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Conclusion: The acceptance of dental implants in the elderly population might be increased by providing further information and promoting oral health in general. Regardless of the age, dental implants should be placed when patients are still in good health and live independently.

Keywords: knowledge, attitude, age, risk factor analysis, dental implants.

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Introduction

In spite of progress in oral health promotion and restorative techniques, tooth loss is still a reality in old age, and there is widespread need for tooth replacement in the elderly population. However, the prevalence of dental implants in the elderly and especially in the very old and institutionalised population is low. According to the national health survey in Switzerland of 2002, 89.5% of the population between 65 and 74 years were rehabilitated with dental restorations, of those 13.1% with complete dentures. The prevalence of dental restorations increases with age and reaches 97.4% in the age group of 85 years and above. Nevertheless, the prevalence of dental implants in that representative population sample was lower than 1% in the patients with removable dentures. In Europe, the highest frequency of dental implants in the edentulous population was found in Sweden, but did still not exceed 8%.

Improvements in orofacial function with implant-supported dental reconstructions are largely documented, especially for edentulous subjects with upper complete dentures and lower implant-supported overdentures. Besides the protection of the peri-implant bone through reduced atrophy, they comprise increased biting force, larger chewing cycles, better coordination of the chewing sequence and improved masticatory efficiency and ability. Furthermore, the positive impact of supporting complete dentures with dental implants on oral health-related quality of life (OHRQoL) has been demonstrated.

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Nevertheless, a substantial number of patients are reluctant to receive implant treatment. In a Swedish study, cost was the main factor for refusing hypothetical implant treatment, followed by the fear of the surgical procedure. Even after removing the cost factor from the decision process through offering free implant treatment whilst recruiting for a study, Walton and MacEntee found 36% of their edentulous study sample refusing such therapy. This fact was mainly attributed to concerns about the surgical procedure. Furthermore, older patients seem to refuse implant treatment if they are satisfied with their conventional denture and at the same time they seem to tolerate poor dentures better than younger patients. In a more recent qualitative approach, fear of pain, complications and social embarrassment were revealed as factors explaining implant refusal by elderly patients.

Elderly persons' knowledge on dental implants is difficult to assess. Tepper et al. reported that only 4% of their representative population sample felt very well informed about dental implants, whereas 42% felt not at all informed. Main discriminating factors were the size of the hometown and level of education. About a third of their participants would be interested to receive more information about implant treatment and would prefer their dentist as source of information. A Norwegian study showed that advanced age, being women, a rural place of residence as well as low income and educational level predicted a negative opinion towards implant.

There is well-established evidence on implant survival as well as improvements in orofacial function with implant-supported overdentures. Therefore, elderly patients' refusal of an implant treatment remains intriguing. Identifying barriers could help to improve acceptance rates and understand patients' reluctance towards an implant treatment. The aim of the present study was therefore to evaluate the knowledge and awareness of dental implants in an elderly population and to identify barriers such as age, gender, general and oral health as well as life circumstances.

**Material and methods**

Approval from the University Hospital of Geneva Ethics committee was obtained (06-020/PSY 06-002).

**Study sample**

Participants were recruited from the Geriatric University Hospital of Geneva (HOGER), the residents of two long-term care facilities in the canton of Geneva (LTC) and community-dwelling patients from a private dental practice (DOM) in the Lake Geneva region, Switzerland. Inclusion required an age of 65 years or over; exclusion criteria were severe cognitive impairment, ongoing dental treatment or previous treatment with dental implants. The patients of HOGER and LTC were contacted by the nursing staff to participate. HOGER patients were hospitalised mostly for chronic diseases and expressed many co-morbidities; the average length of stay in HOGER was 48.8 days in 2008. Participants without current treatment from DOM were selected from the private practice's patient pool to fit the inclusion criteria. Written informed consent was obtained from all study participants.

**Dental state and general health**

A short clinical examination was performed. In denture wearers, the condition of removable prostheses was judged according to Marxkors as 'very good' (free of defaults), 'good' (minor default which requires chair-side correction), 'acceptable' (major defaults which can be corrected by dental technician) or 'poor' (denture should be renewed). Evaluations were made by two dentists (KS and CB). Further, participants were asked to judge their own oral health as 'satisfactory', 'better...', 'equal...', 'worse than the others of my age' or 'unsatisfactory' and indicate the number of drugs taken per day.

**Screening for cognitive impairment**

A clock-drawing test was used to screen for cognitive impairment. The task is to draw a clock on a sheet of paper with 12 numbers and two separate indicators. The drawing is evaluated according to the presence of the 12 numbers, to their correct positioning, to the existence of two separate indicators and to the correctness of time they display. Accordingly, a score from 0 to 4 is attributed. For the participation in this study, a minimum score of 2 had to be achieved (Fig. 1).

**Oral health-related quality of life (OHRQoL)**

The French version of a shortened Oral Health Impact Profile (OHIP-Edent) was used to evaluate the OHRQoL. The original 49-item OHIP was developed and validated by Slade and Spencer in 1994. The OHIP-Edent contains 20 items in
seven domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap), and subjects are asked how frequently they have experienced the event during the last month. Responses are given on a scale (0 – never, 1 – rarely, 2 – occasionally, 3 – frequently, 4 – very frequently, 5 – always). Thus, a higher OHIP score indicates a lower OHRQoL (range 0–100). Items that were not applicable were counted as zero, and no weighting of the items was performed.

Knowledge about dental implants

To evaluate the knowledge on dental implants, a semi-structured questionnaire was developed. If the participant had never heard about dental implants, it was briefly described that the interview dealt with artificial roots to replace missing teeth. Answers were graded as true or false, and the sum of correct answers from five questions was calculated further analysis. Then, a brief one-page information sheet was read out to the participants with basic information on the indication, clinical procedures, delays, risks and the success rates of a dental implant treatment.

Objection towards a hypothetical implant treatment

Subsequently, a second questionnaire with 10 pre-worded statements on the attitude towards a hypothetical implant treatment was developed based on the answers from a previously used open interview. The participant could agree or disagree to each statement on a 100-mm visual analogue scale (VAS) after a short training in the use the VAS. For analysis, the VAS scores in mm were added and expressed as percentages to objectify a possible objection towards implant treatment. Both newly developed questionnaires had previously been tested on six elderly volunteers (HOGER) for wording and comprehension, but no change was necessary. All interviews took place in a private and calm atmosphere, and the interviewer was always available for questions or assistance.

Statistical analysis

Data were analysed descriptively. In addition, differences between groups were tested using the non-parametric Mann–Whitney and Kruskal–Wallis tests for unpaired samples. Correlations were tested with Spearman’s rank correlation. A univariate and multiple linear regression (stepwise backward selection) models were used to predict factors for a negative attitude towards an implant treatment. The Stata Statistical Software, release 11.1, was used (Stata Corporation, College Station, TX, USA). The level of significance was set at 5% (p < 0.05).

Results

Study sample

Initially, 96 patients were recruited. One woman from HOGER and one from LTC had to be excluded because they failed the clock-drawing test. Two further participants were excluded because they had dental implants but were unaware of it. The final study sample comprised 92 persons, 61 women and 31 men with an average age of 81.2 ± 8.0 years (Table 1). Seventy-four of the participants wore removable prostheses, of which 39 were complete dentures. The condition of the prostheses was judged 29 times as ‘good’, 36 times as ‘acceptable’ and eight times as ‘poor’. Only one of the prostheses was graded ‘very good’. The number of drugs taken per day varied significantly between the three types of residence. Participants living at home took 3.3 ± 0.98, those from LTC 4.6 ± 1.13 and those from HOGER 4.9 ± 1.36 different drugs (p < 0.0001, Kruskal–Wallis). Of the 92 participants, 61 judged their oral health as ‘satisfactory’, nine as ‘better than others of my age’, 17 as ‘like others of my age’, four as ‘unsatisfactory’, and only one as ‘worse than others of my age’. The OHIP-20 sum score for all participants was 20.1 ± 11.54 (median 17.0, range 6–68). There was neither a difference in sum scores among different types of residence (n.s., Kruskal–Wallis) nor a correlation with age (Spearman’s correlation). However, there was a significant higher OHIP-20 score in the presence of removable prostheses [with
removable prostheses: $21.9 \pm 12.1$; without: $13.3 \pm 5.6$; $p = 0.002$ (Mann–Whitney), indicating a lower OHRQoL.

**Knowledge about dental implants**

The majority of participants had already heard of dental implants ($n = 65; 70.7\%$). These participants mentioned as source of their information their social environment ($n = 34$), their dentist ($n = 26$), written media ($n = 4$) and others ($n = 1$). No participant had heard about dental implants via the television. Thirty-four of the participants who knew implants had an acquaintance who had received implant treatment.

Those participants who had already heard about implants ($n = 65$) were asked to describe them. One-fifth ($n = 13$) stated that they could not describe an implant although they had heard about them; seven thought implants were a pin, 15 a nail and 30 a screw (Fig. 2).

With regard to the longevity of dental implants, five participants thought they are kept for life, 21 stated that they last up to 20 years, 12 said several years and 54 had no idea at all. Also, a variety of materials was proposed for dental implants (Fig. 3).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Gender, age and number of participants from the geriatric hospital (HOGER), a long-term care facility (LTC) and living freely at home (DOM).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean)</td>
<td>81.2</td>
</tr>
<tr>
<td>SD</td>
<td>8.0</td>
</tr>
<tr>
<td>Age (min)</td>
<td>65</td>
</tr>
<tr>
<td>Age (max)</td>
<td>102</td>
</tr>
<tr>
<td>N</td>
<td>92</td>
</tr>
</tbody>
</table>

When asked to specify how implants are anchored, 47 participants did not know; further answers were grafted ($n = 1$), glued ($n = 3$), planted ($n = 13$) and screwed ($n = 28$). For the osseointegration time, the majority of interviewees did not know or have never heard of it ($n = 77$), four assumed that implants integrated immediately to the bone, whereas 11 thought that the osseointegration took several months.

Of all participants, 63 believed that there is a risk of failure in implant treatment. From these, 27 could not specify what the risk was. Further 12 identified poor gums as failure risk, seven stated implants could be rejected by the body or there could be an allergic reaction, a further seven indicated that a failure would be the dentist’s fault, five attributed a potential failure to bad bone, two to advanced age and one participant each to poor general health, oral hygiene or implant material.

Less than half of the 92 participants were convinced that implants could improve their oral condition or dental appearance ($n = 36$ and $n = 39$, respectively). Slightly over half of the interviewees believed that there was an age limit for implants ($n = 49$). However, only 34 of the study sample could imagine having an implant themselves. Of the 52 who could not imagine
having implants, 13 thought they would be too old for such a treatment, 11 thought the treatment would be too expensive, ten did not see a need, eight would fear the surgical procedure, seven would fear the implant could be rejected, two would feel in bad general medical condition and one participant thought his life expectancy would be too short. Six patients could not specify why they could not imagine having an implant themselves.

Objection towards a hypothetical implant treatment

The agreement to the pre-worded statements regarding reasons for a hypothetical objection towards implant treatment revealed that cost was a predominant factor, followed by ‘I don’t see the need’, ‘I am too old’ and ‘it is not worthwhile’ (Fig. 4). These four main objections did not show a significant difference between men and women (Table 2). For the other six statements, women were significantly more worried than men, in particular regarding the ‘fear of the operation’ and the ‘quality of the bone’. The least concern was raised if acquaintances had bad experience with implants as well as the length of the integration period. There was no correlation between the attitude towards a hypothetical implant treatment and the OHIP-20 sum scores of the participants. The refusal rate varied significantly in relation to the type of residence. The strongest refusal was seen in hospitalised patients, followed by LTC and community-dwelling participants (0.01 < p < 0.05, Mann–Whitney and Kruskal–Wallis, Fig. 5).

Risk factors for an implant refusal

There was a linear and significant correlation between the VAS sum scores for the objection of a hypothetical implant treatment and the age of the participants ($p = 0.0002$, $\rho = 0.39$, Spearman regression analysis). Yet, this correlation exists no longer when the results are corrected for confounding factors.

Table 2 Attitude towards a hypothetical implant treatment. Agreement to 10 pre-worded statements using a visual analogue scale (0 = max disagreement, 100 = max agreement; Mann–Whitney test for unpaired samples).

<table>
<thead>
<tr>
<th>Reason</th>
<th>Women (% $n$ = 61)</th>
<th>Men (% $n$ = 31)</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would not be likely to benefit from dental implants as...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I find implants too expensive</td>
<td>65.1 ± 32.8</td>
<td>74.5 ± 25.0</td>
<td>n.s.</td>
</tr>
<tr>
<td>I don’t see the necessity</td>
<td>54.5 ± 43.9</td>
<td>64.2 ± 46.0</td>
<td>n.s.</td>
</tr>
<tr>
<td>I consider myself too old</td>
<td>52.0 ± 42.4</td>
<td>47.7 ± 43.9</td>
<td>n.s.</td>
</tr>
<tr>
<td>It is not worthwhile</td>
<td>38.5 ± 43.0</td>
<td>58.4 ± 46.4</td>
<td>n.s.</td>
</tr>
<tr>
<td>I am afraid of the surgery</td>
<td>52.7 ± 36.6</td>
<td>9.7 ± 13.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>My bone is of bad quality</td>
<td>31.5 ± 34.7</td>
<td>3.2 ± 6.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>I fear implant rejection</td>
<td>27.9 ± 30.1</td>
<td>6.1 ± 14.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>I fear a foreign body feeling</td>
<td>25.7 ± 30.8</td>
<td>9.0 ± 20.1</td>
<td>&lt;0.0004</td>
</tr>
<tr>
<td>the integration time seems too long</td>
<td>17.9 ± 27.1</td>
<td>6.5 ± 12.5</td>
<td>0.0247</td>
</tr>
<tr>
<td>I know persons with bad experience</td>
<td>12.3 ± 23.7</td>
<td>5.5 ± 17.0</td>
<td>0.0203</td>
</tr>
<tr>
<td>Total</td>
<td>37.8 ± 17.4</td>
<td>28.5 ± 12.8</td>
<td>0.0229</td>
</tr>
</tbody>
</table>

Simple linear regression was used to identify factors that influence the VAS sum score and thus a negative attitude of the participants towards an implant treatment. The age of the participant explained 14.3% of the objection's variance. The older the participant is, the stronger the objection to a hypothetical implant treatment ($p = 0.0002$). Also, the number of drugs taken per day was associated with 11.2% of the variance in rejection ($p = 0.001$). An inverse relationship was found regarding the knowledge about implants for which 11.8% of the objection can be predicted by knowledge of the participants ($p = 0.0008$), so the smaller the knowledge, the higher the rejection towards a hypothetical implant treatment. As a second negative factor, the condition of the prosthesis explained 8.0% of refusal ($p = 0.006$). The judgement of their own health was also associated with attitudes towards dental implants and bad self-judgement was associated with 4.4% of refusal, but that prediction was less reliable ($p = 0.045$).

After applying univariate linear regression models, a multiple model with stepwise backward variables selection identified the variables most significantly associated with the VAS sum score. This model did not include age and showed that 33.2% of refusal is explained by the following selected factors (female gender, type and condition of the prosthesis, knowledge about implants, being hospitalised).

In summary, according to the analysis, certain factors predict a significantly higher refusal:

1. Gender: women > men.
2. The type of removable dentures: temporary > definitive.
5. Place of residence: hospital > domiciliary or LTC.

After adjusting for confounding factors, age did not play a role in denial of a hypothetical implant treatment. The factor age is only indirectly linked via other factors. In this study sample, women were older than men ($p = 0.0260$, Mann–Whitney), denture wearers were older than non-denture wearers (n.s.), and the condition of the prosthesis was judged worse in older people ($p = 0.0004$, Kruskal–Wallis). In addition, participants living at home were significantly younger ($p < 0.0001$, Kruskal–Wallis). Furthermore, there was no correlation between knowledge about implants and age of the participant (n.s., Spearman’s non-parametric rank correlation n.s.).

Discussion

Critique of method

The study design has some inherent shortcomings, which have to be born in mind when interpreting the results. Firstly, the study sample was not representative of the population as participants of HOGER, LTC and DOM represented about one-third each. In contrast, only 5% of the Swiss population above the age of 65 years are institutionalised. Another shortcoming is the convenience sample. Although screening included dementia, it has to be born in mind that the reported sensitivity of the clock-drawing test is around 85% so that despite an additional consultation of the medical records, some participants might have a mild cognitive impairment. As for the interviews, a shortcoming is related to the two questionnaires that were developed for this study. They were tested beforehand on a small focus group but not validated in a large population sample.

Knowledge

In this study, 71% of the participants had already heard about dental implants, but a correct and detailed description remained a challenge for about two-thirds of interviewees. The high prevalence of ‘half-knowledge’ may be related to the source of information, which was in 37% the social environment. Only five of the participants had their information from the media, who are more likely to report on negative outcomes. About a third of...
the participants had received their knowledge from their dentist, so that one can assume they have received scientifically sound information. This percentage was substantially higher in an Austrian study, where 68% of the 1000 study participants had received information on implants from their dentist\textsuperscript{27}. In contrast, only 17% of 109 participants in an American study had been informed by their dentists on implants although a similar percentage had heard about implants as in the present study\textsuperscript{28}. These differences may be explained by differences in culture and health care systems. In Switzerland, the frequency of annual dental visits diminishes with age, which may be related to a shift in priorities but also to limited financial resources in the elderly population. The Austrian cohort was not only larger, but clearly younger and not institutionalised so that a more frequent contact with the dental profession could be assumed. The low awareness of implants in the US study from Zimmer and co-workers\textsuperscript{28} might be time-related as this paper was published in 1992, and the attention paid to implantology has dramatically risen in the last two decades. In addition, health insurance is not compulsory in the United States so that financial restrictions might have limited the contact with dental professionals. When interpreting the low prevalence of knowledge, it needs to be borne in mind that not all patients are aware of the dental treatment they receive, and it remains unclear whether this is a lack of information from the operator, poor communication, cognitive impairment or simply a lack of interest. For example, two patients in the present study were post hoc excluded because they did not know that they already had implants. Another potential explanation for the little information patients receive from their dentists might be that there is no indication for implant placement, hence no need to inform the patient. In the last decades, teeth tend to be retained for longer and prostheses placed only later in life\textsuperscript{29}. However, data on the prevalence of missing teeth suggest still more than a third of the 80-year-old population is in need of tooth replacement. A recent Swiss health survey revealed that 70% of the 75- to 84-year-old population reported wearing removable dentures, and at 85 years or above, 37% of the population were edentulous\textsuperscript{4}. Thus, the numbers suggest that more patients could benefit from dental implants and its low prevalence in the elderly population might be attributed to non-identified barriers.

The high prevalence of ‘layman-knowledge’ was equally reported in the Austrian study\textsuperscript{27}, where only 20% of the sample answered spontaneously that ‘implants are a possibility to replace missing teeth’, while 72% had claimed to have heard about dental implants when prompted. Whereas it is less relevant if a patient knows technical details like the material and osseointegration time, it seems important for the acceptance of such treatment that they are informed on the potential risks of failure. From the two-thirds of participants who stated there was a failure risk, less than half could specify what it would be. Suggested failure reasons such as poor gums, allergic reactions, bad bone, poor general health or age suggest that failure is perceived rather as a fate, which could not be influenced. Few participants blamed the healthcare provider or the material for a potential failure. Only one participant saw the responsibility for a failure in the patient’s behaviour as he stated oral hygiene as a risk factor. The latter was cited more often in other, much younger study samples as a risk factor\textsuperscript{27}. Interestingly, in the open question on causes for implant failure, none of the participants mentioned smoking. More than half of the participants assume there is an age limit for receiving implant treatment; therefore, it seems plausible that age is mentioned frequently as a reason for objection towards such treatment\textsuperscript{30}. However, there is no scientific evidence supporting age as contraindication for an implant treatment\textsuperscript{31}.

**Attitude**

Of the 92 participants, slightly over a third could imagine receiving an implant treatment themselves. When compared with similar studies on younger cohorts\textsuperscript{30}, the acceptance rate is much lower in the present elderly cohort. Berge\textsuperscript{18} stated that 57% of the Norwegian participants would accept an implant treatment, while 23% would not. In Tepper’s Austrian study\textsuperscript{27}, even 61% of those who knew implant would accept such treatment. Finally, the US study of Zimmer and co-workers\textsuperscript{28} reported that of 84 participants who know about dental implants, 51 would accept the possibility of such treatment, 17 would refuse and 16 did not know. They also reported a clear correlation between age and implant acceptance. It is important to bear in mind that questionnaire-based findings do not necessarily reflect a clinical situation. In the present study, the participants judged on a situation that may have not yet or will never arrive. Even then, a third of edentulous patients who have had the experience of functional impairment with complete dentures refused implants within the context of a Canadian RCT on one or two implant-supported lower overdentures\textsuperscript{13}. In a survey by Salonen\textsuperscript{15}, 85% of edentu-
lous patients experiencing functional stability problems with their recently renewed complete dentures were not interested in implant-retained overdentures. Whereas participation in Walton and MacEntee’s study was mainly motivated by improvement in function, refusal was most frequently related to the surgical risk or the lack of necessity. Surely, the objection to implant treatment is multifactorial. Elderly patients often weigh decisions against their remaining life expectancy and consider it not worthwhile to invest time, effort and money on sophisticated dental treatments. In the present study, participants mentioned costs, lack of perceived need or simply feeling too old as main objections. These have changed remarkably little over the years. Other preoccupations such as fear of surgery, fear of having a bone of poor quality or fear of rejection were significantly higher concerns in the female participants. It is true that women have a higher prevalence of osteoporosis, which may explain their reluctance. However, do women really fear more the operation than men or are they simply more openly admitting it? Most participants stated finding an implant treatment to expensive. But even when cost was removed in the above-mentioned Canadian Study, the refusal rate was high.

The multiple linear regression model with stepwise backward variables selection identified predictors for implant refusal and age as such was not amongst them. At first, this seemed surprising, as a simple linear regression showed a close correlation between age and the refusal sum score. Age was also previously reported to influence the patients’ attitude towards implants. Several other parameters such as gender, place of residence, the presence and condition of a removable denture as well as little knowledge about implant treatment were identified as significant predictors. Thus, age only indirectly predicted a negative attitude as it is inevitably linked to other factors predicting refusal such as reduced general health and loss of autonomy. The model further revealed poor condition of the denture as a predictor for a negative attitude towards implants. Palmqvist et al. confirmed that subjects with the best dental conditions showed the highest subjective need for implant treatment, and those with the poorest conditions claimed the least interest. Such findings reflect the known pattern of uptake of dental services, which is less frequent in persons with a poor dental state. The importance attributed to the own oral health and oral functioning may go along with a more open-minded approach towards proposed dental interventions.

Another predictor for a negative attitude was knowledge of implants. It seems somewhat intuitive that an unknown treatment modality elicits less support than a well-known one. Nevertheless, there seems to be a socio-demographic coincidence as Berge reported persons with a high education as being more open to an oral implant treatment. Last but not least, the refusal rate can significantly be predicted by the type of residence (HOGER, EMS, and DOM), which reflects the participants’ general health state as well as their degree of dependency. Again, this finding is intuitive, as with decreasing health and autonomy priorities change and a poor oral health condition may be overshadowed by multiple other health problems.

Summary and conclusions

In the elderly population, knowledge of dental implants is limited and the rate of objection towards an implant treatment is high. Cost, psychological reasons and the surgical intervention were the strongest objections. Univariate and multiple linear regression analysis identified being a woman, wearing a poor denture, having little knowledge of implants and being hospitalised as the main predictors for refusing implants. However, old age as such was not associated with a negative attitude.

In conclusion, the acceptance of dental implants in the elderly population might be increased by providing further information and promoting oral health in general. Less-invasive operation techniques should be developed. Regardless of age, dental implants should be placed when patients are still in good health and live independently so that they can benefit from the functional advantages until late in life.

References


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