State's Damian Eagle (21) goes to the basket as Oakland's Travis Bader (21) defends during a first round CIT game Tuesday night at Beeghly Center. The Penguins won, 99-87.

Serious Penguins ready to play hard

By MIC SCALZO
Staff Writer

YOUNGSTOWN
Last Friday, after the Youngstown State women's basketball team suffered its worst loss of the season in the Horizon League tournament semifinals, Penguins coach Bob Bolden said:

"I'm not going to play hard, then we're not going to play in the NI or any other tournament."

On Tuesday, the day after YSU accepted WNIT bid, Bolden was asked if he was serious.

"I was 100 percent serious," he said.

So what changed?

"The players," said Bolden, whose team will face Indiana State on Thursday night. "We had a sit down when we got back from Green Bay. It was probably the lastest team meet that we've ever had in his three years. We worked some things out and we agreed if we were going to play basketball, we were going to play it the way it was supposed to be played, with a lot of effort and a lot of energy."

"I trust them as players. I trust them as people. If that was their decision, I was more than willing to coach them. I've had a lot of fun coaching this team."

The Penguins (22-9) will play their first postseason tournament game since losing in the first round of the NCAA tournament in 2006. The Penguins (10-12) are coming off a 71-60 loss to Northern Iowa in the Missouri Valley tournament quarterfinals.

GAME TIME
What: Indiana State at Youngstown State
Date: Tuesday
Time: 7:05 p.m.
Where: Beeghly Center
Radio: WYOH 93.1
TV: 570

YOUNGSTOWN STATE
Coach: Bob Bolden
Record: 22-9
Next game: Thursday, 7 p.m., at Indiana State

OAKLAND
Coach: Jerry Allen
Record: 10-12
Next game: Friday, 7 p.m., at Youngstown State

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Coach: Mike Wood
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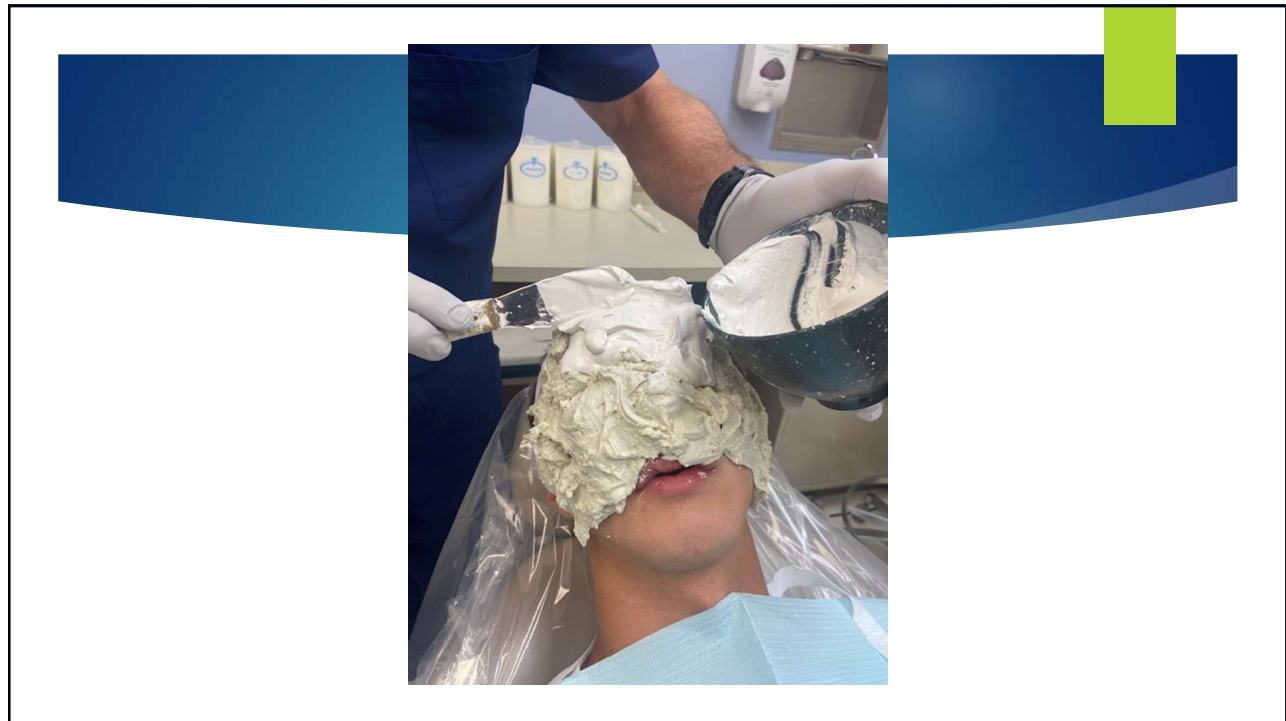
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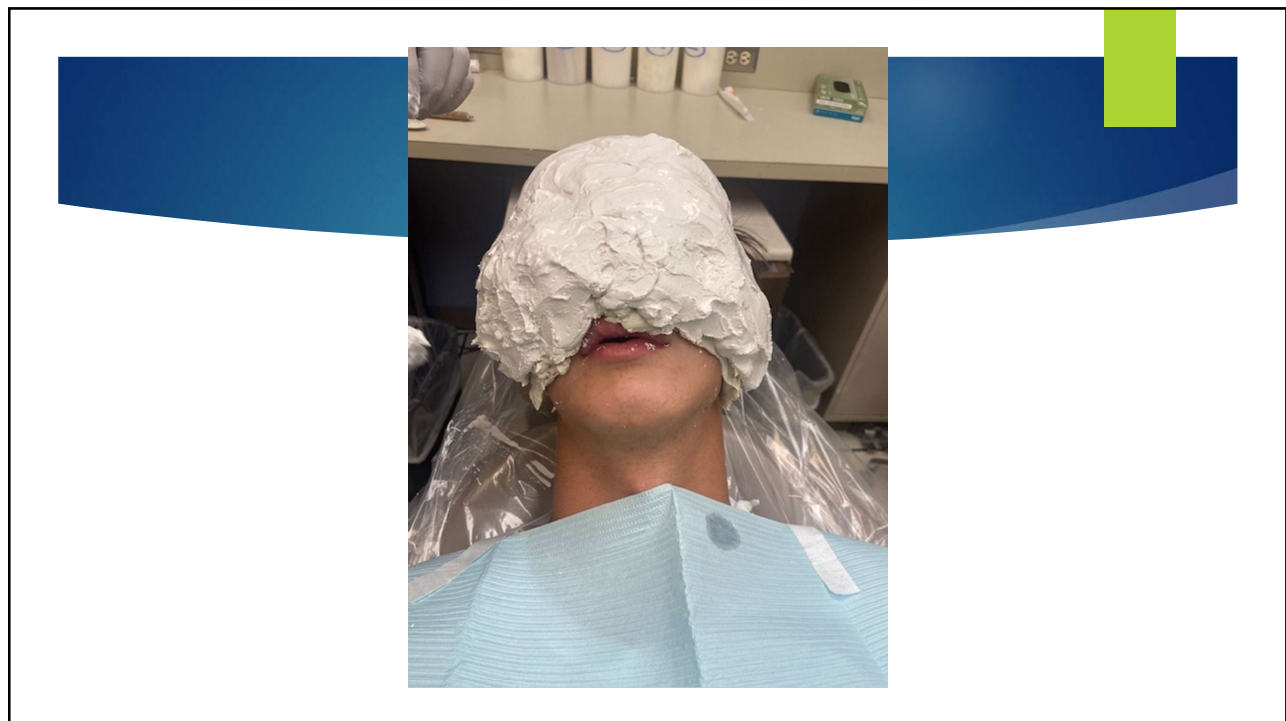
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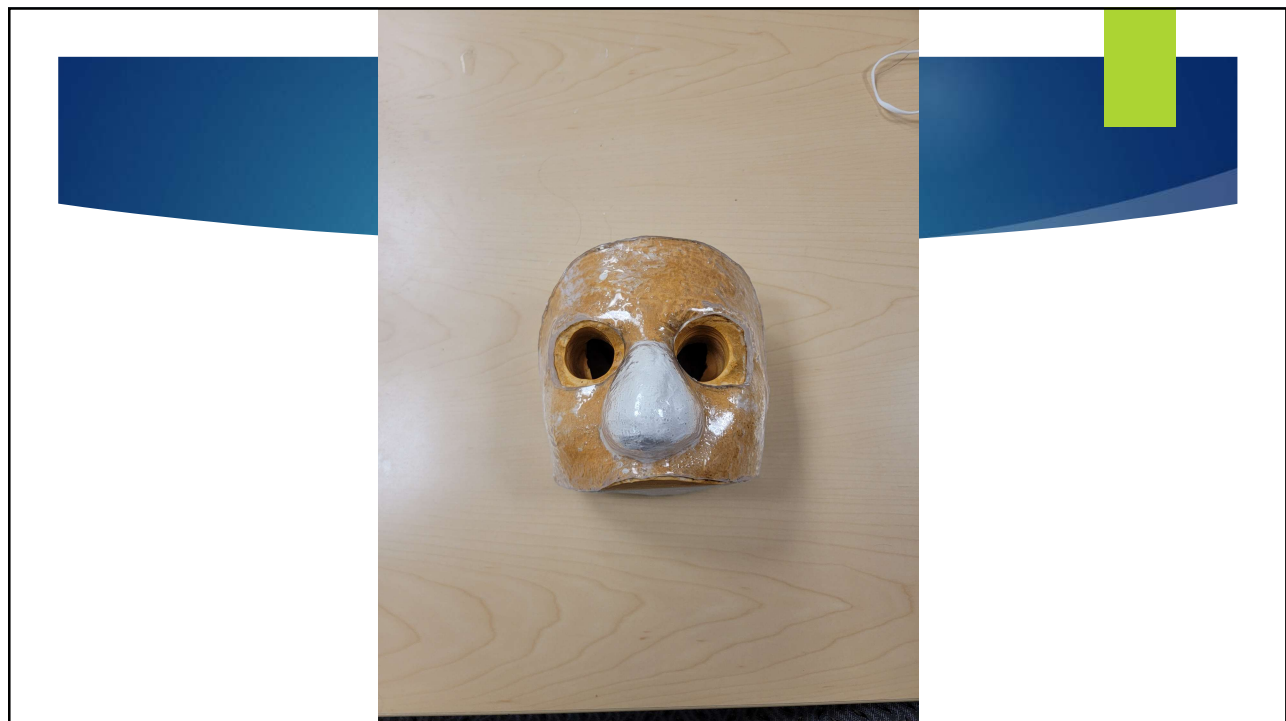
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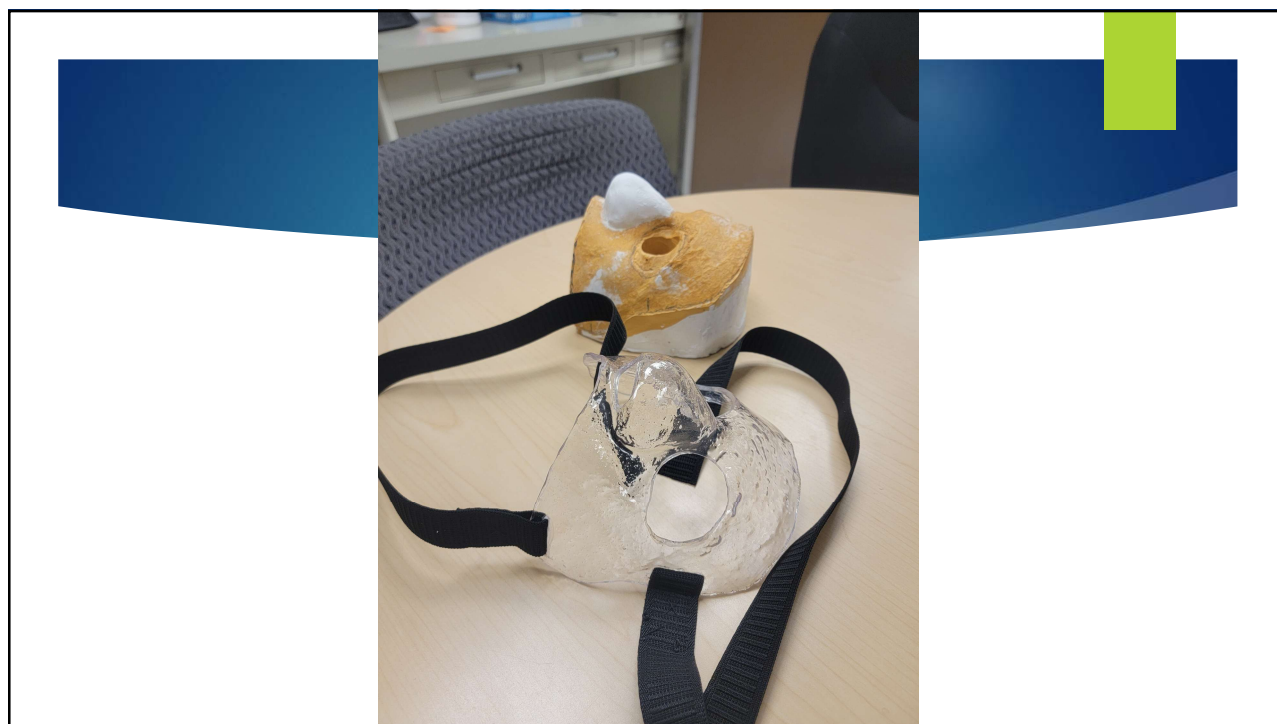
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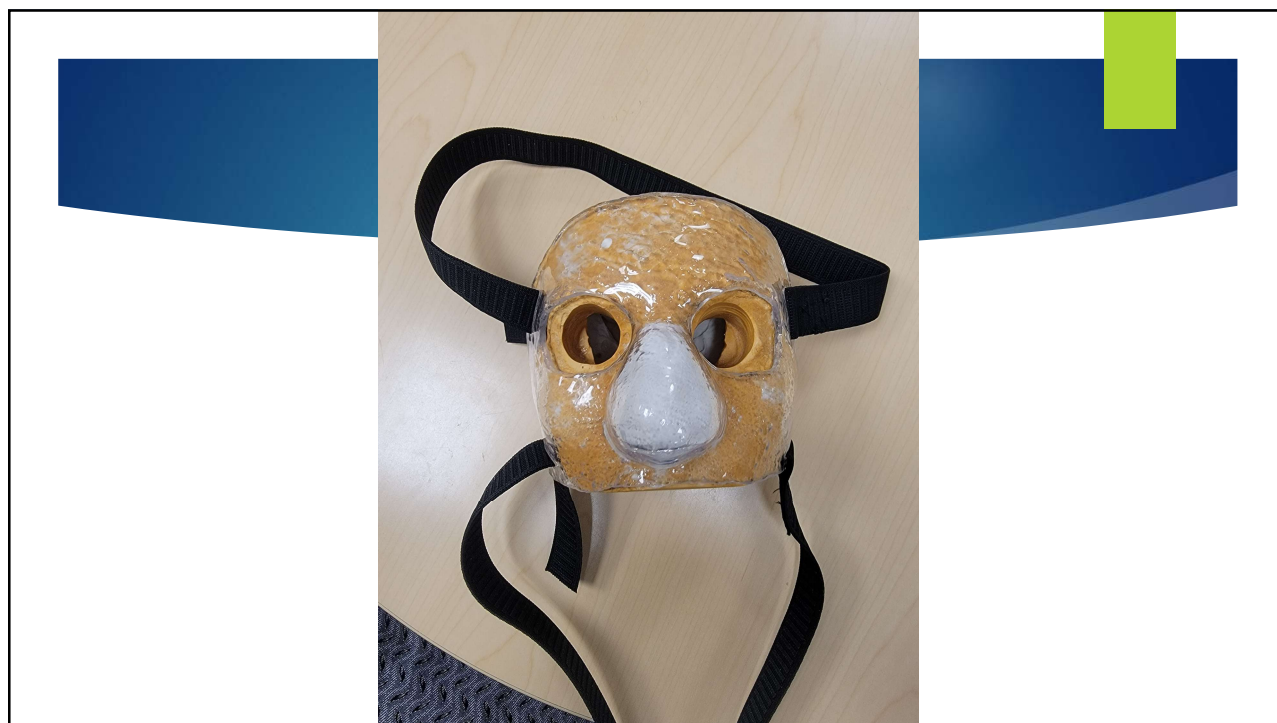
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Centroform EZForm Vacuum Machines:



EZFORM SV 1217 E (EXTERNAL SUCTION)
\$2,590.00



EZFORM SV 1217 V2 (Built in vacuum system) Plug & Play
\$3,297.00



EZFORM LV 1827 E (EXTERNAL SUCTION)
\$3,875.00



EZFORM LV 1827 V2 (Built in vacuum system) Plug & Play
\$4,495.00



EZFORM LV 1827 VX (Built in vacuum system) Plug & Play
\$5,975.00



EZFORM LV 2844 V2 (Built in vacuum system) Plug & Play
\$14,975.00

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“And now for something completely different!”

- This work has all been conventional or “analog”. We now live in the digital world. Both mouthguards and facemasks can be made using digital technology. But using digital methods has drawbacks as well as advantages.

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Pros and Cons of Going Digital

- ▶ Cost comparison:
- ▶ Analog- Custom mouthguard made with alginate impression, stone model, sheet of mouthguard material, vacuum machine, trimming and shaping in lab, adjusting bite in mouth. Maybe \$20 materials, 10 minutes chair time for impression, 20 minutes lab time(both delegable to skilled assistant), 10 minutes Doctor time to seat and refine occlusion.
- ▶ Digital- Scanning time approved by Doctor or done by Doctor, printing model (time and money more than alginate and stone) to use vacuum machine, or decision to print mouthguard- Is printed similar in protection to vacuum formed? Time is variable with scanning skills, printing speed.
- ▶ How much would you need to charge?
- ▶ Patient willingness/ability to pay?

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UAB Graduate Prosthodontics Digital Mouthguard Experience

- ▶ Fabrication of mouthguards for University of Alabama football.
- ▶ Mouthguards contain microchip sensors to detect intensity of hits- value for concussion research?
- ▶ Several companies are making these with embedded sensors. Some mouth-formed, some custom made.
- ▶ Interesting idea. Certainly not more protective. Efficacy TBD.
- ▶ Are we getting away from the intent of mouthguards, which is prevention and protection, and shifting it to research?

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OPRO Prevent iMG (Instrumental Mouthguard)

- ▶ OPRO: Dental lab founded in 1997 by a dentist in Great Britain. University of Alabama has mouthguards made there with chip which monitors forces. Can help with concussion evaluation and more. They supply England Rugby, New Zealand Rugby, UFC, USA Wrestling, England Hockey, and more. U of A uses this info to monitor player safety as well as location throughout practices and games.



<https://www.opro.com/en-us>

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OTHER "SMART" MOUTHGUARDS

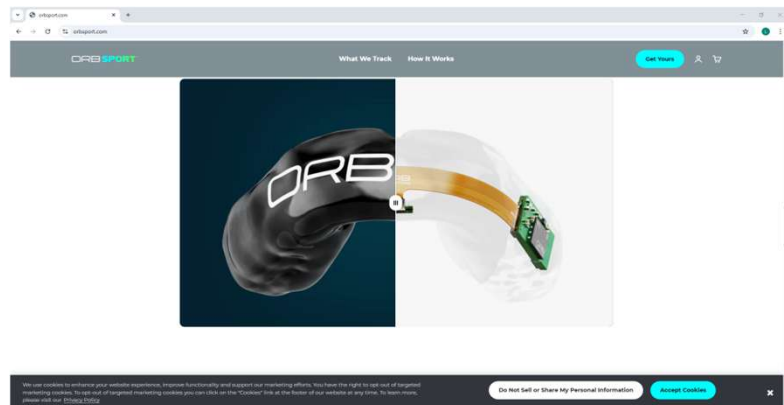
- ▶ HITIQ: Send scan, get MG, charging station, App, \$449 Australian : "Provides a total concussion ecosystem"



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OTHER "SMART" MOUTHGUARDS

- ORB: You take 2 impressions with kit they send you. You get: smart MG, charging case, USB cord. Monitors heart rate, movement, impacts. It is an EVA mouthguard with Bluetooth sensors in it. \$349 + \$7.99/month for app.



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International Female Rugby player: Georgie Perris-Redding: Real World Applicability

- "It's just really comforting to know that I'm protecting my teeth, but also it's something that I feel comfortable in and, you know, it might not be the most attractive thing, but it's definitely better than no teeth."



<https://www.salesharks.com/player/georgie-perris-redding/>

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Digital Mouthguard Options

- ▶ Keystone Industries: Makes Proform. Now producing printing resin, KeyPrint KeyGuard Sportsguard resin. Material is primarily 2-hydroxyethylmethacrylate and TPO (thermoplastic polyolefin polymers including polypropylene ethylene rubbers). \$299 for 35.3 ounces.



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RESEARCH: Printed MGs vs Conventional MGs

- ▶ "The production and materials of mouthguards: Conventional vs additive manufacturing- A systematic review" Goncalves, et al., Heliyon, Vol.10, Issue 14, July 2024:
- ▶ Conclusion: Additive manufacturing is promising and feasible but there are clear gaps in knowledge...
- ▶ "Comparison of shock absorbtion capacities of 3 types of mouthguards: A comparative in vitro study" Yohan Arti, et al., Dental Traumatology, May 25, 2024:
- ▶ Conclusion: Custom-made 3D printed MGs showed slightly better shock absorbtion ability than thermoformed MGs. ...least thickness variations...

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Let's Make A Printed Mouthguard:

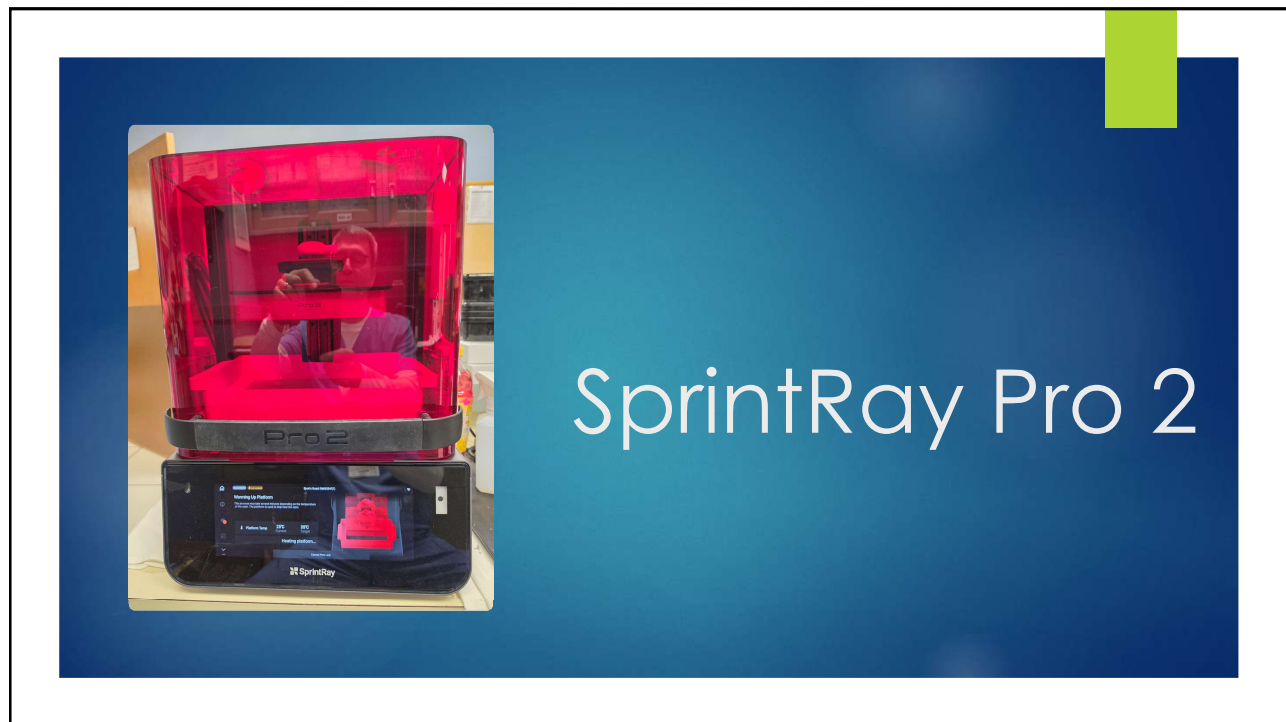


97

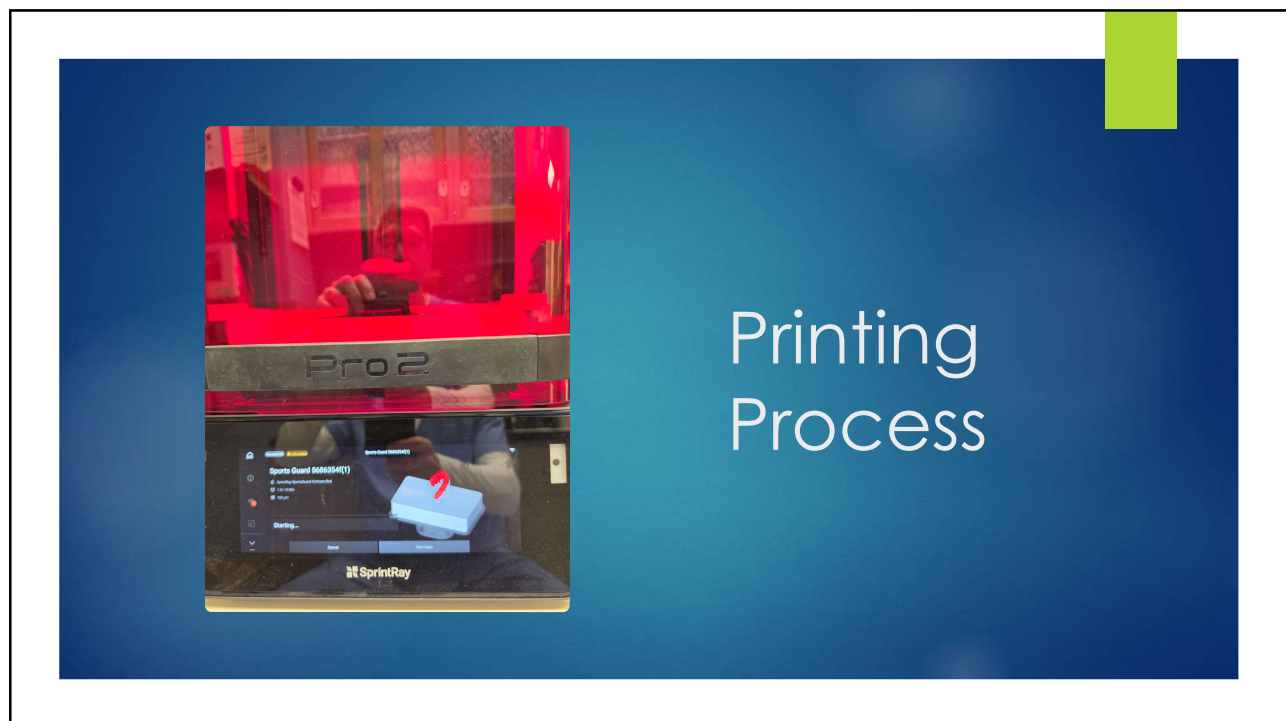


Adding
The Resin
to the Tray

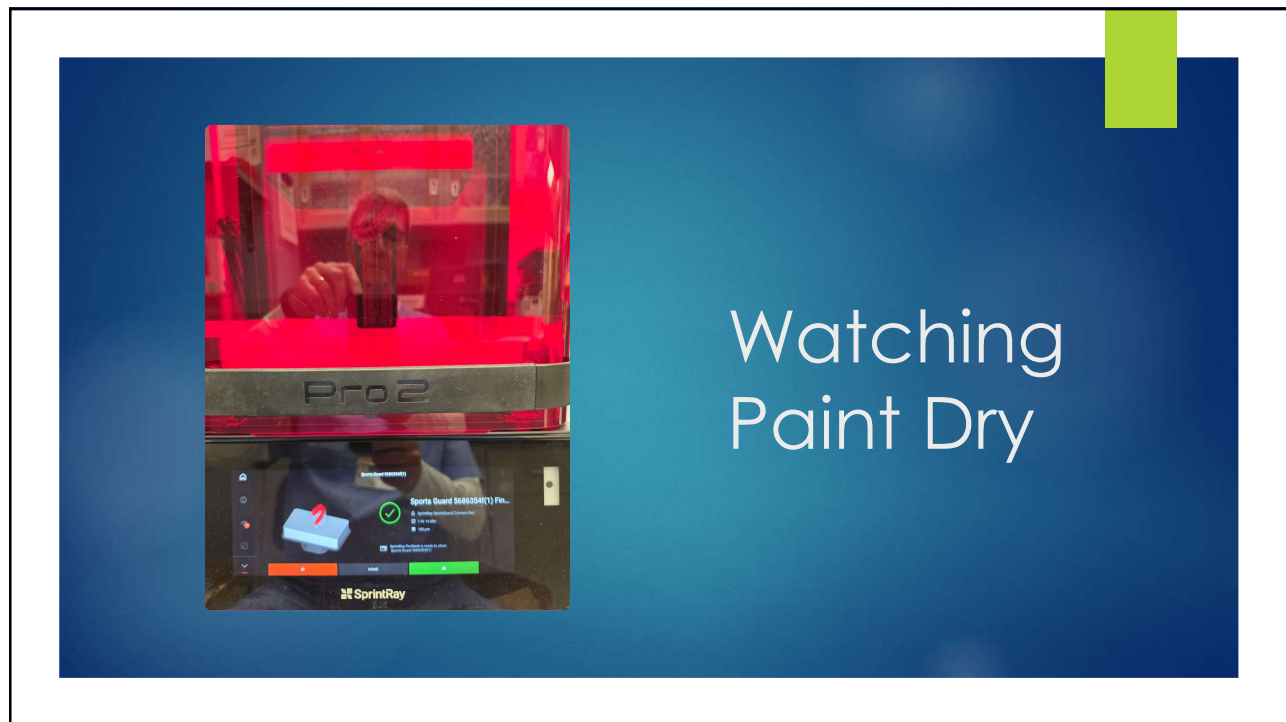
98



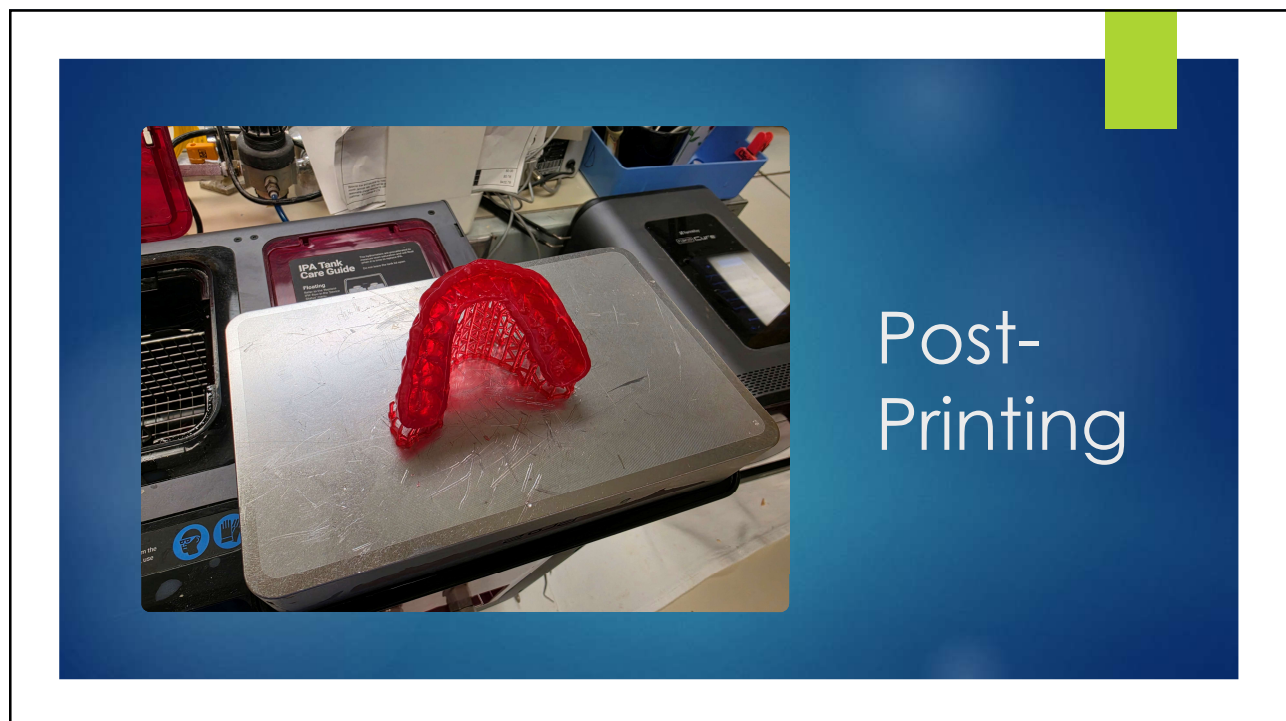
99



100



101



102



Wash
Time

103



91%
Alcohol
Wash

104



Curing Time!

105



“Equilibration”
Time!

106



107



108

What Would I
Recommend
Knowing
What I Know
Now?



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Biostar Scan with LCD Display

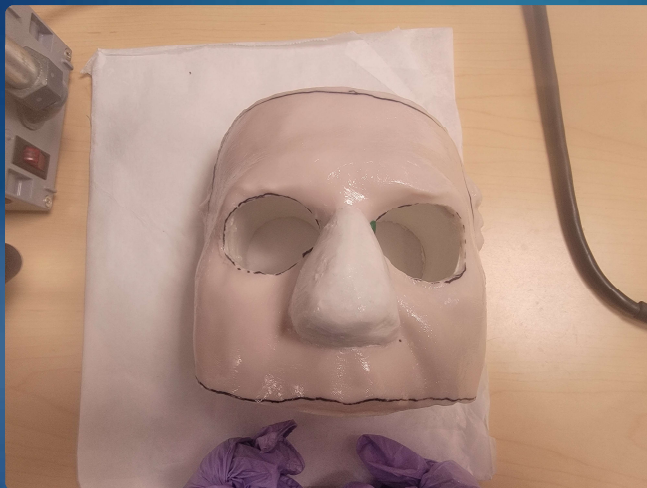
- ▶ Positive Pressure Machine for thermal forming
- ▶ Uses: splints, mouthguards, bleaching trays, Hawley retainers, clear retainers, stents, surgical guides, etc.
- ▶ 90 PSI pressure
- ▶ Positive pressure results in less thinning deformation than vacuum forming, therefore more even thickness of material.

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Digital Applications for Facemasks

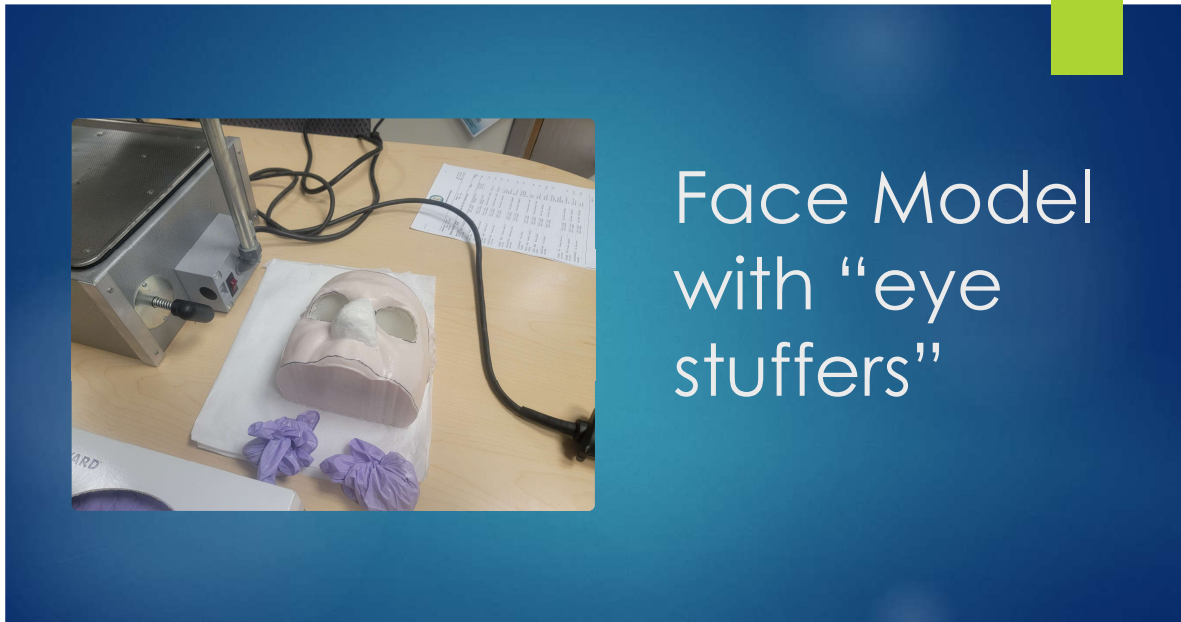
- ▶ More fruitful in my opinion.
- ▶ Facial scans- application in restorative dentistry, can be used for facemask fabrication also.
- ▶ Thanks to Dr. Paul Koch of Birmingham and his staff, I had a facial scan.
- ▶ Models made by Utah Valley Dental Lab.
- ▶ Used one to make a mask for myself with the large vacuum machine.
- ▶ Usefulness? Claustrophobic patients, tech-obsessed patients.
- ▶ Downside? Turnaround time, expense.

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Face Model
After
Customization:

112



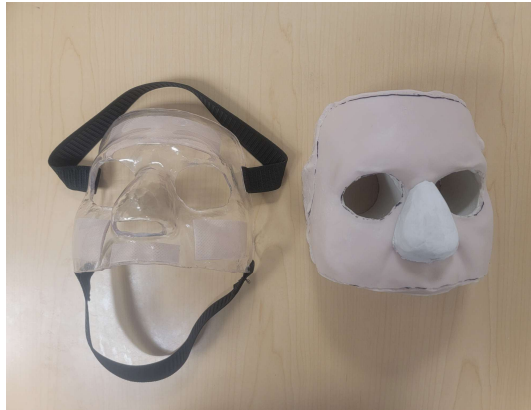
113

After the vacuforming:



114

After fun with a high speed 8 round



115

Finished Product



116



Dr. Paul Koch and his Facial Scanner

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Scanner Info

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The Next Step: All Digital-The Raptor

- ▶ Forward STL file of the facial scan to Invent Medical in Philadelphia(Czech Republic, Germany, UK)
- ▶ No model needed, mask is fabricated from scan info
- ▶ Time/Cost:
 - ▶ 2 Weeks- \$450
 - ▶ 1 Week- \$950

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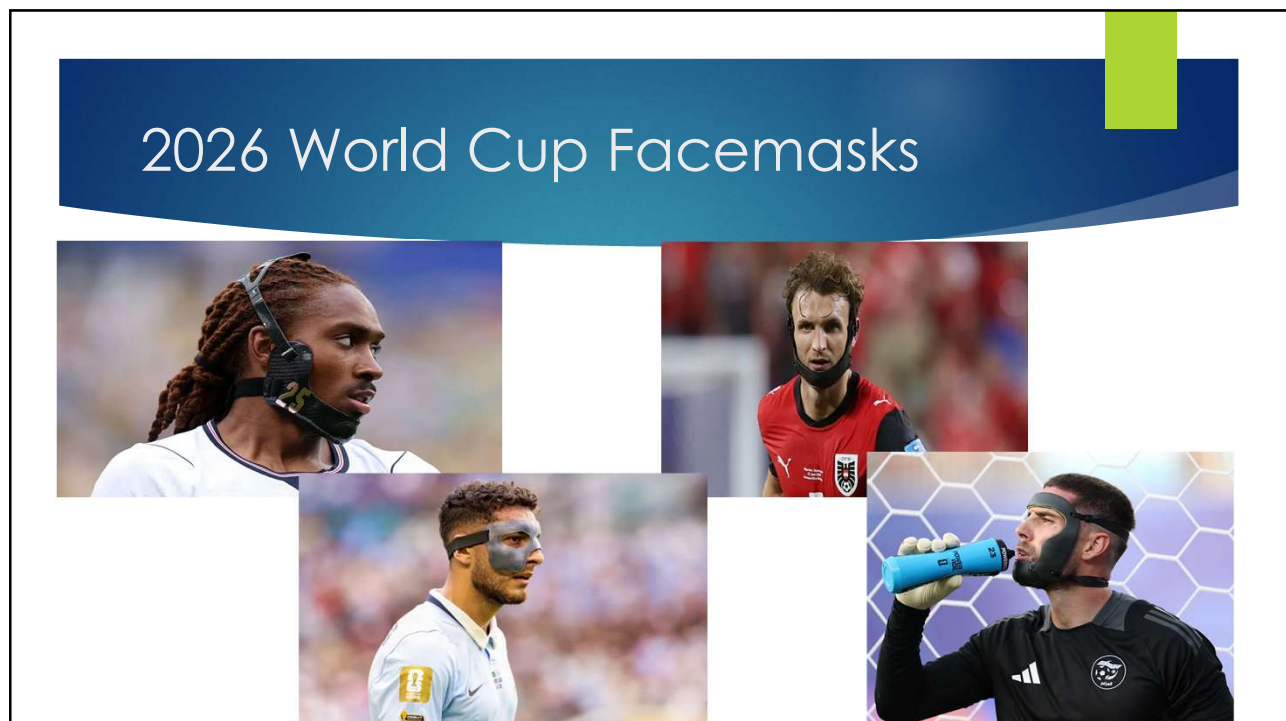


Raptor
from
Invent
Medical

120



121



122



“I’m going to be
a Sports Dentist!”

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