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RESEARCH ARTICLE

SINGLE VS SEQUENTIAL DRILLING IN IMPLANTOLOGY: A SYSTEMATIC REVIEW

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Abstract

Background: Recent clinical protocols in implantology aim at shortening the treatment duration and reducing the trauma and discomfort of the surgical intervention, with good postoperative outcomes. The insertion of dental implants usually engages prior drilling procedures for making implant site. Conventionally, this drilling is done in a sequential way using gradual sizes of drills. However, sequential drilling may be timewasting and disagreeable for the patient (long intervention). Moreover, extended time of tissue exposure may be damaging for the healing response, and prolonging the exposure to the oral environment, which may produce infection. Currently, the clinical advances tend to simpler and minimally invasive procedures. In that respect, simplified drilling was proposed, which consists of minimizing the number of drills through the use of a pilot drill followed by a unique final drill or directly by using a single drill.

Purpose: The aim of this study is to compare, through a systematic review of the literature, the two procedures of drilling and conclude which can lead to a better cicatrization process.

Materials and method: A systematic review of the literature was conducted through the MEDLINE (PubMed) database between from "03/01/2009" to "03/01/2019". The following combination of MeSH terms was used in PubMed: "single drilling AND dental implant". Then a hand search was performed in Ebsco database. Two independent reviewers achieved the quality assessment of the articles retained and two other authors achieved screening, data abstraction and writing of the review.

Results: Most of the studies included in our review concluded no statistically significant differences between single and sequential drilling, and stated that both of them are viable options.

Conclusion: Within the limitations of our review, it can be concluded that implant placement using a single bur method, is a reliable technique allowing the same outcomes as the conventional approach. Additionally, it allows decreasing the treatment's cost and duration.

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Introduction:-

Implant rehabilitation in dentistry is nowadays a well-documented therapy with 10-year success rates of more than 98% (Buser and al. 2012, Gehrke and al 2018). Osseointegration, which is considered as a direct contact between

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the bone tissue and the implant without the presence of fibers, is the key of success of this type of treatment. The successful osseointegration of a dental implant depends on achieving a good primary stabilization to bone. The preservation of bone cell vitality is a crucial condition for its healing and maturation process, and for setting-up a stable bone-to-implant contact. However, bone cell vitality depends on the quantity of surgical trauma and the damage caused by the thermal rising.

The insertion of dental implants normally engages prior drilling procedures for making implant site. Conventionally, this drilling is done in a sequential way using gradual sizes of drills. However, sequential drilling may be timewasting and disagreeable for the patient (long intervention). Moreover, extended time of tissue exposure may be damaging the healing response and prolonging the exposure to the oral environment, which may produce infection. Nowadays, the clinical advances tend to simpler and minimally invasive procedures. In that respect, simplified drilling was proposed, which consists of minimizing the number of drills through the use of a pilot drill followed by a unique final drill or directly by using a single drill.

Our work means through a literature review, to identify the best implant placement procedure, by a single drilling or a gradual drilling method, and which one leads to a better cicatrization process.

Materials and Method:-

Systematic Search Strategy:

Before the beginning of the systematic literature search, the protocol was agreed by the authors. An electronic search was performed through MEDLINE database (PubMed) (<https://www.ncbi.nlm.nih.gov/pubmed>). We meant to include only articles published in English during the last 10 years from "03/01/2009" to "03/01/2019". The following combination of MeSH terms was used in PubMed: "single drilling AND dental implant". Then a hand search was performed in Ebsco database. Two independent reviewers achieved the quality assessment of the articles retained and two other authors achieved screening, data abstraction and writing of the review.

Inclusion criteria:

Articles were included if they met all the following inclusion criteria:

1. Articles in English
2. In vitro studies or RCT
3. The variables must be defined and measured appropriately
4. The study methods must be valid and reliable
5. There must be enough detail in order to replicate the study
6. The density of the bone, the speed of the drilling, and the implant type must be detailed
7. The time of implant placement and loading must be cited (post extractive or in a healed site).

Exclusion criteria:

Articles were excluded if they don't meet the above-mentioned inclusion criteria.

Two authors extracted the data, and if there was a disagreement, the study was checked and discussed until consensus was reached.

Results:-

The systematic review was conducted following the steps as seen in the flow chart below (Figure 1).

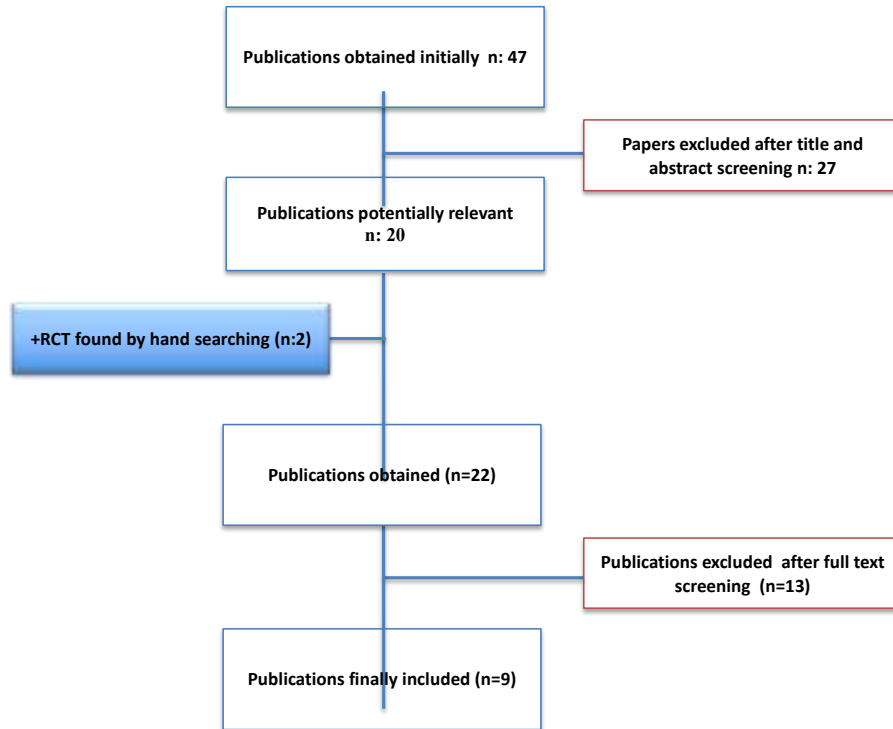


Figure 1:- Flow chart showing the articles selection process.

The data collected was categorized and was organized according to the “PICO” approach as seen in the table below.

Table 1:- Summary of all the included articles with their respective outcomes.

Authors	Year, type of study	Population	Intervention	Comparison of outcomes	Results
Mohlhenrich SC, et al	2016 In vitro study	Artificial bone blocks:solid rigid poly-urethane foam (SRPF) with different densities: (types I–IV; D1–D4)	-10 single (burA: Straumann, Basel, of 2.8 mm, 3.5 mm, and 4.2 mm) and 10gradual implant sites with diameters of 2.8, 3.5, and 4.2 mm were prepared in four artificial bone blocks - An infrared camera was used for temperature measurements (14-bit)	- With increasing drill diameter, the average temperatures were nearly the same for the respective surgical protocols. - Statistically significant differences between surgical techniques were found for the 2.8mm drill in D1 (P = 0.0014) and D4 (P <0.0001), the 3.5mm drill in D3 (P = 0.0087) and D4 (P <0.0001), and the 4.2-mm drill in D1 (P < 0.0001) and D4 (P = 0.0014)	A single-bur system could generate more heat than sequential drilling during implant site preparation in artificial bone types I and II. Therefore, bone density and drill diameter influence thermal increases. Particularly in lower density bone, conventional drilling leads to less temperature rising than sequential drilling Further in vivo studies will be helpful to determine whether these results can be transferred to humans, in order to establish the

					ideal drilling protocol.
Frösch L, and al	2018 in vitro study	Artificial bone blocks: polyurethane foam blocks	The four groups included single and sequential drilling with and without the use of a surgical guide -Temperature was measured with an infraredcamera	-Guided osteotomy preparation (GOP) showed statistically significant higher temperatures than conventional approach (CA): for the 2.2mm, the 3.5mm and the 4.2mm drill ($p=0.032$, $p=0.005$ and $p<0.001$, respectively) - Sequential drilling led to higher heat generation and longer duration of latent heat than single drilling.	When guided implant surgery is performed, a single drilling procedure could reduce heat production compared to a sequential procedure. Higher temperature changes were observed in GOP compared to CA, and in sequential compared to single drilling
Gehrke SA, and al	2018 in vitro study	Rabbit tibiae model	- using a single unique drill of 4.2mm conical implant, -using 3 consecutive cylindrical drills for a 4.1mm cylindrical implant -using 3 consecutive conical drills for a 4.3mm conical implant.	In the removal torque test, no significant difference was found between the 3 groups tested. Histomorphometric analysis showed no significant difference between groups in the bone-to-implant contact % ($p > 0.05$).	Osteotomy using a single bur did not show differences regarding the proposed and evaluated tests parameters for assessing the peri-implant behavior
R. A. Delgado-Ruiz and al	2017 in vitro study	10 bovine bone disks resembling type IV bone	- 600 implant site preparations were performed using three test slow drilling speeds (50/150/ 300 rpm) and a control drilling speed (1200 rpm). - 3 different drill designs with similar diameter and length	- Drilling at 50 rpm resulted in the lowest temperature increment (22.11 ± 0.8 °C) compared to the other slow drilling speeds of 150 (24.752 ± 1.1 °C) and 300 rpm (25.977 ± 1.2 °C) ($p < 0.042$). - Slow drilling speeds required significantly more time to finish the preparation of the implant bed shown as follows: 50 rpm > 150 rpm > 300 rpm > control ($p < 0.05$)	- When using a single-bur protocol with tapered and multistepedtwist drills, a slow drilling speed of 300 rpm in type IV bone density seems to be more efficient in terms of temperature increase and time reduction than using a single bur with a drilling speed of 50 rpm

Authors	Year	Population	Intervention	Comparison of outcomes	Results
Gehrke S.A and al	2015 In vitro study	-Tibiae of 12 rabbits	-48 conical implants, of standard surface type and design and manufactured by the same company, 2 test groups were prepared: in the control group was used a conventional drill sequence with several uses, in the test group (tesG) used a single-use final drill.	- Both groups exhibited new bone in quantity and in quality; however, the tesG exhibited a higher level of new bone deposition than the control group.	- The findings suggest that the use of a single-use final drill leads to better and faster organization of the cortical bone area during the evaluated period
Gehrke S.A and al	2016 In vitro study	Synthetic blocks of bone (type I density)	- Group G1 - drilling with a single bur for a 4.2 mm conical implant; Group G2 and Group G3 - drilling with three consecutive burs for a 4.1 mm cylindrical implant and for a 4.3 mm conical implant respectively. Drilling procedures were performed without irrigation.	- The single drill (group 1) achieved a significantly higher insertion torque value (ITV) and implant stability quotient (ISQ) than the multiple drills for osteotomy (groups 2 and 3)	- A single bur system achieves greater precision in the osteotomy than a conventional drilling sequence while preparing implant site and can be considered as safe as the latter. It may increase the torque of insertion and consequently the initial stability of implants.
Guazzi P and al	2015 RCT	40patients: 20 patients 1-drill group and 20patients: multiple-drill group.	- The implant site was prepared using a single drilling step with a newly designed tapered-cylinder drill (1-drill group) or a conventional procedure with multiple drills (multiple-drill group) - Implants were loaded after 3 months and followed up: 4 months after implant loading	- Implants in the (1-drill group) lost 0.54 mm of peri-implant bone versus 0.41 mm for the implants in the multiple-drill group. - Postoperatively, patients in the 1-drill group vs patients in the multiple-drill group reported statistically significant differences for pain level, number of days in which the swelling persisted and the number of analgesic drugs taken.	Both drilling techniques produced successful results over a 4-month post-loading follow-up period, but the single bur procedure required less surgical time and lead to less postoperative morbidity.
Marheineke N. and al	2017 In vitro	Osseous study model	- Six experimental groups were representing template-	Improved accuracy without template guidance was observed when experienced operators	- Single-step drilling protocols have

			guided and freehanded drilling actions in a stepwise drilling procedure in comparison to a single-drill protocol. -Each experimental condition was studied by the drilling actions of respectively three persons without surgical knowledge as well as three experienced oral surgeons.	were executing single-step versus multi-step technique.	shown to produce more accurate results than multi-step procedures. -The outcome of any protocol can be further improved by use of guiding templates
Bulloch S.E and al	2012 In vitro	Bovine femoral bone model	Drilling was performed at a constant speed (2,100 rpm) and pressure (2kg) under continuous room temperature irrigation. Infrared temperature measurements were taken immediately before and after drilling. The 6 study groups included standard sequential drilling protocols for 3.5 and 4.2mm final drills, and cannulated single drill technique for 3.5-mm and 4.2-mm drills.	No significant difference in thermal increase was found between single drill cannulated implant site preparation and sequential drilling with or without the use of a drill guide for the 3.5-mm or 4.2-mm drilling sequences, respectively	- Cannulated single drill technique does not cause an increase in bone temperature greater than that seen with standard sequential drilling with or without a surgical guide

Discussion:-

The results of our review revealed that there is large heterogeneity of methods of testing, protocols and also the materials tested (human bone, rabbit bone, bovine bone, Synthetic block, osseous study model) which make the comparison of the studies difficult.

It is known that the actual tendency in the dental field is to shorten the treatment duration and decrease the treatment costs. Single drilling allows to simplify the procedure of implant placement.

It has been shown to be a reliable method with no significant differences regarding the bone healing, complications, and patient's satisfaction, when compared to the conventional implant placement.

According to the study of Gehrke S.A and al 2018, the use of a single bur system achieves greater precision in the osteotomy than a conventional drilling sequence while preparing implant site and can be considered as safe as the latter. It may increase the torque of insertion and consequently the initial stability of the implants.

Many other studies agree with this finding: (Frösch L, and al 2018, Bettach R and al. 2018 Bulloch S.E and al 2012, Marheineke N. and al 2017)

Conversely, Mohlhenrich SC and al 2016, established that the single drilling procedure could generate more heat than traditional sequential drilling during implant bed preparation in artificial bone types I and II. Therefore, bone density and drill diameter influence thermal increases. Particularly in poorer density bone, conventional drilling seems to raise the temperature less. Nevertheless, since the study was conducted in a synthetic bone material, it is not identified if the results can be applied to humans.

Mohlhenrich SC and al 2016 also stated that bone density influences temperature development during implant bed preparation. In agreement with the results of Gehrke and al. 2015, no differences in heat generation were found between the two surgical protocols using each drill diameter in type II bone. However, it was found that with decreasing density, higher temperatures could be expected using the single drilling. Thus, it was found that in low-density synthetic bone, sequential implant site preparation generates less temperature, and in high-density bone, single drilling, especially small-diameter osteotomy, generates less temperature.

It is still crucial to emphasize on some precautions like the speed of drilling. Delgado-Ruiz and al. 2017 concluded that drilling at a slow speed of 50 rpm resulted in the lowest temperature increment (22.11 ± 0.8 °C) compared to the other drilling speeds of 150 (24.752 ± 1.1 °C) and 300 rpm (25.977 ± 1.2 °C) ($p < 0.042$).

Moreover, slow drilling speeds required significantly more time to finish the preparation of the implant bed shown as follows:

50 rpm > 150 rpm > 300 rpm > control (1200 rpm) ($p < 0.05$). According to that study, also the diameter and design of drills are significantly important. In fact, it has been shown that using a single-bur protocol with tapered and multisteped twist drills of 3.2 or 3.6mm, with a slow drilling speed of 300 rpm in type IV bone density seems to be more efficient in terms of temperature increase and time reduction.

According to the RCT of Guazzi and al in 2015, both drilling techniques produced successful results over a 4-month post-loading follow-up period, but the single bur procedure required less surgical time and lead to less postoperative morbidity which seems interesting regarding to patient satisfaction and comfort. This team emphasized also on the importance of using sharp drills with high rotation speed (1,500 rpm) in combination with a large applied force and a good irrigation mode, this allows a faster site preparation and a minimum increase of temperature in comparison to lower rotation speed and pressure. Conversely, the use of worn burs makes it difficult to create a breach into the bone, with a consequent prolonged tissue exposure to heat, which, in turn, increases the risk of bone necrosis.

Marheineke and al raised the concerns on the impossibility of adjusting the axis of implant site if using a single bur method, while that Multi-step drilling technique carries the option of detecting and adjusting the axis of misaligned implant sites in early stages. Which needs a steeper learning curve, even for experienced surgeons, and encourages the combination of surgical guidance and single-drill technique allowing a precise implant placement and minimizing the operative discomfort for the patient.

Additionally, Gehrke S.A and al 2018 investigated the bone behavior and the osseointegration of both systems and showed that a single drill system did not change the biomechanical and/or biological of peri-implant tissue response more than a conventional drilling sequence does, while preparing implant site, and indicated that this approach is as safe as the sequential one, and may also increase the torque of insertion and consequently the initial stability of the implants.

Frösch and al. 2018 investigated the temperature development during single and sequential drilling with a conventional and guided approach. Higher temperature changes were observed in guided osteotomy preparation (GOP) compared to conventional approach (CA), and in sequential compared to single drilling. This is in line with several other studies that suggest the greater heat generation with guided procedures is caused by the surgical guide avoiding the irrigation fluid from entering the drilling site (Dos Santos et al. 2014, Markovic et al. 2016, Migliorati et al. 2013, Misir et al. 2009). Drilling with a cooling canal in the guide was proposed by Liu et al. 2016 and has been shown to reduce the temperature increase. Freehand placement is a good alternative but leads operator to a bigger risk of error and misalignment.

R. Bettach and al. 2018 stated that single drilling even in the immediate postextractive sites, either functionalized immediately or in a delayed mode, can be a predictable solution for the rehabilitation of patients in need of tooth extraction.

Conclusion:-

Based on the findings and considering the limitations of our review, it can be concluded that implant placement using a single bur method, is a reliable technique allowing the same outcomes as the conventional approach. Additionally, it allows decreasing the treatment's cost and duration.

Competing interests:

The authors declare no competing interest.

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