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Efficacy of Strontium Chloride in Treating Dentinal Hypersensitivity: A Systematic Review

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***Abstract*: *Aim:* To assess the effectiveness of strontium chloride in treating dentinal hypersensitivity. *Methods:* A literature review was performed using Cochrane, science direct, Pub Med, Wiley, Scopus, Medline, Gray literature, Ovid medicine and CINAHL. A total of 290 records were screened, out of which full text was assessed for 12 articles and 5 studies were included in the qualitative synthesis. The study was reported based on Preferred Reporting Items for Systematic Reviews and Meta-Analysis, and bias was characterized by Cochrane risk of bias tools for Randomized Controlled Trial. *Results:* 3 Out of 5 results show a positive effect of strontium chloride in treating dentinal hypersensitivity. However, some recent advances, such as pluronic F-127 with dibasic sodium citrate and 5% potassium nitrate were found to be more effective than strontium chloride. *Conclusion:* In the available literature, the application of strontium chloride was found to be effective in reducing pain and hypersensitivity.**

***Keywords*: Dentinal hypersensitivity, Strontium chloride, Tactile sensitivity, Treatment.**

1. Introduction

Dentinal hypersensitivity is a common condition causing pain [1]. Dentinal hypersensitivity is a disorder that causes symptoms ranging from mild discomfort to severe pain when the affected teeth are exposed to thermal, tactile, or chemical stimuli [2]. Dentin hypersensitivity occurs due to activated nerve endings present at the pulp-dentin border, which is thought to be induced by a shift in fluid flow inside the dentinal tubules [1]. Wherever the dentin is exposed by attrition or abrasion, or the root surface is exposed by periodontal disease, hypersensitivity can develop. Dentin hypersensitivity is a common condition seen in dentistry [3].

According to clinical findings, the dentinal tubules of individuals with dentinal hypersensitivity are visible from pulp to the oral environment; the tubules in sensitive dentin surfaces are broader and more in number than non-sensitive dentine surfaces, which are usually hidden by smear layer [4]. Dentinal hypersensitivity can occur in any age group but is more common in the third and fourth decades of life. Dentinal hypersensitivity can affect any tooth and tooth surface but has a high predilection for buccal cervical regions of canines and premolars [5]. The cervical buccal surface of the first premolars is most commonly affected [6]. Exposure of tooth to erosive substances (e.g., acidic beverages) and usage of abrasive toothpaste for brushing are the common risk factors associated with dentinal hypersensitivity [7]. Generally, the dentin is more exposed in older individuals and is less sensitive when compared to the younger age group. This is seen because dentinal tubules get clogged with mineral deposits as a result of dentinal sclerosis, reducing permeability and fluid flow through the tubules [8]. Dentinal hypersensitivity can result in sharp, shooting pain, which lasts for a short period of time in patients.

Although dentinal hypersensitivity is not a major dental disease, it can be a very uncomfortable sensation for individuals, limiting the foods and drinks they can consume [9]. Electrical stimulation, which transmits electrical energy through dentin in the form of current or potential and stimulates nerve cells, can also elicit a pain response. The critical Ph at which enamel erodes and causes dentin exposure and dentinal hypersensitivity is 5.5 (±0.5) [8]. Dental pain can be attributed to dentin hypersensitivity, which is characterized by short, sharp pain originating from exposed dentin in response to stimuli, typically thermal, evaporative, tactile, osmotic, or chemical, and which cannot be attributed to any other form of dental defect or pathology [10]. Hypersensitivity after periodontal therapy is experienced by almost all the patients, with a prevalence of 84.5% [11]. There are many treatment options available for reducing dentinal hypersensitivity.

Effective treatment requires a proper diagnosis, which can only be made when all other probable causes of pain have been ruled out. The availability of a large range of therapy alternatives could indicate that there is still no effective desensitizing agent to entirely alleviate the patient's discomfort or that the condition is difficult to cure, regardless of the treatment options available [12]. For the treatment and prevention of dentin hypersensitivity, various drugs and treatment techniques have been tried [13].CPP-ACP (casein phosphopeptide- amorphous calcium phosphate complexes),

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arginine, nanomaterials, herbal products, propolis, etc., are a few recently introduced agents used for the treatment of dentinal hypersensitivity [14]. Topical desensitizing agents include corticosteroids, silver nitrate, strontium chloride, and potassium nitrate, as well as physical agents such as composites, varnish, and GIC. Laser treatment with less application time and fast process gives more quick results when compared to conventional topical desensitizing agents [15].

Many desensitizing compounds have been used to treat sensitivity with varying degrees of success. Strontium chloride is one of them. It's possible that strontium chloride's lower sensitivity reduction is attributable to its mechanism of action [16]. Strontium deposits are thought to be formed by the exchange of strontium with calcium in the dentin, which results in recrystallization in the form of the strontium apatite complex [17]. Tubule occlusion with varying degrees of success can occur because of the presence of abrasives [18]. It may be concluded that using a dentifrice containing 10% strontium chloride hexahydrate on a regular basis at home is an efficient way to reduce the discomfort and pain caused by thermal and tactile stimuli in patients with dentinal hypersensitivity [1]. The aim of the study is to assess the effectiveness of Strontium Chloride as an agent to treat dentinal hypersensitivity.

2. Materials and Methods

Randomized controlled trials with visual/tactile interventions were included in the study.

Eligibility criteria:

A) Inclusion criteria

- Full-text articles
- Studies with randomized controlled trials

B) Exclusion criteria

- Pilot studies
- Studies without involving strontium chloride usage in treating dentinal hypersensitivity.

Search strategy:

Published results on the effect of strontium chloride in treating dentinal hypersensitivity, which includes original articles and research papers in databases such as Cochrane Library, Science Direct, PubMed, Wiley online library, Scopus, CINAHL, were taken into study for review. A literature search to collect relevant data was performed using MeSH terms “Strontium chloride AND dentinal hypersensitivity”.

According to Prisma guidelines, the mesh terms were altered in each search engine when the results went too many or too less.

The search yielded 343 articles, and 5 articles were independently assessed among these eligible articles. Three tables were included; figure 1 shows a flow diagram of the reports identified, screened, assessed for eligibility, excluded and included for the review.

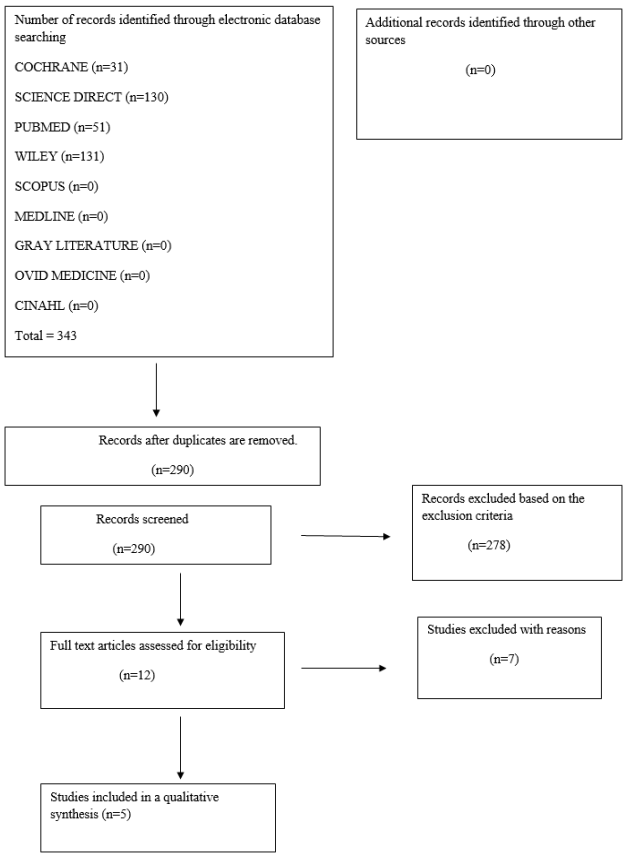

Fig. 1. Flow diagram showing the number of studies identified, screened, assessed for eligibility and included for systematic review

3. Results

Table 1 shows the characteristics of the studies that have been chosen for the systematic review. The following characteristics were studied: Name of the author, year of study, sample number including their details such as age and interventions involved in the study. All the included studies were randomized controlled trials. 10% of Strontium chloride was used the majority of the time in the test group for assessing dentinal hypersensitivity, and it was compared with others like Potassium nitrate-based dentifrice, Silica-based dentifrice, Stannous fluoride-based dentifrice and dibasic sodium citrate in a pluronic gel.

Table 2 shows the characteristics of outcome.

Table 3 shows the bias analysis of the studies included, which were categorized as high risk of bias, low risk of bias and unclear risk of bias. Categorization was done according to the Cochrane risk of bias tools for randomized controlled trials.

4. Discussion

Dentinal hypersensitivity is a very common complaint of middle-aged patient, and this pain increases with age [19]. The patient experiences sharp pain with an unpleasant sensation. The detrimental influence of Dentinal hypersensitivity on daily living is one of the main reasons why people seek dental help in order to enhance their quality of life [20]. Dentinal hypersensitivity can be treated by blocking the exposed dentinal tubules or interfering with the neural stimuli. The most common

agents used for blocking neural transmission are Potassium, Strontium salts, oxalates, Calcium Phosphate, Fluorides, Glutaraldehyde and Formaldehyde [21].

The first bioactive material incorporated in dentifrices approximately 50 years ago was strontium chloride [22]. Strontium chloride has been incorporated in dentifrice for more than four decades now [23]. Strontium chloride being non-irritating, non-toxic and non- allergic, does not cause any harm to the pulp. Strontium chloride, when used in a dentifrice, helps reduce pain in hypersensitive patients. Strontium compounds were found to be chemically similar to calcium, and in many physiological processes, they can be a substitute for calcium. Strontium chloride has a high absorptive capacity for calcified tissues with high organic content [24].

There were various desensitizing agents used for the treatment of dentinal hypersensitivity. The desensitizing agent was introduced in dentifrices long ago. One of the earliest dentifrices used was formalin containing dentifrice, zinc chloride, silver nitrate, strontium chloride and fluorides. There are many findings indicating occlusion of the tubule is also

Table 1
Characteristics of interventions in the study

S.No.	Author	Year	Patient Selection	Duration	Preparation Used	Intervention
1	LIu H, Hu D [32]	2012	80 subjects between the age of 20 to 65 years having dentinal hypersensitivity	3 days	1) Strontium chloride-based dentifrice with 2% concentration and Potassium nitrate-based dentifrice with 5% concentration 2) Silica-based dentifrice without any active ingredient.	Tactile hypersensitivity score was assessed. Airblast hypersensitivity score was assessed.
2	D.G. Gillam, H.N. Newman, J.S. Bulman, E.H. Davies [33]	1992	40 subjects between the age of 40 to 43 years having dentinal hypersensitivity	8 weeks of use of dentifrice and re-examination after 12 weeks	1) Non-commercially available strontium chloride-based dentifrice with a silica abrasive 2) Commercially available strontium chloride-based dentifrice with diatomaceous earth abrasive	Tactile hypersensitivity score was assessed. Cold Air blast hypersensitivity score was assessed.
3	Annett Kobler, Oliver Kub, Hans-Gunter Schaller, Christian R Gernhardt [30]	2008	142 subjects having dentinal hypersensitivity and caries-free teeth with exposed dentin	Evaluation after 2,8,12, and 24 weeks of usage.	1) Strontium chloride-based dentifrice. 2) A placebo	Tactile hypersensitivity score was assessed. Cold air blast hypersensitivity score was assessed.
4	D. D. Zinner, L. F. Duany, H J Lutz [25]	1977	176 subjects between the age of 18 to 63 years having dentinal hypersensitivity	Evaluation for 2 times in 6 weeks of usage.	1) 10% strontium chloride-based dentifrice. 2) 0.4%stannous fluoride-baseddentifrice. 3) 2%dibasic sodium citrate in a pluronic gel. 4) A pluronic gel	Hypersensitivity score was assessed.
5	G. Silverman et- al [31]	1996	230 subjects within the age of 39 to 43 years having dentinal hypersensitivity	Evaluation after 2,4 and 8 weeks of usage	1) 5%potassium nitrate; 0.243%sodium fluoride dentifrice. 2) 5%potassium nitrate; 10%strontium chloride-based dentifrice.	Tactile hypersensitivity score was assessed. Cold air blast hypersensitivity score was assessed.

Table 2
Characteristics of outcome

S.No.	Author	Year	Effect Measure	Result
1	LIu H, Hu D [32]	2012	Yeaple Probe to measure tactile hypersensitivity and the Schiff Cold Air Scale to measure the perception of pain from an air blast stimulus.	Dentifrice containing 2%strontium chloride and 5% potassium nitrate is effective in reducing dentinal hypersensitivity. (P<0.001)
2	D.G. Gillam, H.N. Newman, J.S. Bulman, E.H. Davies [33]	1992	Yeaple Probe to measure tactility, cold air (dental air syringe), and by subjective perception of pain by means of a Visual Analogue Scale.	Both the dentifrices reduce dentinal hypersensitivity irrespective of their abrasivity. (P<0.001)
3	Annett Kobler , Oliver Kub, Hans-Gunter Schaller, Christian R Gernhardt [30]	2008	Levels of hypersensitivity were assessed by cold air and tactile stimuli.	Strontium chloride reduces dentinal hypersensitivity when compared to other desensitizing agents. (P<0.001)
4	D. D. Zinner, L. F. Duany, H. J. Lutz [25]	1977	Hypersensitivity was determined by a light stroke of a dental explorer along with the cervical areas of all teeth present.	Pluronic gel with or without the presence of an active ingredient is more effective in reducing dentinal hypersensitivity as compared to strontium chloride. (P<0.07)
5	G. Silverman, E. Berman, C. B. Hanna, A. Salvato, P. Fratarcangelo, R. D. Bartizek, B. W. Bollmer, S. L. Campbell, A. C. Lanzalaco, B. J. Mackay, S. F. McClanahan, M. A. Perlich, J. B. Shaffer [31]	1996	Sensitivity to cold air and tactile stimulation, along with patients' subjective assessments are used to evaluate hypersensitivity.	Potassium nitrate dentifrice were found to be more effective than strontium chloride in treating dentinal hypersensitivity. (P<0.001)

Table 3
Characteristics of bias in different studies taken for review

S. No.	Author And Year	Random Sequence Generation	Allocation Concealment	Selective Reporting	Incomplete Outcome Data	Blinding of Outcome Assessment	Blinding Participants and Personals
1.	LIu H, Hu D [32]	–	+	+	_	+	+
2	D.G. Gillam, H.N. Newman, J.S. Bulman, E.H. Davies [33]	–	+	?	+	+	+
3	Annett Kobler , Oliver Kub, Hans-Gunter Schaller, Christian R Gernhardt [30]	–	+	+	_	+	+
4	D. D. Zinner, L. F. Duany, H. J. Lutz [25]	–	+	+	?	+	+
5	G. Silverman et al [31]	–	+	+	+	+	+

+ : Low risk of bias; - : High risk of bias; ? : unclear risk of bias

possible by compounds that do not contain desensitizing components [25]. Along with the usage of desensitizing toothpaste, the use of mouthwash and chewing gums containing potassium nitrate, sodium fluoride and potassium citrate are also considered to reduce dentinal hypersensitivity [26].

There are various treatment options available for reducing hypersensitivity pain. Patients can be provided with pharmacotherapy, or in office, treatment can also be given. There are various analgesics available to reduce hypersensitivity pain. Commonly available analgesics are Acetaminophen, NSAIDs, COX-2 NSAIDs, Opioids (tramadol), Benzodiazepines [27]. In office, treatment can also be done for treating dentinal hypersensitivity, the most common agent used is a bonding agent or varnish. Cervical restoration can also be done to reduce hypersensitivity [28].

Studies have shown that gingival recession followed by attrition is the most common factor associated with causing dental hypersensitivity. Erosion was also found to be associated with dental pain. Abrasion found in molars and premolars, abfraction seen in premolars were also seen to be associated with dental hypersensitivity. Treatment of patients with dentinal hypersensitivity due to these lesions was found to be difficult to treat [29].

In this systematic review, 5 studies have been taken into consideration for assessing the effectiveness of Strontium Chloride in treating dentinal hypersensitivity. Visual and comparative studies, along with utilizing scales such as tactile hypersensitivity and cold air blast test, were used in various studies for treating dentinal hypersensitivity.

In all the studies done, patients of specific age were selected and were randomly provided with the dentifrices to be tested and were asked to use them for a particular period of time. After a period of time of usage, they were assessed with a tactile hypersensitivity test and cold air blast score. In most of the studies done strontium chloride was found to be useful in reducing dentinal hypersensitivity. There were no adverse reactions seen in any patients [25], [30]-[33].

According to the studies done by Hongchun Liu et al. (2012), D.G. Gillam et al. (1992), Annett Kobler et al. (2008), it was found that strontium chloride is more efficient in reducing dentinal hypersensitivity. In the study done by D. D. Zinner et al. (1977), a new desensitizing agent pluronic F-127 with dibasic sodium citrate as its active ingredient was found to be more effective in treating dentinal hypersensitivity than strontium chloride. In the study done by G Silverman et al. (1996), potassium nitrate was found to be effective in treating dentinal hypersensitivity when compared to strontium chloride.

This study shows that the use of Strontium chloride has significant effect in treating dentinal hypersensitivity. Although there are newer conventional methods, the use of Strontium chloride can have a beneficial effect on treating dentinal hypersensitivity.

5. Conclusion

The study concluded that Strontium chloride, when used in a dentifrice, plays an important role in reducing hypersensitivity in the affected tooth. Strontium chloride is found to be very effective, and it works by blocking the dentinal tubules with strontium salts resulting in recrystallization in the form of strontium apatite crystals. The use of strontium chloride in the dentifrice is found to be safe and helps in reducing pain and discomfort in patients. However, there are some recent advances, such as pluronic F-127with dibasic sodium citrate and 5% potassium nitrate, which were found to be more effective in reducing hypersensitivity and pain when compared to strontium chloride.

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