Comparing the Efficacy of Sodium Fluoride and Silver Diamine Fluoride in Arresting Caries through Statistical Analysis

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Introduction

Sodium fluoride (NaF) is an inorganic compound that is a source of the fluoride ion in many applications, including dental care. Its benefits on dental health were first observed in the 1930s, when individuals in communities with fluoridated drinking water showed less tooth decay than those without fluoridated water. Sodium fluoride therapies have since been used in managing hypersensitivity, caries control, and dentin strengthening. Sodium fluoride is absorbed by the surface of hydroxyapatite crystals on the teeth, which are necessary for mineralization. This causes the teeth to be more resistant to demineralization by changing the apatite crystal solubility. Due to its low fluoride concentration, NaF has the advantage of a lower risk of fluorosis[1].

Silver diamine fluoride (SDF) is a colorless alkaline topical fluoride solution containing fluoride ions and silver ions. The silver functions as an antimicrobial, while fluoride is present in sufficient concentration to promote remineralization. The ammonia (NH_3) stabilizes the solution. While SDF inhibits the collagenolytic enzymes that break down the exposed dentin organic matrix, ionic silver acts as an antibacterial by disrupting membranes, denaturing proteins, and inhibiting DNA replication[2]. Antibacterial mechanisms of SDF can also be attributed to the formation of organometallic complexes inside the bacterial cell[3]. The most widely known use of SDF is caries control. SDF can be used as a caries-preventing agent for permanent molars and a caries-sterilizing agent for the arrestment of pre-existing caries. Similar to NaF, SDF is also used in dentin strengthening and management of hypersensitivity. Researchers have also found that SDF has the potential to play a part in the elimination of microorganisms of root canals in endodontic treatment[4]. While SDF is advantageous in its antimicrobial and remineralization effects, it also causes black staining of carious lesions. There is also a possibility of gingival and mucosal irritation, as well as fluorosis due to its high fluoride content[5].

Methods

In the randomized controlled trial (RCT) by Lo *et al.*[6], researchers focused on carious lesions of upper anterior primary teeth only. 38% SDF was used in comparison with 5% NaF varnish and water (control). Two treatment groups received caries excavation prior to application of their assigned varnish. The treatment groups were as follows:

Group 1	Caries excavation with 38% SDF applied every 12 months
Group 2	No caries excavation with 38% SDF applied every 12 months
Group 3	Caries excavation with 5% NaF applied at Day 0 and every 3 months
Group 4	No caries excavation with 5% NaF applied at Day 0 and every 3 months
Group 5	Water application (control)

The first null hypothesis is that there is no difference in the effectiveness of silver diamine fluoride solution, sodium fluoride varnish, and water in arresting dentin caries. The second null hypothesis is that caries removal prior to fluoride application had no impact on its effectiveness in arresting caries.

The second randomized controlled trial by Duangthip *et al.*[7] focused on carious lesions of posterior and anterior primary teeth. 30% SDF was used in comparison with 5% NaF varnish. The treatment groups were as follows:

Group 1	30 % SDF applied 3 times annually
Group 2	3 weekly applications of 30% SDF
Group 3	3 weekly applications of 5% NaF

The null hypothesis is that there is no difference between the three topical fluoride application protocols in their effectiveness in arresting dental caries in primary teeth over a 30-month period.

Results

In the first RCT, the children who received an annual application of SDF had more arrested caries lesions than children in other groups (ANOVA, $p < 0.001$). Prior excavation of soft carious tissue did not induce a significant difference in the caries arrest rate (CI 95%)[8].

Treatment Group	No. of Active Caries Lesions at Baseline	New Caries Surfaces at 18 months	Arrested Caries Surfaces at 18 months
1	4.13 (2.35)	0.44 (0.89)	2.84 (2.19)
2	4.26 (2.74)	0.42 (0.82)	2.99 (2.45)
3	3.92 (2.69)	0.84 (1.58)	1.69 (1.88)
4	3.82 (2.57)	0.63 (0.91)	1.50 (1.90)
5	3.75 (2.50)	1.22 (1.60)	0.99 (1.25)

Treatment Group	New Caries Surfaces at 30 months	Arrested Caries Surfaces at 30 months	% Arrested Caries, Black
1	0.26 (0.09)	2.49 (0.27)	100
2	0.47 (0.11)	2.82 (0.30)	100
3	0.89 (0.20)	1.45 (0.19)	26
4	0.70 (0.12)	1.54 (0.27)	66
5	1.58 (0.25)	1.27 (0.19)	42

From the results, we can reject the first null hypothesis as there is a difference in the treatment groups. We would fail to reject the second null hypothesis as there is not a difference in the caries arrest rate due to prior excavation of the soft dentin.

In the second RCT, both SDF protocols significantly shortened the time to caries arrest in comparison to NaF ($p < 0.001$). When comparing the two SDF treatments, there was no significant difference in the caries arrest rate.

Group	Caries Arrest Rate at 6 months	Caries Arrest Rate at 12 months	Caries Arrest Rate at 18 months	Caries Arrest Rate at 30 months
1	18%	20%	40%	48%
2	31%	28%	35%	33%
3	10%	13%	27%	34%

Results (cont.)

From these results, we would fail to reject the null hypothesis because there was no difference in the caries arrest rate of the three treatment groups. Factors that did significantly affect the time to caries arrest include treatment group, presence of plaque on lesions, tooth type, and tooth surface (95% CI).

Conclusion

Silver diamine fluoride has a better outcome in arresting dental caries compared to sodium fluoride in primary teeth. Annual application of SDF does not have a significant difference in arrest rate compared to 3 weekly applications of SDF. Prior excavation of soft carious tissue did not induce a significant difference in the caries arrest rate. There is a higher caries arrest on anterior teeth in the buccal-lingual surfaces without the presence of plaque.

Because SDF treatment does not require caries removal, and it is simple, non-invasive, and inexpensive, SDF is a valuable strategy for caries management in young children and patients with special needs.

References

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